United States Department of Agriculture

Spruce Beetle Epidemic and Aspen Decline Management Response

Final Environmental Impact Statement

Forest Service

Grand Mesa, Uncompahgre, and Gunnison National Forests

May 2016

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer and lender.

Commonly Used Acronyms and Abbreviations

BA - Basal Area
BF - Board Foot
BMP - Best Management Practices
CCF - Cubic Hundred Feet
CEQ - Council on Environmental Quality
CF - Cubic Feet
CFR - Code of Federal Regulations
CMAI - Culmination of Mean Annual Increment
CWD - Coarse Woody Debris
DBH - Diameter Breast Height
DEIS - Draft Environmental Impact Statement
DHC – Dense Horizontal Cover
EIS - Environmental Impact Statement
EPA - Environmental Protection Agency
ESA – Endangered Species Act
FEIS - Final Environmental Impact Statement
FRCC - Fire Regime Condition Class
FS - Forest Service
FSH - Forest Service Handbook
FSM - Forest Service Manual
GA – Geographic Area
GHG - Greenhouse Gas
GIS - Geographic Information System
GMUG – Grand Mesa, Uncompahgre, and Gunnison National Forests
GPS - Global Positioning System
HUC12 – Hydrologic Unit Code 12 (subwatershed)
IDT - Interdisciplinary Team
MA - Management Area
MBF - Thousand Board Feet
MIS - Management Indicator Species
MMBF - Million Board Feet
MVUM - Motorized Vehicle Use Map
NEPA - National Environmental Policy Act
NFMA - National Forest Management Act
NFS - National Forest System
NFSR - National Forest System Road
OHV - Off Highway Vehicle
PTA – Priority Treatment Area
ROD - Record of Decision
SAD - Sudden Aspen Decline
SBEADMR – Spruce Beetle Epidemic and Aspen Decline Management Response
S&G - Standard(s) and Guideline(s)
SHPO - State Historic Preservation Officer
T&E - Threatened and Endangered
TMP - Travel Management Plan
TSI - Timber Stand Improvement
USDA - United States Department of Agriculture
USFWS - United States Fish and Wildlife Service
WUI - Wildland-Urban Interface

(This page intentionally blank)

SPRUCE BEETLE EPIDEMIC AND ASPEN DECLINE MANAGEMENT RESPONSE

Final Environmental Impact Statement

Delta County, Colorado

Lead Agency: **USDA Forest Service**

Responsible Official: **Scott Armentrout, Forest Supervisor**
2250 Highway 50, Delta, CO 81416

For Information Contact: **Samantha Staley**
970-874-6666
samanthajstaley@fs.fed.us

Abstract: The Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG) have prepared a Final Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. Due to the ongoing spruce beetle epidemic and sudden aspen decline that is occurring across a broad landscape on the GMUG Forests, the GMUG proposes the Spruce Beetle Epidemic and Aspen Decline Management Response (SBEADMR) to adaptively implement vegetation management actions. The purpose and need is informed by the Western Bark Beetle Strategy (USDA 2011i) and guided by the GMUG National Forest Land and Resource Management Plan (Forest Plan), the National Cohesive Wildland Fire Management Strategy (USDA & USDI 2014), and other national-level policy and guidance. The focus of the proposed action is to actively manage spruce-fir and aspen vegetation to reduce hazards to the public and infrastructure, salvage dead and dying timber, reestablish forest cover and increase resiliency in green stands. Alternative 1 is the No Action Alternative. This alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. It assumes no implementation of any elements of the proposed action or other action alternatives. Alternative 2 is the Agency Preferred Action. This alternative uses an adaptive implementation approach to implement vegetation management activities across the landscape. Spruce stands with lower mortality would be partially harvested using uneven-aged management to increase spruce-fir resiliency. Both live green trees and pockets of dead and dying trees would be removed. In areas with higher overstory mortality, the amount of salvage harvest would increase. Aspen stands affected by sudden aspen decline would be prioritized for treatment with coppice cuts and/or prescribed fire, though selected aspen stands not currently affected would also be treated to increase resiliency. Alternative 3 focuses all proposed activities within the identified wildland urban interface (WUI) and roadside corridors. This Final EIS discloses the direct, indirect, and cumulative environmental impacts resulting from the action alternatives.

Objection Process

This proposed decision is subject to pre-decisional objection process pursuant to 36 CFR 218, Subparts A and B. Objections will only be accepted from those who submitted project specific written comments during the scoping period (August 2, 2013 to September 1, 2013) or Draft Environmental Impact Statement comment period (May 29, 2015-July 31,2015). Issues raised in objections must be based on previously submitted comments unless based on new information arising after the designated comment periods.

Objections must be submitted within 45 days following the publication of the opportunity to object legal notice in the Grand Junction *Daily Sentinel*, which is the exclusive means for calculating the time to file an objection. Those wishing to object should not rely upon dates or timeframes provided by any other source. It is the objector's responsibility to ensure evidence of timely receipt (36 CFR 218.9). The regulations prohibit extending the time to file an objection.

Objections, including attachments, must be filed via mail, fax, email, hand-delivery, express delivery, or messenger service (Monday through Friday, 8:00 a.m. to 4:30 p.m., excluding holidays) to: Reviewing Officer c/o USDA Forest Service, Region 2, Rocky Mountain Region, Attn: Objection Reviewing Officer – Planning Department, 740 Simms, Golden, CO 80401; FAX: (303) 275-5134, or email r02admin_review@fs.fed.us.

Submit electronic objections, in common (.doc, .pdf, .rtf, .txt) formats, with Subject: SBEADMR FEIS. Objections must include (36 CFR 218.8(d)): 1) name, address and telephone; 2) signature or other verification of authorship; 3) identify a single lead objector when applicable; 4) project name, Responsible Official name and title, and name of affected National Forest and/or Ranger Districts; 5) reasons for, and suggested remedies to resolve, your objections; and, 6) description of the connection between your objections and your prior comments. Incorporate documents by reference only as provided for at 36 CFR 218.8(b).

During the resolution of objections and prior to the issuance of the reviewing officer's written response, either the Reviewing Officer or the Objector may request to meet to discuss issues raised in the objection and potential resolution. Meetings, if held, are not required to be noticed but are open to attendance by the public, and the reviewing officer will determine whether those other than objectors may participate (36 CFR 218.11). Those without objections to the Draft Decision but wishing to participate in resolution of objections for the Final Decision should submit their request to do so to the reviewing officer: Reviewing Officer c/o USDA Forest Service, Region 2, Rocky Mountain Region, Attn: Objection Reviewing Officer – Planning Department, 740 Simms, Golden, CO 80401; FAX: (303) 275-5134, or email r02admin_review@fs.fed.us.

SUMMARY

The Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG) propose to implement multiple vegetation management actions within the Spruce Beetle Epidemic and Aspen Decline Management Response (SBEADMR) project. This proposal is guided by the Ecological Restoration and Resilience Policy (FSM 2020), the GMUG National Forest Land and Resource Management Plan (Forest Plan), the National Cohesive Wildland Fire Management Strategy (USDA & USDI 2014), and it is adapted from the Western Bark Beetle Strategy (USDA 2011i).

The SBEADMR project proposes to treat spruce and aspen forests impacted by the ongoing spruce beetle epidemic and by sudden aspen decline (SAD), as well as those areas that are considered high risk for spruce beetle or SAD across the GMUG National Forests. The GMUG contains approximately 223,000 cumulative acres of spruce beetle mortality and 229,000 acres of affected aspen accumulated over the past decade, which corresponds to approximately 30% of the spruce-fir and aspen vegetation on the Forests. While insects and disease naturally occur in these ecosystems, prolonged drought and unusually high temperatures exacerbated these disturbances. The rate of change in tree mortality is extensive, and both the bark beetle infestation and SAD outbreak are likely to continue for several more years. The implications of these continued conditions include increased high mortality in spruce-dominated stands, decline of aspen stands, risk to the public and infrastructure from hazard trees, and changes in plant community and vegetation structure over time. Given the substantial mortality of spruce-fir and aspen forests on the GMUG over the past decade, and current Forest Plan direction, the need for the project is to manage forest vegetation to bring current and foreseeable conditions closer to desired conditions on landscapes available for active management. Furthermore, in the context of a changing climate conducive to more frequent and extensive wildfires in forests at high elevation *irrespective of tree condition* (Westerling et al. 2006, Agee 2007; Funk 2012; Rangwala and Rondeau), desired conditions for fire and fuels management include more locations across the landscape from which firefighters can safely and effectively manage or suppress fires for values at risk and/or resource benefit.

The purpose of the project is to reduce the safety threats of falling, dead trees and of managing wildfires in affected stands; treat affected stands via recovery of salvageable timber and subsequent re-establishment of desired forest conditions; and improve the resiliency of stands at-risk of insect and disease. In spruce stands, improved resiliency would be achieved via increasing diversity of age class and tree species. In aspen stands, resiliency treatments would be implemented to promote regeneration prior to full-stand mortality.

A maximum of 120,000 acres of National Forest System (NFS) lands –60,000 of commercial treatment and 60,000 of noncommercial treatment—within the GMUG are proposed under both action alternatives in this DEIS for treatments over an approximately 8-12 year implementation timeframe.

Comments on the proposed action, potential concerns, and opportunities for managing the SBEADMR project were solicited through varied public involvement and collaboration efforts. Those solicited for input included Forest Service resource specialists, tribal representatives, members of the public, other public agencies, adjacent property owners, and organizations. Methods used to request comments included: Publishing a Notice of Intent (NOI) in the Federal Register to prepare this Environmental Impact Statement (EIS); mailing a scoping letter that solicited comments to approximately 1,300 interested parties; conducting public meetings prior to and throughout the two-year planning process; publishing a Notice of Availability (NOA) in the Federal Register of the Draft EIS; mailing and e-mailing notice letters of the Draft EIS comment period to approximately 2,100 interested parties; and meetings with interested parties and individuals.

Comments received during scoping were used to help define issues, develop alternatives and mitigation measures, and analyze effects. Through review and analysis of the scoping comments, the Interdisciplinary Team (IDT) identified four substantial issues: (1) impacts from roads, (2) efficacy of resiliency treatments, (3) socioeconomic impacts to local communities, and (4) restricting treatments to address only public safety.

To address the issues, the IDT developed action alternatives, design features common to all action alternatives, and/or completed more analysis of the particular effect. The alternatives analyzed in detail in the Final EIS are briefly described as follows:

Alternative 1: No Action – The National Environmental Policy Act (NEPA) requires the study of the No Action Alternative and to use it as a basis for comparing the effects of the Proposed Action and other alternatives. This alternative assumes no implementation of the proposed action or any of the alternatives within the project area. Vegetation management would not take place unless authorized by other decisions. Vegetation structure would change over time through natural growth and mortality and events such as wildfires, storms, and insect or disease outbreaks. Under the No Action alternative, current management plans would continue to guide management of the project area. Routine activities not tied to this analysis such as scheduled road maintenance, treatment of noxious weeds, and fire suppression would also continue.

Actions Common to All Action Alternatives

Each action alternative proposed adaptive management implementation of a suite of treatments to address the effects of the spruce beetle epidemic and sudden aspen decline and promote resiliency to future insect outbreaks and disease.

Treatment methods used would consist of: 1) commercial mechanical treatment, which is ground-based mechanized timber cutting that produces a commercial product; SBEAMDR limits such to lands suitable for timber harvest; 2) non-commercial mechanical treatment, which is ground-based mechanized timber cutting that does not produce a commercial product, and includes use of mechanized equipment for tree cutting, mastication, and hand treatments using chainsaws; and 3) prescribed burning, which includes broadcast burning and pile burning. Both action alternatives

would use existing roads where possible and include some amount of road construction; all new roads would be decommissioned following project implementation.

The maximum total acres proposed for treatment is the same for both action alternatives, with 120,000 acres proposed for treatment across the life of this project. Approximately 4,000-6,000 acres of commercial harvest would be treated annually, and approximately 3,000-6,000 acres of non-commercial mechanical or prescribed burning treatments would be treated annually over the life of the project. While the maximum proposed treatment is the same, the *areas* where these treatments would be implemented differ by alternative.

Continued public participation during project implementation is a critical aspect of both action alternatives, and it is integrated into the adaptive implementation strategy.

Alternative 2: Agency Preferred Action – Alternative 2 analyzes 207,615 acres of potential disturbance acres. 190,014 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 17,388 acres as potential hazard tree treatments outside of PTAs, and 213 acres as potential new road disturbance outside of PTAs. Both PTAs and potential hazard tree treatments are located in spruce, aspen, and aspen-mix cover types. Of the PTA acres, approximately 59% (112,768 acres) are identified as commercially suitable timber acres, and 41% (77,246 acres) are identified for noncommercial treatment.

Alternative 3: Wildland Urban Interface (WUI) Focus – Alternative 3 shifts the geographic extent of treatments exclusively to 1) the wildland urban interface (WUI) and 2) outside the WUI, proximal to roads and additional human infrastructure. This alternative was developed to address public comments that proposed that treatments focus on public safety objectives.

The total area analyzed in Alternative 3 encompasses 127,023 acres. 102,159 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 24,695 acres as potential hazard tree treatments outside of PTAs, and 169 acres as potential new road disturbance outside of PTAs. Of the PTA acres, approximately 45% (45,967) are identified as commercially suitable timber acres, and 55% (56,192) are identified for noncommercial treatment. Both noncommercial and commercial PTAs in Alternative 3 total less than 60,000 acres, so treatments of hazard trees may or may not make up the difference. Depending on the extent of hazard trees within the identified roadside corridors over the life of the project, fewer total acres may be treated in Alternative 3, ranging from ~46,000-60,000 acres commercially to 56,192-60,000 acres noncommercially.

All treatment types and methods would remain the same as in Alternative 2.

Chapter 1 of this EIS identifies the purpose and need for the proposed actions as well as related National and Forest-level policy and direction. Given this purpose and need, the Deciding Official (Forest Supervisor) reviews the project record and analysis, the proposed action, issues identified during scoping, the alternatives, and the environmental consequences of implementing the proposed

action and alternatives disclosed in this EIS. This forms the basis for the Deciding Official to make the following determinations:

- Whether or not the proposed action, alternatives, and effects analysis address the issues, are responsive to National policy/guidance/law and Forest Plan direction, and meet the purpose of and need for action described in the SBEADMR EIS;
- Whether or not the information in this analysis is sufficient to implement the proposed activities;
- Which actions, if any, to approve.

Table of Contents

Summary v

Chapter 1. Purpose and Need for Action 1

Document Structure 1

Background 2

Spruce 3

Aspen 10

Project Area 18

Purpose and Need for Action 20

Proposed Action 21

Management Direction and Strategies 21

National Policy and Direction 22

National Strategy 23

Forest Plan 23

Decision Framework 26

Public Participation 26

Issues 30

Issue 1. Roads 31

Issue 2. Effectiveness of Resiliency Treatments and the Need for Treatment 31

Issue 3. Expanded Treatments to Provide Socioeconomic Benefits 32

Issue 4. Treat Only for Human Health and Safety Purposes 33

Other Related Efforts 33

Chapter 2. Alternatives, Including the proposed action 35

Introduction 35

Changes between the Draft and Final EIS 35

Alternatives Considered in Detail 36

Alternative 1 (No Action Alternative) 37

Activities Common to All Action Alternatives 37

Alternative 2 (Agency Preferred Action) 54

Alternative 3 (WUI Focus Alternative) 58

Summary of Alternatives 62

Alternatives Considered but Eliminated from Detailed Study 66
Comparison of Alternatives 69
Chapter 3. Affected Environment and Environmental Consequences 76
Changes between Draft and Final EIS 76
Introduction 78
Geographic Areas - Grand Mesa 79
Gunnison Basin North & South 81
North Fork Valley 82
San Juan 84
Uncompahgre Plateau 85
Physical Environment 87
Watershed and Soil Resources 87
Transportation 198
Air Quality 215
Fire and Fuels 273
Biological Environment 340
Compliance with Regulatory Direction 340
Botany 341
Noxious and Invasive Weeds 375
Range 400
Silviculture 402
Wildlife 460
Social Environment 687
Cultural 687
Economics 697
Recreation Use 724
Scenic Quality and Visual Resources 746
Cumulative Effects – Actions Considered & Analysis Approach 755
Short-term Uses and Long-term Productivity 759
Unavoidable Adverse Effects 760
Irreversible and Irretrievable Commitments of Resources 760
Other Required Disclosures 761

Chapter 4. List of Preparers, Consultation and Coordination **763**

A. PREPARERS 763

B. GOVERNMENT AGENCIES AND TRIBAL GOVERNMENTS CONTACTED 764

Index **769**

Glossary **773**

Bibliography / References **787**

List of Tables

Table 1. Spruce-Fir Vegetation Characterization for the GMUG by Geographic Area, 2006. 4
Table 2. Succession (Seral Stages) in Spruce-fir and Spruce-fir Aspen PNV Types by GA, 2006. 5
Table 3. Current Aspen Vegetation Characterization for GMUG by Geographic Area, 2006..... 12
Table 4. Succession (Seral Stages) in Aspen PNV Types by GA, 2006. 13
Table 5. Management Area Summary by Action Alternative. 24
Table 6. Decision-Making Triggers for Adaptive Implementation in SBEADMR..... 44
Table 7. Alternative 2: Summary of Analysis Acres 55
Table 8. Alternative 2: Summary of Analysis Acres by Geographic Area & Activity Type. 56
Table 9. Alternative 2: Cover Type by PTA Treatment Category..... 57
Table 10. Alternative 2 Maximum Road Treatments 58
Table 11. Alternative 3: Summary of Analysis Acres 59
Table 12. Alternative 3: Summary of Analysis Acres by Geographic Area & Activity Type. 60
Table 13. Alternative 3: Cover Type by PTA Treatment Category..... 61
Table 14. Alternative 3 Maximum Road Treatments 62
Table 15. Summary of Alternatives. 62
Table 16. Comparison of Environmental Consequences of Alternatives. 69
Table 17. Indicators in each Watershed Condition Class Process Category 91
Table 18. Wetlands, Fens and Riparian Areas within the GMUG..... 97
Table 19. Minimum Horizontal Width of Water Influence Zones (WIZ). 97
Table 20. Watershed Condition Class and Source Water Areas in Grand Mesa Watersheds 102
Table 21. Streams in Grand Mesa Watersheds. 103

Table 22. Summary of "Aquatic Habitat Condition" Indicator for Grand Mesa Watersheds. 103
Table 23. 303(d) Listed Impaired Waterbodies in Grand Mesa Watersheds. 104
Table 24. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Grand Mesa Watersheds. 105
Table 25. Acres of Wetlands that Intersect or are Near an Identified SBEADMR Treatment Area by Alternative in Grand Mesa Watersheds. 105
Table 26. Summary of "Soils Condition" Indicator for Grand Mesa Watersheds..... 106
Table 27.Watershed Condition Class and Source Water Areas in Gunnison Basin North Watersheds. 106
Table 28. Streams in Gunnison Basin North Watersheds. 108
Table 29. Summary of "Aquatic Habitat Condition" Indicator for Gunnison Basin North Watersheds.109
Table 30. 303(d) Listed Impaired Waterbodies in Gunnison Basin North Watersheds. 109
Table 31. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin North Watersheds..... 111
Table 32. Acres of Wetlands That Intersect or Are Near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin North Watersheds..... 111
Table 33. Summary of "Soils Condition" Indicator for Gunnison Basin North Watersheds. 112
Table 34. Watershed Condition Class and Source Water Areas in Gunnison Basin South Watersheds.112
Table 35. Streams in Gunnison Basin South Watersheds. 114
Table 36. Summary of "Aquatic Habitat Condition" Indicator for Gunnison Basin South Watersheds.114
Table 37. 303(d) Listed Impaired Waterbodies in Gunnison Basin South Watersheds. 115
Table 38. Acres of Fens that Intersect or are near an identified SBEADMR Treatment Area by Alternative in Gunnison Basin South Watersheds..... 116
Table 39. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin South Watersheds..... 116
Table 40. Summary of "Soils Condition" Indicator for Gunnison Basin South Watersheds 117
Table 41. Watershed Condition Class and Source Water Areas in North Fork Valley Watersheds 117
Table 42. Streams in North Fork Valley Watersheds. 118
Table 43. Summary of "Aquatic Habitat Condition" Indicator for North Fork Valley Watersheds. 119
Table 44. 303(d) Listed Impaired Waterbodies in North Fork Valley Watersheds. 119
Table 45. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in North Fork Valley Watersheds. 120
Table 46. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in North Fork Valley Watersheds. 120
Table 47. Summary of "Soils Condition" Indicator for North Fork Valley Watersheds. 121
Table 48. Watershed Condition Class and Source Water Areas in San Juans Watersheds. 121

Table 49. Streams in San Juans Watersheds. 122
Table 50. Summary of "Aquatic Habitat Condition" Indicator for San Juans Watersheds. 123
Table 51. 303(d) Listed Impaired Waterbodies in San Juans Watersheds. 123
Table 52. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in San Juans Watersheds. 124
Table 53. Acres of Wetlands that Intersect or are near an SBEADMR Potential Treatment Area by Alternative – San Juans Watersheds 125
Table 54. Summary of "Soils Condition" Indicator for San Juans Watersheds. 125
Table 55. Watershed Condition Class and Source Water Areas in Uncompahgre Plateau Watersheds. 126
Table 56. Streams in Uncompahgre Plateau Watersheds. 127
Table 57. Summary of "Aquatic Habitat Condition" Indicator for Uncompahgre Plateau Watersheds. 128
Table 58. 303(d) Listed Impaired Waterbodies in Uncompahgre Plateau Watersheds. 128
Table 59. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Uncompahgre Plateau Watersheds. 129
Table 60. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Uncompahgre Plateau Watersheds. 129
Table 61. Summary of "Soils Condition" Indicator for Uncompahgre Plateau Watersheds. 130
Table 62. Design Features for Water and Soil Resources. 133
Table 63. Number of New Road/Stream Crossings Constructed in Each Geographic Area. 144
Table 64. Miles of New Road Constructed in the WIZ in each Geographic Area. 146
Table 65. Borderline Watersheds in Grand Mesa Geographic Area. 154
Table 66. Alternative 2 New Crossings and Road in the WIZ in Grand Mesa Watersheds. 155
Table 67. Acres of Commercial Treatments in Grand Mesa Watersheds. 156
Table 68. Fens and Wetlands in or near Alternative 2 Treatment Areas in Grand Mesa Watersheds ... 157
Table 69. Borderline Watersheds in Gunnison Basin North Geographic Area. 158
Table 70. Riparian Vegetation and New Road Construction in Borderline Watersheds in Gunnison Basin North Geographic Area. 158
Table 71. Alternative 2 New Crossings and Road in the WIZ in Gunnison Basin North Watersheds... 160
Table 72. Acres of Commercial Treatments in Gunnison Basin North Watersheds. 161
Table 73. Fens and Wetlands in or near Alternative 2 Treatment Areas in Gunnison Basin North Watersheds. 162
Table 74. Borderline Watersheds in Gunnison Basin South Geographic Area. 163
Table 75. Riparian Vegetation and New Road Construction in Borderline Watersheds in Gunnison Basin South Geographic Area. 164
Table 76. Alternative 2 New Crossings and Road in the WIZ in Gunnison Basin South Watersheds... 165

Table 77. Acres of Commercial Treatments in Gunnison Basin South Watersheds. 166
Table 78. Fens and Wetlands in or near Alternative 2 Treatment Areas in Gunnison Basin South Watersheds..... 167
Table 79. Borderline Watersheds in North Fork Valley Geographic Area..... 168
Table 80. Alternative 2 New Crossings and Road in the WIZ in North Fork Valley Watersheds 169
Table 81. Acres of Commercial Treatments in North Fork Valley Watersheds..... 170
Table 82. Fens and Wetlands in or near Alternative 2 Treatment Areas in North Fork Valley Watersheds 171
Table 83. Borderline Watersheds in San Juans Geographic Area. 172
Table 84. Alternative 2 New Crossings and Road in the WIZ in San Juans Watersheds..... 173
Table 85. Acres of Commercial Treatments in San Juans Watersheds 173
Table 86. Fens and Wetlands in or near Alternative 2 Treatment Areas in San Juans Watersheds. 174
Table 87. Borderline Watersheds in Uncompahgre Plateau Geographic Area..... 175
Table 88. Alternative 2 New Crossings and Road in the WIZ in Uncompahgre Plateau Watersheds. .. 177
Table 89. Acres of Commercial Treatments in Uncompahgre Plateau Watersheds..... 178
Table 90. Fens and Wetlands in or near Alternative 2 Treatment Areas in Uncompahgre Plateau Watersheds..... 179
Table 91. Alternative 3 New Crossings and Road in the WIZ in Grand Mesa Watersheds..... 180
Table 92. Fens and Wetlands in or near Alternative 3 Treatment Areas in Grand Mesa Watersheds. .. 181
Table 93. Alternative 3 New Crossings and Road in the WIZ in Gunnison Basin North Watersheds... 183
Table 94. Fens and Wetlands in or near Alternative 3 Treatment Areas in Gunnison Basin North Watersheds..... 184
Table 95. Alternative 3 New Crossings and Road in the WIZ in Gunnison Basin South Watersheds... 185
Table 96. Fens and Wetlands in or near Alternative 3 Treatment Areas in Gunnison Basin South Watersheds..... 186
Table 97. Alternative 3 New Crossings and Road in the WIZ in North Fork Valley Watersheds..... 188
Table 98. Fens and Wetlands in or near Alternative 3 Treatment Areas in North Fork Valley Watersheds. 189
Table 99. Alternative 3 New Crossings and Road in the WIZ in San Juans Watersheds..... 190
Table 100. Fens and Wetlands in or near Alternative 3 Treatment Areas in San Juans Watersheds. 191
Table 101. Alternative 3 New Crossings and Road in the WIZ in Uncompahgre Plateau Watersheds. 192
Table 102. Fens and Wetlands in or near Alternative 3 Treatment Areas in Uncompahgre Plateau Watersheds..... 193
Table 103. Results of SBEADMR ERA Analysis 197
Table 104. Road Construction and Reconstruction Standards..... 200

Table 105. GMUG-managed NFS Roads. 203
Table 106. Transportation System Design Features. 209
Table 107. Maximum Alternative 2 Road Treatments. 213
Table 108. Alternative 3 Road Treatments. 214
Table 109. Comparison of Alternatives 215
Table 110. Changes between DEIS and FEIS. 216
Table 111. Colorado State 2013 NAAQS Criteria Pollutant Emissions Inventory (tons per year). 224
Table 112. 2013 Annual County Level Emissions Inventory. 225
Table 113. Colorado Statewide Prescribed Fire PM10 Annual Emissions 1992-2014 (Tons). 226
Table 114. Air Pollutant Monitoring Results for Selected Counties in Western Colorado. 244
Table 115. Piled Fuels Biomass and Emissions Calculator Report. 248
Table 116. Incidental Vegetation Types Estimated Percent of Consumption. 249
Table 117. Class I and II Areas in and adjacent to SBEADMR Geographic Areas. 250
Table 118. Smoke Sensitive Areas Affected by Geographic Areas. 251
Table 119. Current and Proposed GMUG Fossil Fuels Development and Production. 252
Table 120. Current and Proposed Natural Gas and Coal Development and Production Annual Emissions Scenarios (Tons). 253
Table 121. SBEADMR Annual Emissions (Tons). 253
Table 122. Current and Proposed Mechanical & Prescribed Burning Projects by GA. 254
Table 123. Current and Proposed Prescribed Burning only Projects by GA. 255
Table 124. Logging Equipment Types, Daily Production Rates, Equipment Horse Power and the Total Numbers of Operating Days Required to Complete Logging Operations Proposed in Alternative 13. 257
Table 125. Total Amount of Logging Equipment NAAQS Criteria Pollutants and GHG Emissions Produced in Alternative 2 Over Fifteen Years (Tons). 258
Table 126. Estimated Alternative 2 Treatment Types and Corresponding Acreage. 259
Table 127. Alternative 2 Estimated Range of Total NAAQS and GHG Emissions from Prescribed Burning of Slash Pile Over Fifteen Years (Tons). 260
Table 128. Alternative 2 Estimated Emissions from Broadcast Prescribed Burning in Aspen Over Fifteen Years (Tons). 261
Table 129. Alternative 2 Incidental Vegetation Types and Acreages. 261
Table 130. Alternative 2 Estimated Emissions from Broadcast/Underburning Incidental Vegetation Types Over Fifteen Years (Tons). 262
Table 131. Total Alternative 2 Estimated Emissions Range for the SBEADMR Project Over Fifteen Years (Tons). 263

Table 132. Alternative 2 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources. The SBEADMR annual average represents the estimated total annual project GHG emissions from equipment use and prescribed burning. 264

Table 133. Counties within SBEADMR Geographic Areas. 265

Table 134. Logging Equipment Types, Daily Production Rates, Equipment Horse Power and the Total Numbers of Operating Days Required to Completed Logging Operations Proposed in Alternative 3. 266

Table 135. Total Amount of Logging Equipment NAAQS Criteria Pollutants and GHG Emissions Produced in Alternative 2 Over Fifteen Years (Tons). 266

Table 136. Estimated Alternative 3 Treatment Types and Corresponding Acreage. 267

Table 137. Alternative 3 Estimated Range of Total NAAQS and GHG Emissions from Prescribed Burning of Slash Pile Over Fifteen Years (Tons). 268

Table 138. Alternative 3 Estimated Emissions from Broadcast Prescribed Burning in Aspen (Tons Per Acre). 269

Table 139. Alternative 3 Incidental Vegetation Types and Acreages. 269

Table 140. Alternative 3 Estimated Emissions from Broadcast/Underburning Incidental Vegetation Types Over Fifteen Years (Tons). 270

Table 141. Total Alternative 3 estimated emissions range for the SBEADMR project over fifteen years (Tons). 271

Table 142. Alternative 3 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources. 272

Table 143. Fuel Scenarios, Fuel Models Assigned and Fuel Characteristics. 284

Table 144. Surface Fire Behavior Characteristics in Sample Fuel Types Given 90th Percentile Weather. 286

Table 145. Design Features Specific to Fuels Impacts. Excerpt from Appendix B, Design Features. .. 295

Table 146. Effects of Silvicultural Prescriptions (Individual Treatments or Multiple Treatments) by Spruce Vegetation Type, on Fuels and Fire Behavior/Fire Management. 305

Table 147. Effects of Silvicultural Prescriptions (Individual Treatments or Multiple Treatments) by Aspen Vegetation Type/Condition, on Fuels and Fire Behavior/Fire Management. 309

Table 148. Potential Treatment Acres Available for up to 60,000 Acres of Commercial Treatment for the Preferred Alternative (Alternative 2). 322

Table 149. Potential Treatment Acres Available for up to 60,000 Acres of Non-Commercial Treatment for the Preferred Alternative (Alternative 2). 323

Table 150. Summary of Effects to Fuels Indicators. 326

Table 151. Alternative 2 Incidental Vegetation Types Included within Potential Burn Perimeters..... 329

Table 152. Potential Treatment Acres Available for up to 60,000 Acres of Commercial Treatment for the WUI Alternative (Alternative 3). 332

Table 153. Potential Treatment Acres Available for up to 60,000 Acres of Non-Commercial Treatment for the WUI Alternative (Alternative 3). 333

Table 154. Alternative 3 Incidental Vegetation Types Included within Potential Burn Perimeters..... 336

Table 155. Forest-wide Impacts to Fuels and Fire from SBEADMR Treatments..... 340

Table 156. Sensitive Plant Species on the GMUG, by Habitat 343

Table 157. Design Features for Sensitive Species for all SBEADMR Project Alternatives. 349

Table 158. Environmental Conditions that Result from Activities Associated with the Action Alternatives. 353

Table 159. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area. 359

Table 160. Comparison of Overlapping Habitat for Sensitive Species by Alternative 362

Table 161. Areas within the Proposed Action where Design Features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be Applied (Appendix B). Units are in acres. 364

Table 162. Areas within the Proposed Action where Design Features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be Applied (Appendix B). Units are in acres. 370

Table 163. Priority Invasive Plant Species for the Grand Mesa-Uncompahgre-Gunnison National Forests. 380

Table 164. Design Features for Invasive Plants. 385

Table 165. Location, Forest Type, Treatment Types, Response Variables, Direction of Response, and Authorship of Investigations of the Effects of Multiple Silvicultural Treatments on Nonnative Plants. (Reproduced from Sutherland and Nelson 2010.)..... 391

Table 166. Percent of Priority Treatment Areas for Alternative 2 by Invasibility Risk Class and Geographic Area. 394

Table 167. Percent of Priority Treatment Areas for Alternative 3 by Invasibility Risk Class and Geographic Area. 394

Table 168. Comparison of Invasibility Risk by Action Alternative (acres for all Geographic Areas)... 395

Table 169. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area 397

Table 170. Grazing Allotments, Status, and Acreages for Alternatives 2 and 3. 400

Table 171. Design Features for Range. 401

Table 172. Description of Habitat Structural Stage across the GMUG National Forests..... 405

Table 173. Desired Conditions as per Potential Natural Variation: Crosswalk between Habitat Structural Stage and Successional Stages..... 405

Table 174. Design Features Related to Silviculture..... 410

Table 175. Spruce Prescriptions and Anticipated Effects by Indicator Measure. 414

Table 176. Categorization of Stand Structural Stages, Post Treatment, Based on Oliver and Larson (1996)..... 416

Table 177. Summary of Commercial Treatments in Spruce-fir, Grand Mesa GA. 423

Table 178. Summary of Noncommercial Treatments in Aspen, Grand Mesa GA. 423

Table 179. Summary of Effects for Commercial Activities: Succession (Seral Stages) in Spruce-Fir PNV Type, Grand Mesa GA. 424

Table 180. Summary of Effects from Non-Commercial Activities: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Grand Mesa GA 425

Table 181. Summary of Commercial Treatments in Spruce-fir, Gunnison Basin North & South GAs.426

Table 182. Summary of Noncommercial Treatments in Aspen, Gunnison Basin North & South GAs. 427

Table 183. Summary of Effects of Commercial Activities: Succession (Seral Stages) in Spruce-Fir PNV Type, Gunnison Basin North & South GAs. 428

Table 184. Summary of Effects for Non-Commercial Activities: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Gunnison Basin North & South GAs. 429

Table 185. Summary of Commercial Treatments in Spruce-fir, North Fork GA. 431

Table 186. Summary of Noncommercial Treatments in Aspen, North Fork GA. 431

Table 187. Summary of the effects of Commercial Activity within the North Fork Valley GA. Succession (Seral Stages) in Spruce-Fir PNV Type 432

Table 188. Summary of Effects of the Non-Commercial Activities within the North Fork Valley GA. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type. 433

Table 189. Summary of Commercial Treatments in spruce-fir, San Juan GA. 434

Table 190. Summary of noncommercial Treatments in aspen, San Juan GA. 435

Table 191. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, San Juan GA. 436

Table 192. Summary of Effects of Non-Commercial Activities on Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, San Juan GA. 436

Table 193. Summary of Commercial Treatments in Spruce-fir, Uncompahgre Plateau GA. 438

Table 194. Summary of Noncommercial Treatments in Aspen, Uncompahgre Plateau GA. 438

Table 195. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, Uncompahgre Plateau GA. 440

Table 196. Summary of the effects of Non-Commercial Activity on Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Uncompahgre Plateau GA. 440

Table 197. Effects to Seral Stage in Spruce-fir from Commercial Activities 441

Table 198. Effects to Seral Stages in Aspen from Non-Commercial Activities. 441

Table 199. Summary of Effects to Seral Stages in Spruce, Adapted Potential Action (All Spruce Salvage). 442

Table 200. Summary of Commercial Treatments in Spruce-fir, Grand Mesa GA. 443

Table 201. Summary of Noncommercial Treatments in Aspen, Grand Mesa GA. 443

Table 202. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, Grand Mesa GA. 444

Table 203. Summary of the Effects of Commercial Activity within the Grand Mesa GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type. 445

Table 204. Summary of Commercial Treatments in Spruce-fir, Gunnison Basin North & South GAs. 445

Table 205. Summary of Noncommercial Treatments in Aspen, Gunnison Basin North & South GAs. 446

Table 206. Summary of the Effects of Commercial Activity within the Gunnison Basin North & South GAs: Succession (Seral Stages) in Spruce-Fir PNV Type 447

Table 207. Summary of the Effects of Non-Commercial Activity within the Gunnison Basin North & South GAs: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type 448

Table 208. Summary of Commercial Treatments in Spruce-fir, North Fork Valley GA. 448

Table 209. Summary of Noncommercial Treatments in Aspen, North Fork Valley GA. 449

Table 210. Summary of the Effects of Commercial Activities within the North Fork Valley GA: Succession (Seral Stages) in Spruce-Fir PNV Type. 450

Table 211. Summary of the Effects of Non-Commercial Activity within the North Fork Valley GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type. 451

Table 212. Summary of Commercial Treatments spruce-fir, San Juan GA. 451

Table 213. Summary of Noncommercial Treatments in Aspen, San Juan GA. 451

Table 214. Summary of the Effects of Commercial Activity within the San Juan GA: Succession (Seral Stages) in Spruce-Fir PNV Type 453

Table 215. Summary of the Effects of Non-Commercial Activity within the San Juan GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type 453

Table 216. Summary of Commercial Treatments in spruce-fir, Uncompahgre Plateau GA. 454

Table 217. Summary of Noncommercial Treatments in aspen, Uncompahgre Plateau GA. 454

Table 218. Summary of the Effects of Commercial Activity within the Uncompahgre Plateau GA: Succession (Seral Stages) in Spruce-Fir PNV Type. 455

Table 219. Summary of the Effects of Non-Commercial Activity within the Uncompahgre Plateau GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type. 456

Table 220. Effects to Seral Stage in Spruce-fir from Commercial Activities. 456

Table 221. Effects to Seral Stages in Aspen from Non-Commercial Activities. 457

Table 222. Summary of Effects to Seral Stages in Spruce, Adapted Potential Action (All Spruce Salvage). 457

Table 223. Wildlife-Related Design Criteria for Both Action Alternatives. 462

Table 224. Federal Threatened, Endangered or Proposed Species That May Occur in the Action Area. 471

Table 225. Effects to Lynx Based on Type of Treatment in the Silvicultural Prescription Matrix. 484

Table 226. Summary of Treatment Effects to Secondary Lynx Habitat in Aspen and Spruce-fir Aspen Stands 493

Table 227. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat on the Grand Mesa GA. 496

Table 228. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat within WUI. 497

Table 229. Alternative 2 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type within Commercial PTA in Lynx Habitat on the Gunnison North and South GA. 498

Table 230. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat. 499

Table 231. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the North Fork Valley GA. 499

Table 232. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. 500

Table 233. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the San Juan Mountains GA. 500

Table 234. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat. 501

Table 235. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the Uncompahgre Plateau GA. 501

Table 236. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat. 502

Table 237. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Grand Mesa GA. 504

Table 238. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Grand Mesa GA 505

Table 239. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Gunnison Basin North and South GA. 506

Table 240. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Gunnison North and South GA. 507

Table 241. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the North Fork GA. 508

Table 242. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the North Fork GA. 509

Table 243. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the San Juan GA. 510

Table 244. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the San Juan GA. 510

Table 245. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Uncompahgre GA. 512

Table 246. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Uncompahgre Plateau GA. 512

Table 247. Alternative 2 Commercial Treatments under Current Conditions with Lynx Habitat and Adapted/Potential Future Conditions of Spruce Beetle-Induced Mortality Becomes Widespread Across the GMUG. 514

Table 248. Lynx Linkage Areas Occurring in the Proposed Action Area (Alt 2). 517

Table 249. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen by LAU in the Grand Mesa GA. 519

Table 250. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Gunnison GA. 518

Table 251. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Gunnison Basin- South GA. 522

Table 252. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Fork GA. 526

Table 253. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the San Juan GA. 529

Table 254. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Uncompahgre Plateau GA. 532

Table 255. Comparison Of Existing Average Daily Traffic, Projected Traffic in 2025 and the Influence Of Increase Truck Traffic Associated with SBEADMR. 534

Table 256. Haul Routes and Acres of Potential Addition Snow Compaction over Environmental Baseline. 536

Table 257. Alternative 2 – Acres of Lynx Habitat in Commercial PTA and Hazard Trees. 539

Table 258. Projected Cumulative Effects Under Current Stand Conditions and Adapted/potential future Stand Conditions Conditions for Alternative 2. 542

Table 259. Alternative 3 – Commercial Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Grand Mesa GA. 547

Table 260. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat within WUI. 547

Table 261. Alternative 3 – Commercial Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Gunnison Basin North and South GAs. 548

Table 262. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. 549

Table 263. Alternative 3 - Acres of Spruce-Fir And Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the North Fork GAs. 550

Table 264. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. 551

Table 265. Alternative 3 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the San Juan GAs. 551

Table 266. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. (%) – Represents percent of Lynx total lynx habitat in LAU affected. 552

Table 267. Alternative 3 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Uncompahgre Plateau GA. 552

Table 268. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. 553

Table 269. Comparison of Modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir on the Grand Mesa GA. 555

Table 270. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir-Aspen on the Grand Mesa GA. 555

Table 271. Comparison of Modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir on the Gunnison Basin North and South GA. 557

Table 272. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Gunnison Basin North and South GA. 557

Table 273. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the North Fork GA. 559

Table 274. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the North Fork GA. 559

Table 275. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the San Juan GA. 561

Table 276. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the San Juan GA. 561

Table 277. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions In Spruce-Fir on the Uncompahgre Plateau GA. 563

Table 278. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Uncompahgre Plateau GA. 563

Table 279. Alternative 3 Commercial Treatment Under Current Conditions with Lynx Habitat and Adapted/Potential Future Conditions if Spruce Beetle-Induced Mortality Becomes Widespread Across the GMUG. 565

Table 280. Lynx Linkage Areas Occurring in the Proposed Action Area (Alt 3). 567

Table 281. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen PNV Types by LAU in the Grand Mesa GA. 569

Table 282. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen PNV Types by LAU in the Gunnison North-GA. 572

Table 283. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Gunnison Basin South GA. 576

Table 284. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Fork GA. 580

Table 285. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the San Juan GA. 583

Table 286. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Uncompahgre Plateau GA. 586

Table 287. Acres of Lynx Habitat in PTA and Hazard Trees. 588

Table 288. Projected Cumulative Effects of Proposed and Adapted Treatments, Current Stand Conditions and Potential Future Stand Conditions for Alternative 3. 591

Table 289. Alternative 2 Potential Activities in Gunnison Sage-grouse Critical Habitat: Dominated by Trees. 595

Table 290. Alternative 3 Potential Activities in Gunnison Sage-grouse Critical Habitat: Dominated by Trees 597

Table 291. Cutthroat Trout Conservation Populations Associated with Priority Treatment Areas. 598

Table 292. SBEADMR Design Features for Stream Habitat and Resident Aquatic Populations. 599

Table 293. Summary of Effects to Canada lynx and SRLA Compliance Documentation by Action Alternative 603

Table 294. Summary of Findings USFS Region 2 Sensitive Species that may be impacted by the SBEADMR Project. 621

Table 295. Activities Proposed under Alternative 2 - Overlap with Goshawk Nesting Habitat (Acres and % of Total) within each Geographic Area 624

Table 296. Activities Proposed under Alternative 3 - Overlap with Goshawk Nesting Habitat (Acres and % of Total) within each Geographic Area. 625

Table 297. Comparison of Alternatives (Acres and % of Total) 626

Table 298. Effects of Silvicultural Treatments to Goshawks in Spruce – Fir Stands. 628

Table 299. Effects of Silvicultural Treatments to Northern Goshawks, Flammulated Owls, Purple Martin in Aspen Stands. 634

Table 300. Effects of Silvicultural Treatments in Spruce Fir to Boreal Owl, Olive sided Flycatcher, and Pygmy Shrew. 638

Table 301. Activities Proposed Under Alternative 2 – Overlap with American Marten Habitat (Acres) within each Geographic Area. 646

Table 302. Activities Proposed Under Alternative 3 – Overlap with American Marten Habitat (Acres) within each Geographic Area. 647

Table 303. Comparison of Alternatives 2 and 3 to the Baseline – Potentially Affected American Marten Habitat (acres) within each Geographic Area. 648

Table 304. Effects of Silvicultural Treatments to American Marten in Spruce - Fir Stands. 650

Table 305. SBEADMR Design Features for Stream Habitat and Resident Aquatic Populations. 657

Table 306. Management Indicator Species (MIS) in the SBEADMR Project Area. 660

Table 307. Length (Miles) of Haul Routes within Elk Winter Concentration Areas (as Mapped by Colorado Parks and Wildlife Species Activity Mapping Data). 662

Table 308. Activities Proposed Under Alternative 2 - Overlap with Elk Foraging and Cover Habitat (Acres) within each Geographic Area. 663

Table 309. Activities Proposed Under Alternative 3 - Overlap with Elk Foraging and Cover Habitat (Acres) within each Geographic Area 664

Table 310. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data. 667

Table 311. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data in combination with Alternative 2. 667

Table 312. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data in combination with Alternative 3. 667

Table 313. Activities Proposed Under Alternative 2 – Overlap with Red-Naped Sapsucker Habitat (Acres) within Each Geographic Area. 673

Table 314. Activities Proposed Under Alternative 3 – Overlap with Red-Naped Sapsucker Habitat (Acres) Within Each Geographic Area. 674

Table 315. Comparison of Alternatives 2 and 3 to the Baseline – Potentially Affected Red-Naped Sapsucker Habitat (Acres) within each Geographic Area. 675

Table 316. FWS Birds of Conservation Concern for BCR 16 and Anticipated Influence of Alternatives 678

Table 317. Priority Habitats and Species of the Southern Rocky Mountains Province and their Relationship to Assessment for the SBEADMR Action Area. 680

Table 318. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area. 682

Table 319. Cultural Resources Design Features. 693

Table 320. Annual Treatment Estimates and Cost per Alternative. 701

Table 321. Racial and Hispanic Composition of 2012 Population in the 22-County Analysis Area (U.S. Department of Commerce 2013). 711

Table 322. Present Net Value of SBEADMR Treatments over 10-year Period, 4 Percent Discount Rate. 719

Table 323. Total (Direct, Indirect and Induced) Average Annual Employment and Labor Income for All Alternatives using 22-county analysis area. 719

Table 324. Total (Direct, Indirect and Induced) Average Annual Employment and Labor Income for All Alternatives using 10-county analysis area. 720

Table 325. Design Features for Recreation Resources. 734

Table 326. Design Features for Scenic Quality and Visual Resources. 750

Table 327. Reasonably Foreseeable Future Activities. 757

List of Figures

Figure 1. Annual acres affected by spruce beetle in Colorado (USDA Forest Service 2014d, Forest Health Protection). 8

Figure 2. Spruce beetle activity in Colorado 1996-2014 (USDA Forest Service 2014d, Forest Health Protection). 8

Figure 3. Future climatic habitat zones of Engelmann spruce. 10

Figure 4. Change in climatic suitability for aspen (top) and overlying mapped aspen decline (bottom) (Worrall et al. 2013). 14

Figure 5. Future habitat zones of aspen. 17

Figure 6. Geographic Areas (GAs) on the GMUG National Forests. GAs are referenced throughout the FEIS. 19

Figure 7. Adaptive implementation and monitoring framework for SBEADMR 40

Figure 8. Percentage of Watersheds in each Geographic Area Rated as Class 1, Class 2, or Class 3 for WCF "Aquatic Habitat Condition" Indicator. 93

Figure 9. Average watershed percentage of severe or very severe EHR soil in SBEADMR treatment areas by Geographic Area. 99

Figure 10. Percentage of Watersheds in each Geographic Area Rated as Class 1, Class 2, or Class 3 for WCF "Soils Condition" Indicator. 101

Figure 11. Dead and dying spruce along the Los Pinos to Cebolla NFS Road in the GMUG. 204

Figure 12. Major forest carbon pools. 230

Figure 13. Model of carbon storage - Increase in Stands and Time. 231

Figure 14. Carbon balance of a U.S. forest sector in millions of metric Tons of carbon per year. 232

Figure 15. Carbon density (Tonnes/acre) for the national forests and grassland in the Rocky Mountain Region (1990 -2013). 235

Figure 16. Annual timber product output in the Rocky Mountain Region (1906 to 2012). 236

Figure 17. Cumulative total carbon stored in harvested wood products (HWP) manufactured from Northern Region timber using the IPCC/EPA approach. 236

Figure 18. Carbon stocks on the GMUG from 1990 to 2013. The green band shows the range of analysis uncertainties. 237

Figure 19. Maximum daily temperatures for the past ten years for Lujan RAWS. 277

Figure 20. Maximum daily temperatures for the past ten years for McClure Pass RAWS. 277

Figure 21. Energy Release Components for the past 10 years for Lujan RAWS. 278

Figure 22. Energy Release Components for the past 10 years for McClure Pass RAWS. 278

Figure 23. Fire history of the GMUG. 282

Figure 24. Map illustrating the benefit of redundant fuel treatments on the landscape to enhance wildfire management capabilities. 289

Figure 25. Distribution and concentration of management priority invasive plants on the GMUG, based on the invasive inventory and priorities. 381

Figure 26. Predicted habitat vulnerability based on aspect, elevation, vegetation, precipitation, slope, and road and trail densities. 384

Figure 27. Habitat structural stage distribution of forest and woodland cover types, Grand Mesa Geographic Area. 406

Figure 28. Habitat structural stage distribution of forest and woodland cover types, Gunnison Basin Geographic Area. 407

Figure 29. Habitat Structural Stage distribution of forest and woodland cover types, North Fork Valley Geographic Area. 407

Figure 30. Habitat Structural Stage distribution of forest and woodland cover types, San Juans Geographic Area. 408

Figure 31. Habitat Structural Stage distribution of forest and woodland cover types Uncompahgre geographic area. 408

Figure 32. Schematic stages of stand development following major disturbances (Oliver and Larson, 1996). 415

Figure 33. Example of Variable Retention 418

Figure 34. Summary of structural stages in the spruce-fir cover type, Grand Mesa GA. 422

Figure 35. Summary of seral stages in the spruce-fir cover type, Grand Mesa GA. 422

Figure 36. Effects of treatment on habitat structural stages within spruce-fir on the Grand Mesa GA. 423

Figure 37. Shift in Seral stages in spruce-fir on the Grand Mesa GA 424

Figure 38. Summary of structural stages in the spruce-fir cover type, Gunnison Basin North & South GAs. 426

Figure 39. Summary of seral stages in the spruce-fir cover type, Gunnison Basin North & South GAs. 426

Figure 40. Shift in habitat structural stages in spruce-fir in the Gunnison North & South Geographic Areas. 427

Figure 41. Shift in Seral Stages in spruce-fir for the Gunnison North & South GAs. 427

Figure 42. Summary of habitat structural stages in the spruce-fir cover type, North Fork GA. 430

Figure 43. Summary of seral stages in the spruce-fir cover type, North Fork GA. 430

Figure 44. Shift in habitat structural stages in spruce-fir within the North Fork Valley GA. 431

Figure 45. Shift in seral stages in spruce-fir within the North Fork Valley GA. 432

Figure 46. Summary of structural stages in the spruce-fir cover type, San Juan GA. 434

Figure 47. Summary of seral stages in the spruce-fir cover type, San Juan GA. 434

Figure 48. Shift in habitat structural stages in the spruce-fir cover type in the San Juan GA. 435

Figure 49. Shift in seral stages in the spruce-fir cover type in the San Juan GA. 435

Figure 50. Summary of habitat structural stages in the spruce-fir cover type, Uncompahgre Plateau GA. 437
Figure 51. Summary of seral stages in the spruce-fir cover type, Uncompahgre Plateau GA. 438
Figure 52. Shift in Habitat Structural Stages within spruce-fir in the Uncompahgre Plateau GA. 439
Figure 53. Shift in Seral Stages in spruce-fir in the Uncompahgre Plateau GA. 439
Figure 54. Shift in Habitat Structural Stages in Spruce-fir in the Grand Mesa GA. 443
Figure 55. Shift in Seral Stages in Spruce-fir in the Grand Mesa GA. 444
Figure 56. Shift in Habitat Structural Stage within Spruce-fir in the Gunnison Basin North & South GAs 446
Figure 57. Shift in Seral Stages in Spruce-fir in the Gunnison Basin North & South GAs. 447
Figure 58. Shift in Habitat Structural Stage within the spruce-fir cover type in North Fork GA..... 449
Figure 59. Shift in Seral Stages within the spruce-fir cover type in the North Fork Valley GA. 450
Figure 60. Shift in Habitat Structural Stages in the spruce-fir cover type, San Juan GA. 452
Figure 61. Shift in Seral Stage in the spruce-fir cover type, San Juan GA. 452
Figure 62. Shift in Habitat Structural Stages in the spruce-fir cover type, Uncompahgre Plateau GA.. 454
Figure 63. Shift in Seral Stages in the spruce-fir cover type, Uncompahgre Plateau GA. 455
Figure 64. Map of SBEADMR economic analysis area. 704
Figure 65. Population change in the 22-county analysis area between 1970 and 2010 (U.S. Department of Commerce 2013b). 705
Figure 66. Services and Non-Services employment history (U.S. Department of Commerce 2013b). . 706
Figure 67. Analysis area employment specialization (IMPLAN 2012). 707
Figure 68. Employment in sectors related to SBEADMR management (IMPLAN 2012). 708
Figure 69. Analysis area labor income distribution and specialization (IMPLAN 2012). 710
Figure 70. Individuals and families living below the poverty level, 2012 (U.S. Department of Commerce 2013). 712
Figure 71. GMUG Cut and Sold Report 1980-2014 (Headwaters Economics 2015) 713
Figure 72. Facilities in Colorado Using Biomass (Colorado State Forest Service 2016)..... 713

This page intentionally blank

CHAPTER 1. PURPOSE AND NEED FOR ACTION

Document Structure

The Forest Service has prepared this Draft Environmental Impact Statement (DEIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This Environmental Impact Statement discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into four chapters:

Chapter 1. Purpose and Need for Action: The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives, including the Proposed Action: This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.

Chapter 4. Interdisciplinary Team Membership: This chapter provides a list of team members who participated to prepare this DEIS.

Appendices: The appendices provide more detailed descriptions of fundamental components of actions common to all alternatives.

Index: The index provides page numbers by topic.

Additional documentation, including more detailed analyses of project-area resources, may be found in the project planning record located at Grand Mesa, Uncompahgre, and Gunnison National Forests, 2250 Highway 50, Delta, CO 81416.

Background

The Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests are located on the western slope of the Southern Rockies and into the Colorado Plateau. Elevations of the 3,161,900 acre GMUG range from about 5,800 ft. (1,770 m) on the west foothills of Battlement Mesa, to over 14,200 ft. (4,330 m) on the high peaks of the San Juan and Saguache Mountains. All of the Grand Mesa, Uncompahgre, and Gunnison National Forests are on the western slope, as the Continental Divide forms the eastern and southeastern boundaries of the National Forests.

The GMUG includes diverse vegetation ranging from semi-desert, sagebrush, piñon-juniper, mountain shrublands, and ponderosa pine to lodgepole pine, Engelmann spruce, subalpine fir and quaking aspen to the alpine zone.

Annual precipitation on the GMUG ranges from about 10 inches (25.4 cm) per year in the bottom of the Gunnison Basin, to over 50 inches (127 cm) per year on the high peaks of the San Juan and Elk Mountains. Precipitation largely parallels elevation, with some notable exceptions in the rain shadows in the bottom of the Upper Gunnison Basin and the Cochetopa Hills area. Thus the higher precipitation areas are those associated by the higher mountain ranges – the Elk and West Elk Mountains, the San Juan Mountains, and the Grand and Battlement Mesas. The Cochetopa Hills and the Uncompahgre Plateau are on the low end of precipitation range for the Forests.

The GMUG has experienced approximately 223,000 cumulative acres of spruce beetle mortality and 229,000 acres of Sudden Aspen Decline accumulated over the past decade. Neighboring San Juan and Rio Grande National Forests have been experiencing a massive spruce beetle outbreak for the past decade. The spruce beetles have spilled over the Continental Divide into the GMUG. From 2013-2014, the cumulative acreage affected by spruce beetles increased by approximately 64,000 acres on the GMUG (pers.comm. Tom Eager). The landscape south and east of Gunnison, Colorado bordering the Rio Grande National Forest, is one of the highest spruce mortality areas on the GMUG. Mortality in spruce stands is expected to continue at relatively high levels for several years to come.

Similarly, aspen forests have been affected by Sudden Aspen Decline (SAD). SAD was first noticed in southwestern Colorado in 2004 (Worrall et al. 2008). On the San Juan National Forest, large and growing patches with of crown thinning, branch dieback, and mortality were found. It occurred on a landscape scale and rapidly increased in area and severity. Over the next few years, SAD spread to the GMUG and throughout Colorado. Approximately 33% (over 229,000 acres) of the GMUG's 712,000 acres of aspen vegetation was affected from 2000 to 2010. In 2009, the detection of new areas dropped considerably, and little new area has been mapped since then. However, stands currently exhibiting SAD continue to decline.

Furthermore, these disturbances are occurring in the context of a changing climate. Over the past 100 years, Southwestern Colorado temperatures have increased, and modeled climate projections

for the region include warmer and longer frost-free summers, snowline moving up in elevation, earlier snowmelt, and consequently, a longer fire season.

Due to predicted warming, spruce beetle outbreaks could be more likely in the future. Higher summer temperatures can foster spruce beetle outbreaks by allowing beetles to reproduce every year rather than every two years (Bentz et al. 2010). Additionally, anticipated more frequent drought conditions place water-stressed stands at greater risk of insect and disease.

Climate changes could lead to larger fires and possibly fire with more high-severity area than in previous decades (Westerling et al. 2006, Agee 2007, Funk 2012). Modeled climate scenarios for the Gunnison Basin by 2035 indicate potential for the fire season to increase by one month; for fire frequency in high-elevation forests to increase from 4 to 12 times as often as experienced between 1971-2000; and for fire extent to increase from 6 to 11 times the extent burned between 1971-2000. These scenarios model severity and frequency irrespective of tree mortality (Rangwala and Rondeau, *Southwest Colorado Social-Ecological Climate Resilience (SECR) Project*).

The GMUG forest managers have developed the SBEADMR alternatives with the help of the public, partners, scientists and resource specialists to treat areas impacted by – and likely to be impacted by – insects and diseases in spruce and aspen forested ecotypes. The following sections contain a detailed description of the existing vegetation conditions in spruce-fir and aspen on the GMUG, the spruce beetle and SAD epidemics, and how changing climate impacts these species.

Spruce

Engelmann spruce (*Picea engelmannii*) is an important species in the Southern Rockies. Engelmann spruce has value not only as timber, but also through the jobs and labor income connected to the harvesting of that value. The spruce-fir forests of the Southern Rockies provide “shade and shelter that help to maintain the winter snow pack and prevent quick runoff during the spring melt and summer storms” (Western Bark Beetle Strategy). Additionally, spruce-fir forests provide recreational opportunities to hikers, hunters, mountain bikers, campers, four-wheelers and skiers as well as outstanding scenic views. Engelmann spruce and subalpine fir on the GMUG serves as valuable habitat for the Canada lynx, a federally listed endangered species, plus several other species which are either endangered, threatened or under consideration of being protected. Additionally, spruce-fir stands also provide habitat for the main prey species of lynx (snowshoe hares) and its secondary prey item, red squirrel.

A detailed description of existing vegetation types for the five geographic areas encompassing the GMUG are available in comprehensive assessments completed in 2006 (USDA Forest Service, 2006e). Geographic areas (GA) are the Gunnison Basin, Uncompahgre Plateau, San Juan Mountains, Grand Mesa and the North Fork of the Gunnison River (See Figure 6).

Habitat structural stages at the time of the assessment (2006) for spruce-fir for each geographic area are presented in Table 1. Data used to complete the assessment has had only minor adjustments since 2006. Overall, spruce-fir was dominated by mature and dense stand conditions (4B and 4C) across all GA. Where age data existed, most spruce-fir ranged in age from 100-200 years old. The highest percentage (>80%) of stands in a mature condition existed on the Grand Mesa, San Juan Mountains and the Uncompahgre Plateau. However, more than 50% of spruce-fir stands were in a mature condition for each of the GAs on the GMUG. Note that acres affected by beetles since 2006 are not reflected in this data. The following section, Spruce Beetles and Spruce Mortality, concludes with a discussion of how the GMUG spruce beetle epidemic has shifted the habitat structural stages.

Table 1. Spruce-Fir Vegetation Characterization for the GMUG by Geographic Area, 2006.

GA	**Cover Type**	**Composition of GA** (% is of GA)	**Age Distribution**	**Habitat Structural Stages[1]**	**Canopy Conditions**
Gunnison Basin	Spruce-fir	354,300 acres (25%)	Most spruce-fir is between 120 to 200 years.	3A - 7% 3B – 20% 3C – 2% 4A- 10% 4B – 42% 4C – 19%	21% single-storied 79% multi-storied 98% continuous canopy
Grand Mesa	Spruce-fir	93,300 acres (26%) (58% without aspen in species mix, 42% with aspen in the species mix)	Ranges from 10 to 210 years. Most spruce-fir is between 100-160 yr. old	3A – 1% 3B – 5% 3C – 1% 4A – 7% 4B- 41% 4C- 46%	34% - single-storied 71% - multi-storied 97% - continuous canopies
San Juan Mountains	Spruce-fir	135,900 acres (36%)	Age data not available	3A -5% 3B- 4% 3C-<1% 4A- 10% 4B – 50% 4C- 31%	85% - single-storied 15% - multi-storied 79% - continuous canopies
North Fork Gunnison River	Spruce-fir	121,800 acres (23%)	Age data not available	3A – 5% 3B – 14% 3C – 2% 4A – 13% 4B – 38% 4C- 27%	28% - single-storied 72% - multi-storied 99% - continuous canopies
Uncompahgre Plateau	Spruce-fir	43,100 acres (7%)	Most spruce is between 80–140 yr. old Most subalpine fir is between 40-120 yr. old.	3A – 1% 3B- 7% 3C – 3% 4A – 4% 4B -47% 4C- 37%	54% - single-storied 46% - multi-storied 92% - continuous canopies

GA	Cover Type	Composition of GA (% is of GA)	Age Distribution	Habitat Structural Stages[1]	Canopy Conditions

[1]Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T/1M	Grass-Forb	Not applicable	0 – 10%
2T/2S	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B*	Mature	9+ inches	41 - 70%
4C*	Mature	9+ inches	71 – 100%

**These structural stages are considered most susceptible to spruce beetle infestation.*

To evaluate how current conditions compare to historic ranges, the 2006 assessments on the GMUG used the Vegetation Dynamics Development Tool (VDDT). Current knowledge on disturbance intervals and succession pathways were used to build models for the timber, woodland, and some shrub PNV types on the GMUG. Current conditions were then compared to model results to see where departures exist (Table 2). Generally speaking, the spruce-fir cover type was dominated by late-mid and late seral stages as compared to modeled PNV. The natural and human disturbance histories for the different geographic areas were reflected in the current conditions as of 2006. Areas with more recent activities/disturbances had higher percentages in the earlier seral stages. Areas where disturbance regimes had been interrupted (i.e., fire suppression) tended to have higher percentages in the later seral stages, typically much higher than would have occurred historically when disturbances were not suppressed. Note that changes due to spruce beetle activity since 2006 are not reflected in this data.

Table 2. Succession (Seral Stages) in Spruce-fir and Spruce-fir Aspen PNV Types by GA, 2006.

Spruce-Fir PNV	Early Seral	Early-Mid Seral	Late-Mid-Seral*	Late Seral*
VDDT Model - PNV	*27-32%*	*20-24%*	*12-13%*	*31-40%*
Existing Vegetation Condition				
Grand Mesa	8%	40%	52%*	
Gunnison Basin	5%	49%	45%*	
North Fork Valley	14%	32%	53%*	
San Juans	1%	43%	56%*	
Unc. Plateau	3%	45%	52%*	
VDDT Model - PNV	*13-19%*	*22-29%*	*13-16%*	*35-49%*
Existing Vegetation Condition				
Grand Mesa	5%	63%	32%*	
Gunnison Basin	4%	63%	33%*	

Spruce-Fir PNV	Early Seral	Early-Mid Seral	Late-Mid-Seral*	Late Seral*
North Fork Valley	6%	69%	25%*	
San Juans	1%	24%	75%*	
Unc. Plateau	3%	45%	52%*	
**These seral stages are considered most susceptible to spruce beetle infestation.*				

Spruce Beetles and Spruce Mortality

The spruce beetle (*Dendroctonus rufipennis*) is the primary disturbance agent for mature spruce trees at high elevation. On the GMUG, spruce beetles are currently infesting mostly Engelmann spruce; they prefer mature, large-diameter spruce trees, but will infest smaller trees once most of the larger trees are exhausted within a stand. The spruce beetle outbreaks are a natural event that eventually lead to the death of old stands and the initiation of new stands; however, warmer winters in recent years have allowed a larger number of beetles to survive. Substantial wind throw events in 2011 and 2012 created prime breeding habitat for spruce beetles, exacerbating the problem. Consequently, the beetle flight (when new adult beetles emerge from the dead tree) in recent summers has been the largest witnessed by entomologists in decades (USDA Forest Service 2013d, Forest Health Protection).

Once attacked by beetles, most trees typically die and eventually fall to the ground, adding dead and dry fuels that can increase wildfire hazard. Standing infected trees also increase the risk of wildfire; in the first two-three years of a bark beetle outbreak when dead trees still have needles, the likelihood of crown fires and ember lofting are higher. The dead needles that cling to the trees provide fuel that can ignite quickly during weather conditions conducive to fire (Page and Jenkins 2007). The short-term burst in elevated fire hazard associated with the dead needle phase poses an increased safety hazard for wildland firefighters engaged in tactical suppression of wildfires that threaten WUI and infrastructure outside WUI. Furthermore, unlike other species affected by bark beetle, spruce branches are fine enough that even when needles drop, the standing dead trees – with flammable fine branches – remain an elevated fire hazard. Though spruce-fir wildfire severity, including extent and frequency, is driven by climate, wildfire *behavior* in recently-dead spruce-fir and areas with heavy fuel loadings can create more unpredictable fire behavior that is more hazardous to manage.

Falling dead trees also have the potential to cause property damage and pose risks to human safety. Trees falling across roads and trails could block ingress/egress during emergency operations, such as during wildfire suppression operations. Falling tree hazards continue to increase the longer dead trees remain standing. In WUI areas, fuel treatments can increase defensible space and provide safe locations from which firefighters can initiate fire management actions.

Beetle outbreaks commonly occur following windthrow events. Several current spruce beetle activity centers on the GMUG are known to have been initiated by windthrow. These types of

events are referred to as "eruptive" because beetles are produced locally in response to on-site conditions (e.g. blow-down of trees creating ideal habitat for beetles). Eruptive populations typically result in patchy mortality and infestation is at a much slower rate. Beetle activity on the Grand Mesa is currently operating as an eruptive population. Other spruce beetle activity centers have apparently originated from the beetles themselves dispersing during wind events. Sustained dry, windy weather over the past ten years has contributed to the epidemic (Pielke et al. 2005, Worrall et al. 2013, Worrall and Rehfeldt 2013). In these types of events, beetle populations are referred to as "inundative" because beetles are emigrating en masse from other locations. Inundative populations typically result in much higher tree mortality as seen on the southern-end of the Gunnison Ranger District. Tree ring records and recent weather data indicate that the past decade has been the hottest and driest in centuries (Worrall et al. 2013, Worrall and Rehfeldt 2014).

In addition, there are several documented climate trends across the western United States creating conditions conducive to beetle outbreaks:

- More precipitation in the form of rain, and less in the form of snow (Knowles et al. 2006), coupled with declining snowpack (Mote et al. 2005).
- Earlier peaks in streamflow (Stewart et al. 2005). This can already be seen in recent streamflow records set in the last few years in the area below the GMUG.
- Earlier spring onset (Cayan et al. 2001).

These climate patterns, together with disturbance such as windthrow and vast areas of susceptible forest, are supporting huge outbreaks across the landscape.

Each year the USDA Forest Service and the Colorado State Forest Service work collectively to aerially monitor insect and disease caused tree mortality or damage across all ownerships of Colorado's forested land. From 2002-2009, spruce beetle damage averaged in the range of 50,000 to 100,000 acres annually. The 2014 aerial forest health survey highlights revealed that the number of acres damaged has increased dramatically, rising to 485,000 acres statewide, an increase of 232,000 new acres. Spruce beetle expansion on the Gunnison National Forest alone was 54,000 new acres affected on 79,000 active acres (USDA Forest Service 2014d, Forest Health Protection), rising to a cumulative total of 223,000 affected acres to-date, or approximately 30% of the total spruce-fir vegetation on the GMUG. This increase in activity is indicative of a rapidly expanding outbreak. Based upon patterns of bark beetle kill that have occurred on adjacent Forests, continued and rapidly increasing mortality can be expected (Worrall et al. 2013, Worrall and Rehfeldt 2013).

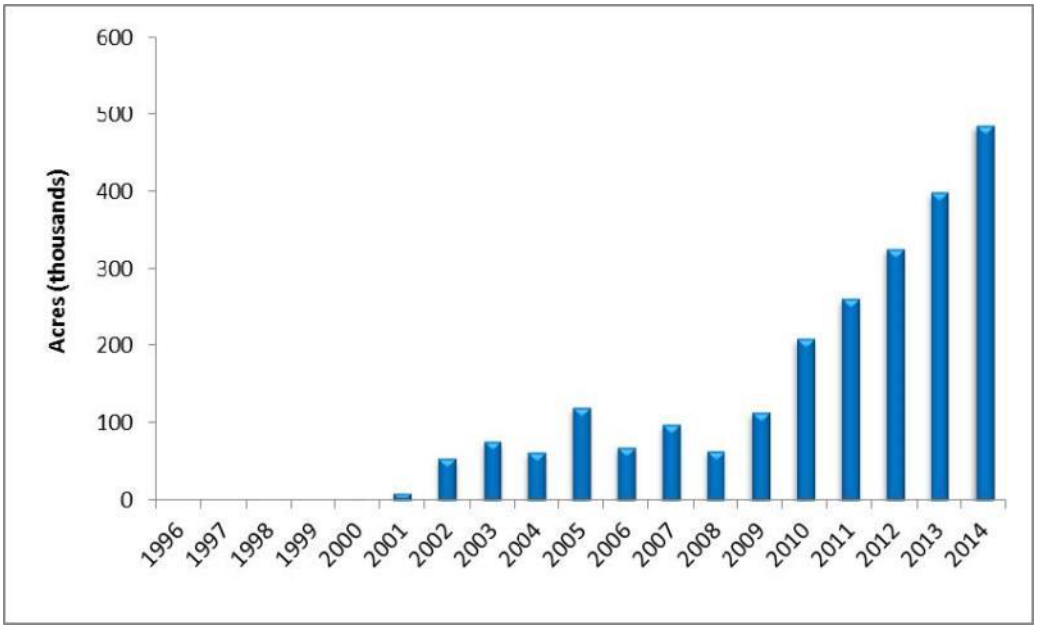

Figure 1. Annual acres affected by spruce beetle in Colorado (USDA Forest Service 2014d, Forest Health Protection).

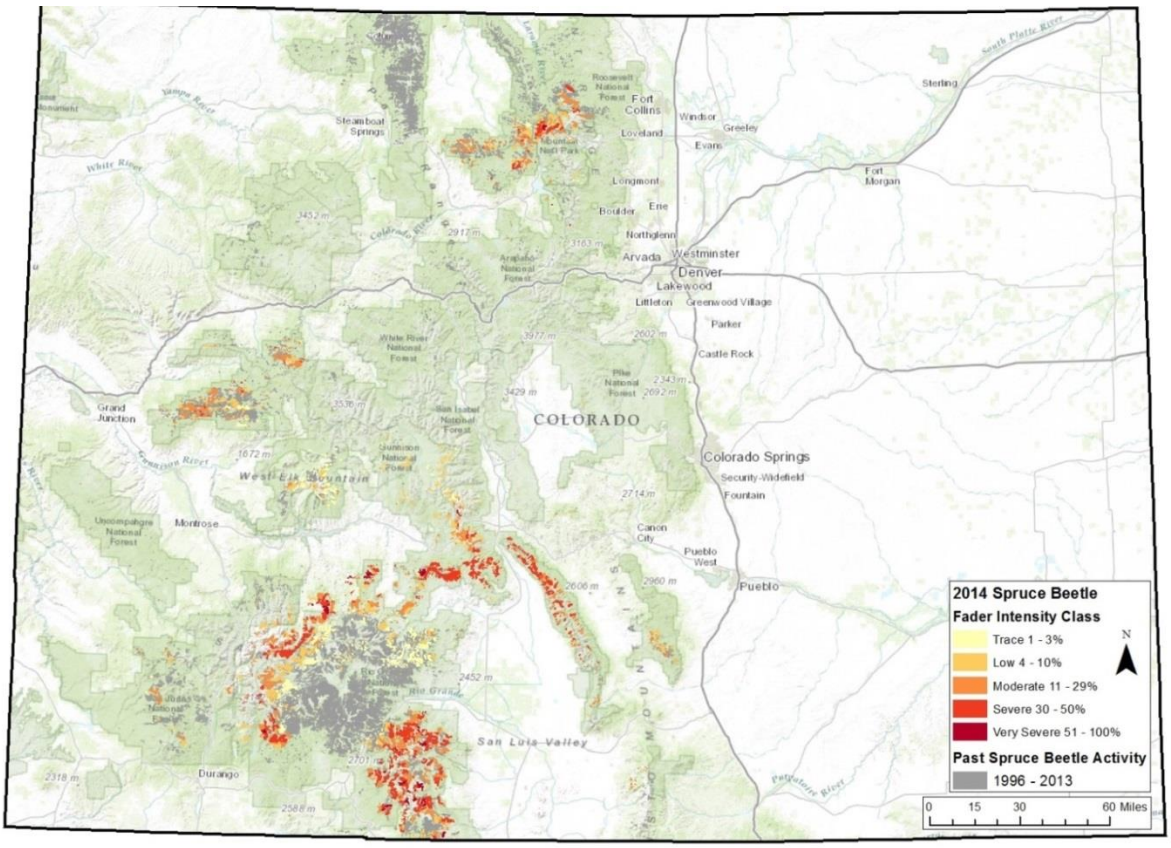

Figure 2. Spruce beetle activity in Colorado 1996-2014 (USDA Forest Service 2014d, Forest Health Protection).

Generally trees down to 8 inch dbh and in some cases smaller trees are being affected (Eager, pers. comm). Most (>90%) of mature over-story trees are dying from beetle infestation in affected areas, usually within 18 months to 2 years. Regeneration of the understory can be extensive in some instances and lacking in others. Where regeneration occurs, the stand is shifted from mature (habitat structural stage 4B and 4C) to shrub-seedling (habitat structural stage 2T/2S) or sapling pole (habitat structural stage 3A).

Effects of Climate Change on Engelmann Spruce

The warming trend on the GMUG is expected to continue, with temperatures increasing 5.4 F to 7.0 F by the years 2040 – 2060 (Mearns and Barsugli, 2009). Although there has been no major trend in the Gunnison River stream flow over the past 60 years, there has been a trend toward earlier snowmelt and peak stream flow, leading to a longer growing season, which in turn increases the demand for water needed for healthy forests. Projections for annual precipitation range from a 10% decrease to no change. Most research for mid-latitude locations indicates the greatest temperature change should be at high elevations, where spruce-fir forests tend to occur. Even with no change in precipitation, the longer, warmer summers could lead to severe moisture stress. In order to explore effective methods of forest management under changing climatic conditions, a bioclimatic model created by Rehfeldt, et al. (2006) was used to project changes in climatic suitability for spruce in the western United States. Results projected a 47% drop in suitable spruce habitat in the decade around 2060, and a 72% loss of spruce habitat by 2090. Only 23% of habitat was expected to persist in place through 2100 (Rehfeldt, et. al 2006).

For application on the GMUG, the bioclimatic model was rebuilt using local data, more topographical predictors, newer global climate models (GCMs) and carbon scenarios, and higher-resolution climate data (Rehfeldt et al. 2015). The decade surrounding 2060 was selected as the target timeframe. Projections are an average of those from three GCMs and three greenhouse gas emission scenarios.

Habitat for spruce was classified into the following four zones, using the decade 2060 as the target timeframe:

- Lost Habitat – future climate is so unfavorable that spruce is unlikely to survive the century.
- Threatened Habitat – future climate will be unfavorable, but climate-based seed transfer guidelines and low basal areas may allow spruce to persist.
- Persistent Habitat – future climate is expected to be minimally favorable to favorable, through 2060.
- Emergent Habitat – Future climate is expected to be suitable to spruce; these areas are currently outside spruce habitat.

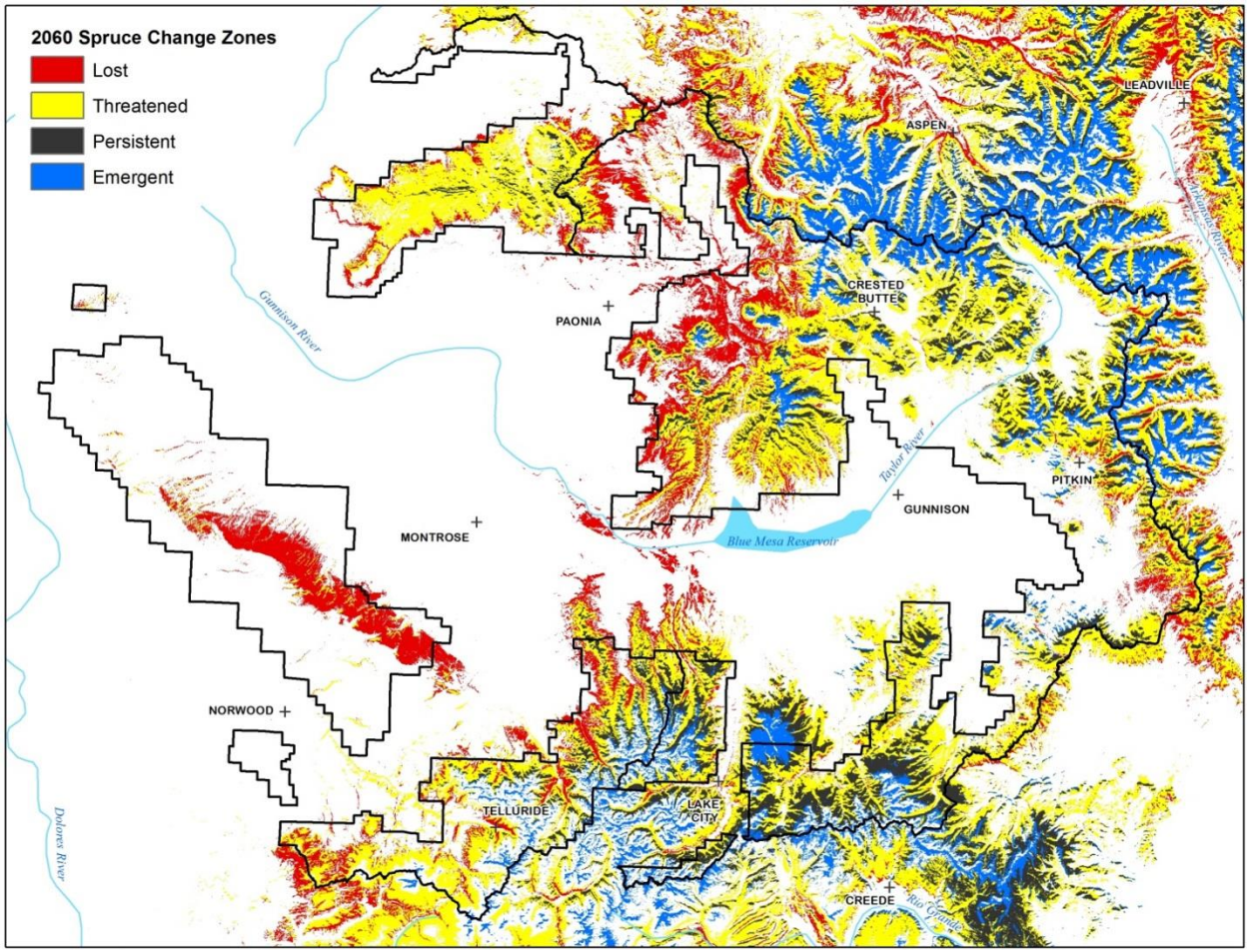

Figure 3. Future climatic habitat zones of Engelmann spruce.

The Rehfeldt (2015) model (Figure 3) projects little remaining habitat for spruce on the Uncompahgre Plateau, and substantial loss in the West Elk Mountains, east of Grand Mesa, and south of the Black Canyon/Blue Mesa Reservoir. Much of the Grand Mesa and low elevations elsewhere are in the threatened zone. Increases in suitability (emergent habitat) are expected in high elevations in the eastern part of the GMUG. About 22% of the current spruce distribution is classified as lost and 58% is classified as threatened, meaning that it is conceivable that 80% of current spruce distribution may not continue into the next century. Projected rates of climate change are faster than the response rate of natural systems (Davis, Shaw, and Etterson, 2005). Thus, if no forest management action is taken, it will most likely result in the gradual conversion of spruce forests in “lost” and threatened zones to other forest and non-forest cover types (Rehfeldt, et al., 2015).

Aspen

Aspen is an important component of GMUG’s forests. Over 712,000 acres of aspen-dominated forest type occur across the GMUG.

Aspen is a unique and important tree species in western North America, where aspen is the most diverse upland forest type. Of roughly 1,669 species of wood-decay fungi tallied in North America, Gilbertson (1980) noted 260 on aspen, more than on any other tree species, many of which are specialized on aspen. Bird species richness and total abundance are higher in aspen stands than in other North American montane habitats (e.g., Turchi *et al.* 1995), and many species show strong preferences for aspen trees or forests for nesting habitat (Flack 1976). Aspen modifies soil properties and microclimate in ways that foster luxuriant growth of varying herb and shrub layers, and are therefore major contributors to plant species diversity (Kuhn *et al.* 2011, Mueggler 1985). Aspen improves streamflow and habitat for plants and animals by improving water movement. Results of modeling based on rates of water movement by season in various tree species suggested significantly greater water yield from aspen than from conifer forests (Gifford *et al.* 1984). The importance of aspen communities to large ungulates such as elk is well known, and in dry forest ecosystems, patches of aspen are also hotspots of diversity for small mammals (Oaten & Larsen 2008). Thus, aspen is truly a keystone species, and as such its loss leads to substantial alteration of habitat conditions and loss of species diversity.

In addition, aspen forests have significant economic value based on tourism and fiber production. Esthetically, aspen contribute a major share of Colorado's scenic beauty. Tourism is the second largest industry in Colorado, with tourists spending $17 billion in the state in 2012 (Tourism Pays, Denver Convention and Visitor Bureau). The properties of aspen wood make it valuable for paneling, oriented strandboard, excelsior and chips (used in erosion control and oil-spill cleanup), all of which are or were produced in southwestern Colorado.

Finally, aspen forests, like other forest types, store considerable carbon in above- and below-ground biomass (and especially for aspen, in the soil). As aspen stands mature and regenerate, there is a cycle of carbon release and sequestration with a high net storage of carbon. If aspen forests are replaced by shrub or meadow communities with lower carbon storage capacities, the difference will contribute to atmospheric CO_2. Aspen mortality episodes in the aspen parkland of Alberta and Saskatchewan and in southwestern Colorado are expected to result in significant carbon release and positive feedbacks to climate change (Huang & Anderegg 2012, Michaelian *et al.* 2011).

Habitat structural stages for the aspen cover type for each geographic area on the GMUG, as assessed in 2006, are presented in Table 3 (USDA Forest Service, 2006e). Overall, aspen was dominated by mature and dense stand conditions (4B and 4C) across all GA. Where age data existed, most aspen ranged from 80 to 120 years old. The highest percentage (>70%) of stands in a mature condition existed on the Grand Mesa, San Juan Mountains and the Uncompahgre Plateau. The following section, *Sudden Aspen Decline (SAD),* concludes with a discussion of how sudden aspen decline on the GMUG has shifted structural stages.

Table 3. Current Aspen Vegetation Characterization for GMUG by Geographic Area, 2006.

GA	Cover Type	Composition of GA	Age Distribution	Habitat Structural Stages[1]	Canopy Conditions
Gunnison Basin	Aspen	197,500 acres (14%)	Most aspen is between 80 to 120 years old.	3A - 9% 3B – 34% 3C – 10% 4A- 5% 4B – 22% 4C – 21%	26% single-storied 74% multi-storied 96% continuous canopy
Grand Mesa	Aspen	94,500 acres (26%) (60% pure aspen, 39% with spruce-fir in species mix, 1% with other tree species in mix)	Ranges from 16 to 131 years. Most aspen is between 80-120 yr. old.	2T- 2% 3A – 2% 3B- 10% 3C- 3% 4A – 1% 4B- 28% 4C- 54%	27% - single-storied 73% - multi-storied 98% - continuous canopies
San Juan Mountains	Aspen	76,200 acres 20%.	Age data not available	3A – 9% 3B – 12% 3C – 1% 4A – 4% 4B – 71% 4C – 3%	82% - single-storied 18% - multi-storied 71% - continuous canopies
North Fork Gunnison River	Aspen	212,600 acres 40%.	Age data not available	2T - <1% 3A – 7% 3B – 41% 3C – 6% 4A – 3% 4B – 16% 4C- 26%	40% - single-storied 60% - multi-storied 99% - continuous canopies
Uncompahgre Plateau	Aspen	160,100 acres 25% of NFS lands 4% of total GA 71% of aspen is on NFS land.	Most aspen is between 80-120 yr. old.	2T – 1% 3A – 9% 3B – 25% 3C- 3% 4A – 2% 4B – 44% 4C – 16%	65% - single-storied 35% - multi-storied 86% - continuous canopies

[1]Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T/1M	Grass-Forb	Not applicable	0 – 10%
2T/2S	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

Generally speaking, the aspen cover type was dominated by late-mid and late seral stages as compared to modeled PNV (Table 4; USDA Forest Service, 2006e).

Table 4. Succession (Seral Stages) in Aspen PNV Types by GA, 2006.

Aspen PNV	Early Seral	Early-Mid Seral	Late-Mid-Seral	Late
VDDT Model - PNV	*8-14%*	*23-26%*	*17-24%*	*23-43%*
Existing Vegetation Condition				
Grand Mesa	3%	15%	82%*	
Gunnison Basin	6%	43%	50%*	
North Fork Valley	5%	58%	36%*	
San Juans	4%	25%	72%*	
Unc. Plateau	13%	41%	46%*	

Sudden Aspen Decline (SAD)

SAD was first noticed in southwestern Colorado in 2004 (Worrall *et al.* 2008). On the San Juan National Forest, large and growing patches of crown thinning, branch dieback, and mortality were found. It occurred on a landscape scale and rapidly increased in area and severity. Over the next few years, SAD spread to the Uncompahgre Plateau, the Grand Mesa, and the Gunnison River basin. Aspen throughout Colorado was affected. In 2008, 543,630 acres were affected in Colorado (Worrall *et al.* 2010). About 45% of that area was rated as “severe,” indicating estimated mortality over 50% of the overstory.

From 2000-2010, 1,322,000 acres were impacted by SAD in the Southern Rockies ecoregion, with 1,216,000 acres in Colorado (an estimated 17% of the aspen cover type in the state) (Worrall *et al.* 2013). The GMUG was affected more severely, with approximately 31% (over 229,000 acres) of the GMUG’s aspen affected from 2000 to 2010. In 2009, the detection of new areas dropped considerably, with few new areas mapped since that time. However, stands currently exhibiting SAD continue to decline, so aspen mortality continues.

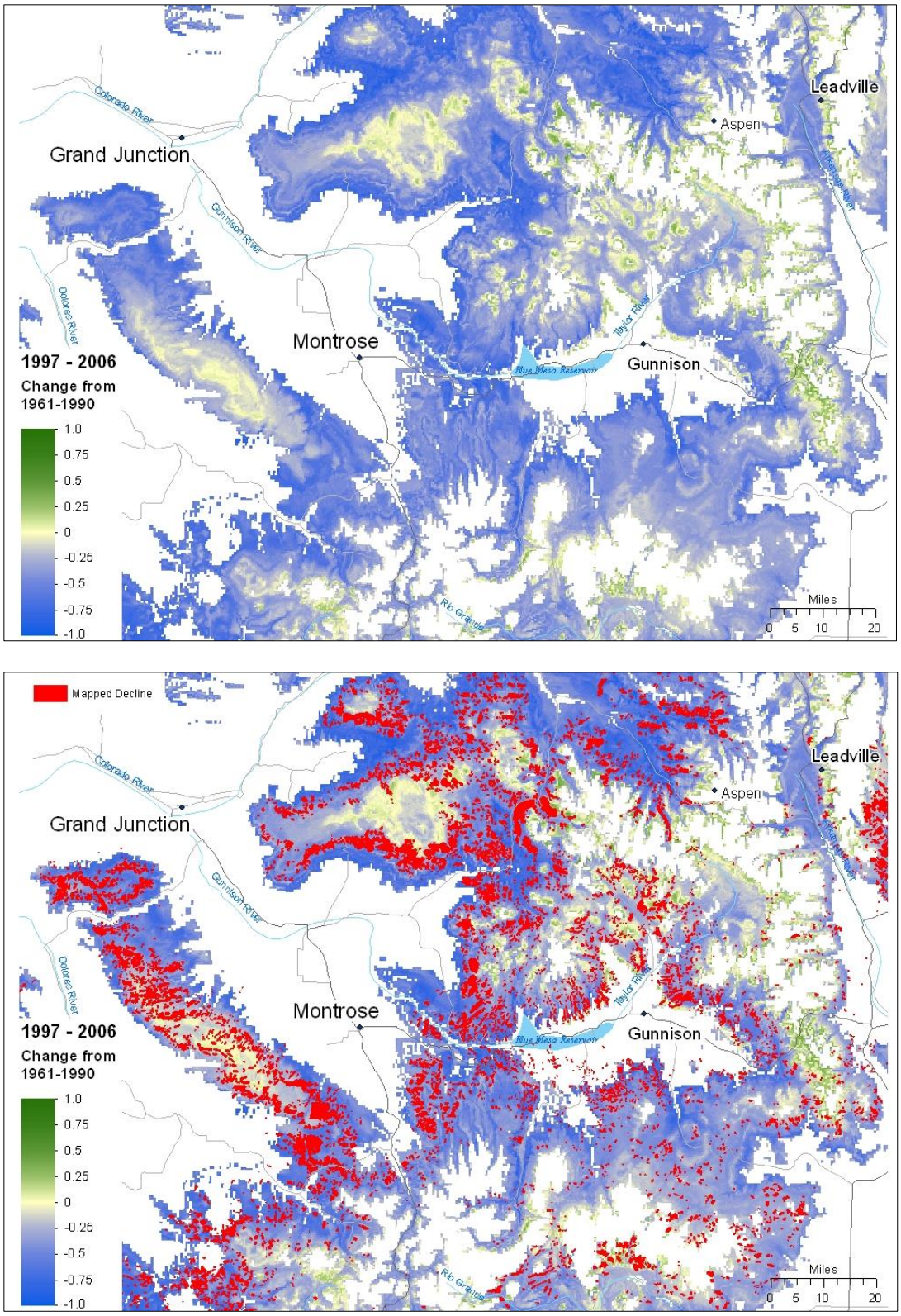

Figure 4. Change in climatic suitability for aspen (top) and overlying mapped aspen decline (bottom) (Worrall et al. 2013).

In Figure 4, the top map and underlying layer of bottom map indicates change in climatic suitability for aspen between the reference period, 1961-1990, and the decade preceding and accompanying the recent episode of SAD, 1997-2006 (provided by Andreas Hamann, Univ. Alberta). Blue indicates decrease in suitability; green an increase. SAD tended to occur where climate suitability decreased (blue areas do not necessarily have significant aspen). The mapped decline of aspen, show in red on the bottom map, is from aerial survey data gathered 2000-2010.

Although the cause of SAD was initially unknown, examinations of outbreaks found a link between moisture stress and SAD. Damage was highest at low elevations, where temperature is high and precipitation is low (Dudley 2011, Worrall *et al.* 2008). Damage tended to be high on south and west-facing slopes and on the shoulders and summits of slopes (Huang & Anderegg 2012, Worrall *et al.* 2008). Southwestern Colorado had a drying trend from the mid-1980s to 2002, culminating in a record drought in much of Colorado (Pielke *et al.* 2005). In 2002, areas with SAD had lower values of climate moisture index than did aspen areas that remained healthy (Worrall *et al.* 2010). Various moisture indices showed that the area underwent a protracted, severe moisture deficit (Worrall *et al.* 2013). Climatic suitability for aspen generally decreased around the time of SAD, and SAD tended to occur in marginal sites where suitability decreased the most (Figure 4).

While the evidence that severe, warm drought incited SAD was clear, a broader view gives a more comprehensive concept of the cause. Stand conditions, especially low density and openness, may have also predisposed stands to damage. Aspen bark beetles, bronze poplar borer, poplar borer, and Cytospora canker killed trees that had been stressed by drought (Marchetti *et al.* 2011). Thus, the predisposing and contributing factors played important roles, in addition to the inciting factor, drought.

A ground survey in 2007 and 2008 sampled the entire GMUG and the Mancos-Dolores Ranger District of the San Juan National Forest (Worrall *et al.* 2010). Areas identified as SAD by aerial survey had an average 54% recent crown loss and 45% mortality. SAD plots had higher root mortality than healthy plots (Worrall *et al.* 2010), and regeneration counts showed no evidence of increased suckering in response to the overstory damage (Dudley 2011, Worrall *et al.* 2010). Some patches of aspen at the lower-elevation fringe were completely dead with no regeneration. Remote sensing over 2009-2011 suggested that 30% of the total aboveground aspen biomass was dead in a large section of southwestern Colorado, with the resulting carbon emissions expected to provide an amplifying feedback to climate change (Huang & Anderegg 2012).

Approximately 54%% of the stands on the GMUG are experiencing regeneration, shifting the stand to a younger age class. Approximately 46% of the affected stands have limited (<120 stems/acre) or no regeneration.

SAD vs. "Aspen Decline"

As described, sudden aspen decline is a rapid, landscape-scale deterioration of overstory aspen incited primarily by drought and warm temperatures. It is often confused with an older concept of "aspen decline". The latter refers to a long-term (over many decades) decrease in the area of aspen due primarily to succession (Bartos 2001, Bartos & Campbell 1998). Factors that have been suggested to lead to it include a large increase in aspen associated with fires during the time of European settlement, subsequent fire exclusion, and overgrazing (Bartos & Campbell 1998, Kulakowski *et al.* 2004).

Effects of Climate Change on Aspen

Due to expected increases in dry weather, especially drought, more cases of SAD are expected. Suitability for aspen in the Southern Rockies is expected to deteriorate rapidly through the rest of the century. Rehfeldt's (2015) bioclimatic model (Figure 4) and studies on climatic change point to a complete loss of aspen in some lower-elevation sites and on south slopes, while at the other extreme, aspen habitat is expected to persist and newly suitable habitat may emerge at higher elevations and north slopes.

As with spruce, aspen were also classified into suitable habitat by geographic zones based on expected climatic changes (Rehfeldt *et al.* 2015) .

- Lost Habitat– future climate will be so unfavorable that aspen is unlikely to survive the century.
- Threatened Habitat– future climate will be unfavorable, but young stands will probably survive. Opportunities would exist to treat to distribute young patches on landscape and to help SAD stands recover.
- Persistent Habitat – future climate will remain suitable for aspen. No climate-change adaptation needed, but normal management may proceed. Opportunities would exist to promote existing aspen near emergent habitat.
- Emergent Habitat – future climate will become suitable; areas are currently outside distribution. Opportunites to facilitate migration into this zone would exist, via allowing or creating disturbance (mechanical and/or fire).

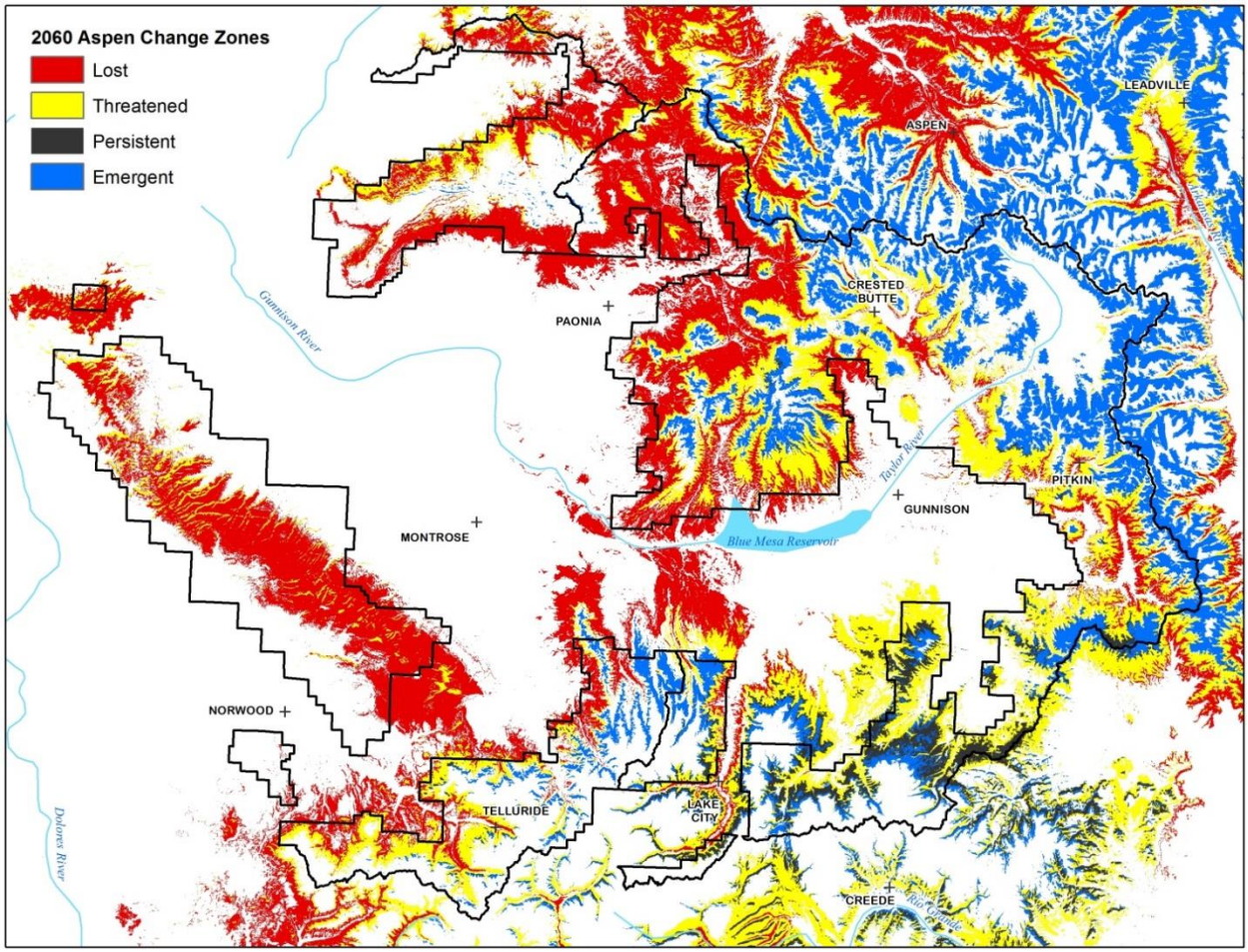

Figure 5. Future habitat zones of aspen.

Results of the bioclimatic model show that 52% of the current aspen distribution on the GMUG is in the lost category and 42% is in the threatened category, meaning it is conceivable that 94% of current aspen distribution may not continue into the next century (Figure 5). In general, habitat will be lost at low elevations, especially on south aspects, while new habitat will emerge at elevations above the current distribution of aspen. Little suitable habitat is expected to remain on the Uncompahgre Plateau, the southern and eastern fringes of the Grand Mesa, and the western West Elks. The remainder is largely threatened, as persistent habitat is mostly limited to the southeastern portion of the GMUG. However, there are substantial areas of Emergent habitat in the higher elevations.

The following tactics have proven effective for aspen management:

1. Aspen stands dying from SAD can be regenerated when less than 50% of the stand has been affected. Stands can be treated by removing overstory through coppice cuts and prescribed fire.

2. Young stands of less than 40 years old have been found to be more resilient to drought; ensuring that there are significant patches of aspen under 40 years old will increase resilience of aspen clones.
3. Preparing a seed source and seedbed can facilitate aspen migration into newly suitable habitat.

The following strategy for aspen management is recommended by Worrall, et al. (2014) to employ the climate change projections:

1. **Resilience**: regenerate patches of mature aspen, or mixed stands with an aspen component in threatened habitat zone to increase younger component on the landscape.
2. **Recovery**: Treat previously affected SAD stands to aid recovery and regeneration, but treatments in the "lost" zone may not be durable.
3. **Migration**: Conduct treatments and/or allow natural disturbances to proceed in the persistent and emergent habitat zones in order to facilitate self-migration of aspen.

During extreme climate periods causing new SAD episodes, it may be necessary to prioritize resilience treatments in new SAD patches before canopy loss reaches 50%. Such treatments should also concentrate on the threatened habitat zone.

It should be recognized that while the bioclimatic model is quite effective at replicating the distribution of spruce and aspen at large scales, at smaller scales, errors of omission (predicting absence where spruce/aspen occur) and errors of commission (predicting presence where no spruce/aspen occurs) can be seen. Climate projections are based on a representative carbon pathway that may not represent the actual future trend in greenhouse gasses. For example, conditions projected for 2060 could occur sooner if emissions are higher than projected or later if they are lower. For these reasons, although boundaries between future habitat zones are mapped as though precise, ideally they should be regarded as a best estimate and the timing of projected changes as likely but uncertain.

Project Area

The Spruce Beetle Epidemic and Aspen Decline Management Response project (SBEADMR) includes stands affected by the spruce beetle epidemic and sudden aspen decline, including those that are considered threatened or at high risk. The area covered by this project includes spruce, aspen, and spruce/aspen mix on National Forest System (NFS) lands within the GMUG, excluding designated Wilderness Areas, Roadless Areas, or are designated as a special area (Research Natural Areas, Botanical Areas, etc.). Consistent with previous Forest-wide planning efforts, the SBEADMR FEIS divides the GMUG Forests into distinct Geographic Areas (GAs; see Figure 6). Throughout the FEIS, proposed actions are summarized and depicted by GA in order to provide more context both for analysis and for the interested public.

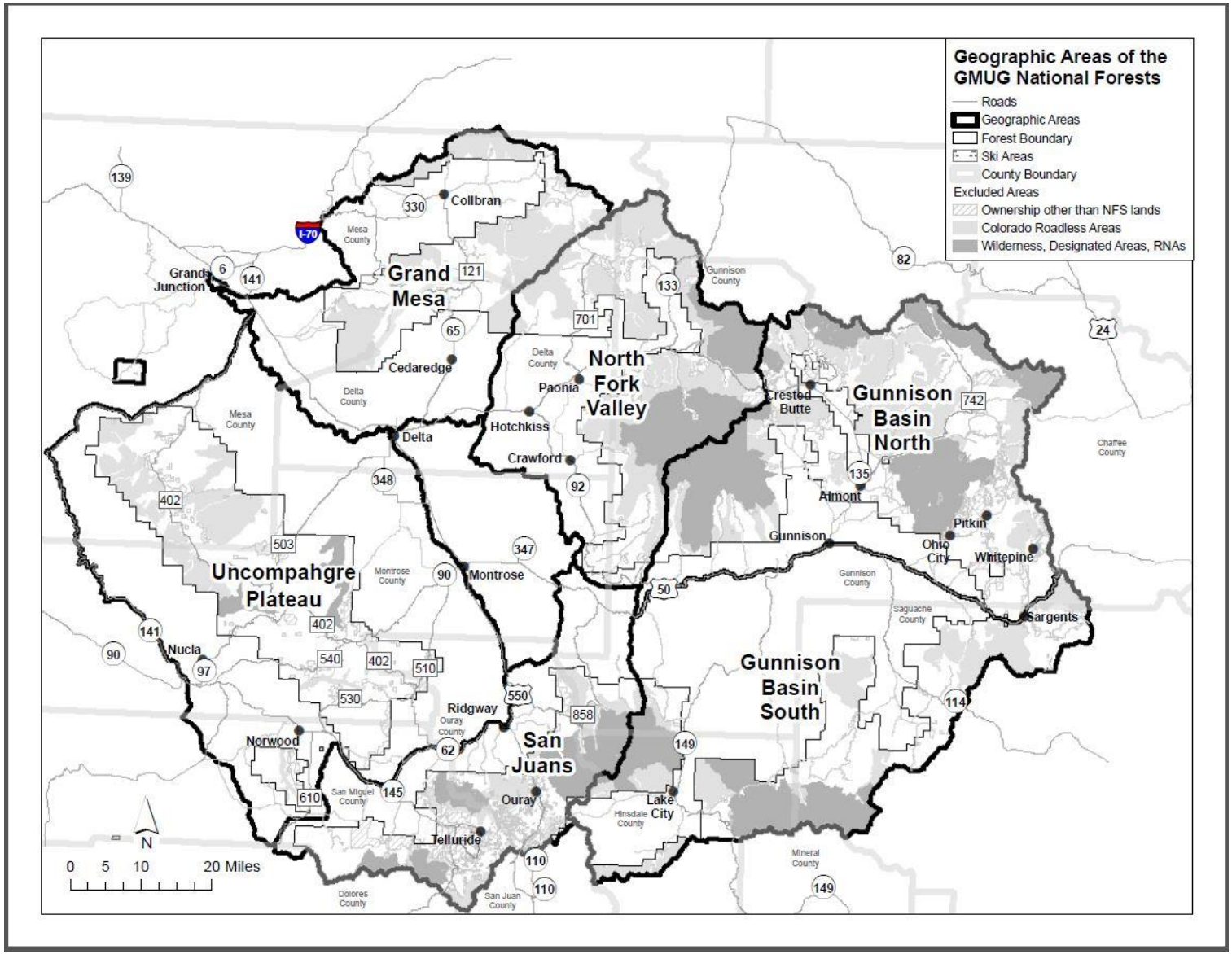

Figure 6. Geographic Areas (GAs) on the GMUG National Forests. GAs are referenced throughout the FEIS.

Purpose and Need for Action

The purpose of the project is to reduce the safety threats of falling, dead trees and of managing wildfires on the landscape (safety); improve the resiliency of stands at-risk of insect and disease (resiliency); and to treat affected stands via recovery of salvageable timber and subsequent re-establishment of desired forest conditions (recovery). Given the substantial mortality of spruce-fir and aspen forests on the GMUG over the past decade, the need for the project is to manage forest vegetation to bring current and foreseeable conditions closer to desired conditions on landscapes available for active management. On these landscapes, vegetation management would be used to help sustain or promote potential natural vegetation types. Desired conditions include a balance of habitat structural stages, tree species composition, and seral stage distributions that are appropriate for each vegetation type across the geographic areas of the GMUG (See Figure 6). Furthermore, in the context of a changing climate conducive to more frequent and extensive wildfires in forests at high elevation irrespective of tree condition (Westerling et al. 2006, Agee 2007; Funk 2012; Rangwala and Rondeau, unpub.), desired conditions for fire and fuels management include more locations across the landscape from which firefighters can safely and effectively manage or suppress fires for values at risk and/or resource benefit.

The following goals elaborate on the stated purpose:

Public Safety[1]

1. Remove hazard trees proximal to roads, utility corridors, communication sites, dispersed recreation sites, developed campgrounds and other recreation sites, and within ski areas both within and outside the wildland urban interface (WUI).
2. Increase the extent of defensible space around values at risk.
3. Provide safer locations from which firefighters can initiate fire management actions.

Resiliency

1. Increase the forest's ability to respond to multiple and interacting stresses, including climate change, insect attack, drought or disease.
    a. In healthier spruce-fir stands, promote regeneration and create multiple age classes of trees.
    b. Where the beetle population is endemic, minimize spread of bark beetle from infected stands to neighboring healthy stands.
    c. Promote aspen regeneration via active treatments in live stands, with emphasis on those affected by Sudden Aspen Decline.

Recovery

[1] Note that treatments to meet public safety goals may simultaneously meet recovery or resiliency goals.

1. Provide commercial forest products to local dependent industries at a level commensurate with Forest Plan direction and in harmony with other Plan goals (1991 GMUG Amended Forest Plan, p. III-3).
2. Subsequent to treatment, treat fuels, prepare sites, and re-establish and maintain forest cover via replanting where seed sources are lacking.

The purpose and need is adapted from the Western Bark Beetle Strategy (USDA Forest Service, 2011i) and furthers goals identified within the National Cohesive Wildland Fire Management Strategy (USDA & USDI 2014).

Proposed Action

The Forest Service developed the Proposed Action (Alternative 2), now the Agency Preferred Action, to meet the purpose and need outlined above.

Alternative 2 analyzes 207,615 acres of potential disturbance acres. 190,014 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 17,388 acres as potential hazard tree treatments outside of PTAs, and 213 acres are for potential new road disturbance outside of PTAs. Both PTAs and potential hazard tree treatments are located in spruce, aspen, and aspen-mix cover types. Of the PTA acres, approximately 59% (112,768 acres) are identified as commercially suitable timber acres, and 41% (77,246 acres) are identified for noncommercial treatment.

As noted in *Chapter 2*, *Activities Common to All Alternatives*, maximum commercial treatments would total 60,000 acres and maximum noncommercial treatments would total another 60,000 acres, for a total of 120,000 maximum treated acres. Therefore, for commercial treatments, approximately 1 of every 2 acres analyzed for commercial treatment in the Preferred Alternative would be treated. For noncommercial, approximately 1 of every 1.3 acres analyzed for noncommercial treatment in the Preferred Alternative would be treated.

Commercial mechanical treatment is ground-based mechanized timber cutting that produces a commercial product. In the SBEADMR EIS, commercial treatments are limited to those areas designated as suitable for timber production in the Forest Plan. Non-commercial mechanical treatment is ground-based mechanized timber cutting that does not produce a commercial product, and includes use of mechanized equipment for tree cutting, mastication, and hand treatments using chainsaws. Prescribed fire includes broadcast burns and pile burns.

The Proposed Action, as with each action alternative, would be implemented using an Adaptive Implementation Framework, as detailed further in Chapter 2.

Management Direction and Strategies

Direction and national strategies guiding the proposed action and action alternatives is summarized below.

National Policy and Direction

Ecological Restoration and Resilience (FSM 2020)

Forest Service policy on ecological restoration and resilience was first written as an interim directive in 2008, and revised in 2010, 2011, and 2013. Final Forest Service policy on these topics was proposed in 2013. The proposed directive provides broad foundational policy for using ecological restoration to manage National Forest System lands in a sustainable manner. The policy spans all resource areas and activities applicable to land management and establishes a common definition for ecological restoration and resilience that is consistent with the 2012 Land Planning rule. The discussion below follows the latest (2013) interim directive, because that is current Forest Service policy.

The objective of restoration is stated as follows:

"The aim is to reestablish and retain ecological resilience of National Forest System lands and associated resources to achieve sustainable management and provide a broad range of ecosystem services. Healthy, resilient landscapes will have greater capacity to survive natural disturbances and large scale threats to sustainability, especially under changing and uncertain future environmental conditions, such as those driven by climate change and increasing human uses." (FSM 2020.2, Objective, interim directive).

Ecological restoration activities may include recovery from high-severity fires, restoring terrestrial and aquatic habitat, and watershed restoration treatments, among others. The policy incorporates consideration of increased human use and climate change on National Forest System lands when developing restoration and resilience activities. The directive reinforces the use of adaptive management, scientific information, and collaboration in agency planning and decision-making.

The directive defines restoration as:

"The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions." (FSM 2020.5).

Adaptive management is defined as:

"A system of management practices based on clearly identified outcomes and monitoring to determine if management actions are meeting desired outcomes, and if not, to facilitate management changes that will best ensure that outcomes are met or reevaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain." (36 CFR 219.16; FSM 1905; FSM 2020.5). In context of the SBEADMR

project, desired outcomes are associated with tree species and structural stand conditions and successful implementation of project design features designed to minimize/eliminate impacts to natural resources.

National Strategy

Western Bark Beetle Strategy

The Western Bark Beetle Strategy (USDA Forest Service, 2011i) was developed in response to current bark beetle epidemic in the western United States. The strategy addresses the three prongs of the bark beetle problem: human safety, forest recovery, and forest resiliency. Due to budget constraints and the scale of the epidemic, the Forest Service recognized it could not treat all affected acres, and the Strategy prioritized treatments areas with human safety as the first priority, followed by recovery and resiliency.

National Cohesive Wildland Fire Management Strategy

In the Federal Land Assistance, Management, and Enhancement Act of 2009 (FLAME Act), Congress mandated the development of a national cohesive wildland fire management strategy to comprehensively address wildland fire management across all lands in the United States. Shortly after enactment of the FLAME Act, a three-phased, intergovernmental planning and analysis process involving stakeholders and the public was initiated: the National Cohesive Wildland Fire Management Strategy, more commonly referred to as the Cohesive Strategy. Its vision for the next century is “to safely and effectively extinguish fire, when needed; use fire where allowable; and as a Nation, live with wildland fire” (USDA & USDI). The Cohesive Strategy is an effort to work collaboratively among all stakeholders and across all landscapes, using best science, to make meaningful progress towards three identified goals: resilient landscapes, fire-adapted communities, and safe and effective wildfire response. The SBEADMR project is informed by the Cohesive Strategy’s identified goal of achieving and maintaining resilient landscapes via fire and non-fire vegetation and fuels management.

Forest Plan

The 1991 Grand Mesa, Uncompahgre and Gunnison National Forests Amended Land and Resource Management Plan (Forest Plan), is the programmatic document required by the rules implementing the Forest and Rangeland Renewable Resources Act of 1974 (RPA) as amended by the National Forest Management Act of 1976 (NFMA). The purpose of the Forest Plan is to provide direction for the multiple use and sustained yield of goods and services from NFS lands in an environmentally sound manner. The Forest Plan provides overall goals and objectives, standards and guidelines, and management area-specific goals and objectives that direct management of the Grand Mesa, Uncompahgre and Gunnison National Forests. The Forest Plan can be viewed online on the Grand Mesa, Uncompahgre and Gunnison National Forests website:

Amended Land and Resource Management Plan, 1991
http://www.fs.usda.gov/detail/gmug/landmanagement/planning/?cid=fsbdev7_003229

The SBEADMR project is consistent with general management direction identified in the amended GMUG Forest Plan. General direction pertinent to this analysis include vegetation management, cultural resources, wildlife resources, old growth management, forest products, water quality, economics, air quality, fire, insects and disease, and soil resources (Forest Plan, 1991, pp. III-2 through III-5).

General Direction for Forest Plan Management Areas

The Forest Plan set management allocations for specific uses of land and established twenty Management Areas (MA) within the Forest to meet multiple use objectives (p. III-86). The MAs that overlap with the planning area for the SBEADMR project area are noted in Table 5, along with the percentage distribution of each action alternatives' area throughout these MAs.

Because activities are proposed in ski areas on the GMUG, Management Area 1B, implementation will also need to comply with the established vegetation management plans for each ski area.

Table 5. Management Area Summary by Action Alternative.

		% Distribution by MA	
Treatment Category & MA	**Management Area Description**	**Alt 2**	**Alt 3**
Commercial		**44%**	**30%**
1B	Downhill Skiing and Winter Sports	3%	8%
2A	Semi-Primitive Motorized Recreation Opportunities	4%	5%
2B	Roaded Natural and Rural Recreation Opportunities	4%	5%
4B	Wildlife Habitat Management For One or More Management Indicator Species	4%	7%
4D	Aspen Management	7%	10%
6B	Livestock Grazing - Maintain Forage Composition	15%	14%
7A	Timber Management on Slopes Under 40 Percent	63%	52%
Noncommercial		**56%**	**70%**
1B	Downhill Skiing and Winter Sports	1%	2%
2A	Semi-Primitive Motorized Recreation Opportunities	9%	9%
2B	Roaded Natural and Rural Recreation Opportunities	3%	5%
4B	Wildlife Habitat Management For One or More Management Indicator Species	12%	15%
4D	Aspen Management	8%	8%

		% Distribution by MA	
Treatment Category & MA	**Management Area Description**	**Alt 2**	**Alt 3**
5A	Big Game Winter Range in Non-Forested Areas	18%	16%
5B	Big Game Winter Range in Forested Areas	6%	4%
6B	Livestock Grazing - Maintain Forage Composition	26%	26%
7A	Timber Management on Slopes Under 40 Percent	16%	15%
Total		**100%**	**100%**

Applicable Standards and Guidelines

All Forest Plan standards and guidelines are 116 pages in length and cannot be summarized here. Applicable standards and guidelines for the SBEADMR project are identified and addressed under unique resource area analysis in *Chapter 3, Affected Environment and Environmental Consequences.* The proposed action and action alternatives are consistent with applicable standards and guidelines, and validation of Forest Plan compliance would be completed during treatment implementation (See Appendix C).

Lands Suited for Timber Production

According to the National Forest Management Act (NFMA) regulations, timber production and commercial harvest generally may only take place on lands classifed as suitable lands (36 CFR 219.14).

As stated in 36 CFR 219.14(c), lands identified as "tentatively suited" for timber production must be further evaluated to determine which lands are "not appropriate" for timber production to meet the objectives of each alternative analyzed in detail. Pages B-7 to B-10 of the GMUG Forest Plan describe the process used to identify lands not suitable for timber production. Factors used to identify areas not suitable for timber production include low productivity sites, steep slopes (>40%), sites where irreversible damage could occur, and visually sensitive areas. In the GMUG Forest Plan, the Forest evaluated all tentatively suited lands on a site-specific basis using 1:24,000 scale topographic maps together with field verification and on-the-ground knowledge of Ranger District personnel.

Tentatively suited lands which pass through this screen are considered "suited" for timber production; however, during treatment reconnaissance and layout, Forest Service personnel can exclude portions of these lands from commercial harvest based upon these factors and other considerations for resource protection.

NFMA regulations also provide direction regarding resource protection and re-establishment of trees within five years of harvest.

Decision Framework

The SBEADMR Project purpose and need provides the focus and scope of the proposal as related to National and Forest level policy and direction. Given this purpose and need, the Deciding Official (Forest Supervisor) reviews the proposed action, the issues identified during scoping, the alternatives, and the environmental consequences of implementing the proposal and alternatives disclosed in this EIS. This forms the basis for the Deciding Official to make the following determinations:

- Whether or not the proposed alternatives address the issues, are responsive to law, regulation, policy and Forest Plan direction, and meet the purpose of and need for action in the SBEADMR EIS.
- Whether or not the information in this analysis is sufficient to implement proposed activities.
- Which alternative, if any, to approve (decide which alternative or mix of alternatives to authorize).

Public Participation

Based on the rapid spread and epidemic nature of the infestation and decline of spruce beetle infestation and aspen on the GMUG, the Forest Service initially decided to utilize a traditional approach where public comment is sought through scoping. On the spectrum of public participation from inform→consult→involve→collaborate, the GMUG's initial public participation approach for SBEADMR was on the inform/consult end of the spectrum. After conducting formal scoping the Forest Service identified public interest in a higher level of public involvement and collaboration for the project, which influenced the Forest Service's subsequent strategies for public participation with respect to SBEADMR, discussed in further detail below.

Beginning in 2012, prior to the formal initiation of SBEADMR, GMUG provided updates and presentations to the existing Public Lands Partnership (PLP) collaborative, community groups, news media, and to the local boards of county commissioners about the spruce beetle activity on the Forests.

The SBEADMR project was entered into the GMUG's Schedule of Proposed Actions (SOPA) on July 1, 2013. The SOPA for each national forest contains a list of proposed actions that will soon begin or are undergoing environmental analysis and documentation. The SOPA serves as a tool so the public can be-aware of and indicate interest in specific proposals.

On the GMUG website, a project page was established for the SBEADMR so the public could access relevant project documents online throughout the process.

The Notice of Intent to Prepare an Environmental Impact Statement (NOI) was published in the Federal Register on July 31, 2013. The NOI asked for public comment on the proposal from

August 2, 2013 to September 1, 2013. A Legal Notice/Opportunity to Comment was published in the Grand Junction Daily Sentinel (the newspaper of record for Forest Supervisor decisions) on August 2, 2013. The Legal Notice provided similar information as the Notice of Intent and identified how and where to provide comment on the project. In addition, a communication plan for the SBEADMR was established and updated throughout the planning process to ensure coordinated outreach and communication for the project.

A scoping letter was mailed to approximately 1,300 potentially interested individuals, including adjacent landowners, federally recognized tribes, other federal agencies, and federal, state and local government representatives on July 29, 2013. The letter included a description of the project area, an overview of the analysis (NEPA) process, a general explanation of the actions proposed, the reasons for the proposal and an invitation to comment. The GMUG received 28 scoping comment letters and emails during the scoping period. Based on the comments received the interdisciplinary team developed a list of issues and concerns associated with the project.

The purpose of the project, the intent to prepare an EIS and the extent of the infestation was discussed with various stakeholder groups and interests by forest and regional officials in concurrence with the joint Forest Service/Colorado State annual survey report on forest health and subsequent to publishing the NOI. In addition, discussions about SBEADMR and the extent of the beetle infestation were conducted with local units of government, various interest groups and county boards of commissioners to address the need for the project and seek comment. Updates and progress reports on the project continued during the analysis with these same stakeholders.

Despite the initial intent of the Forest Service to pursue a more limited inform/consult mode with respect to public participation for the SBEADMR project, after the scoping period and subsequent scoping meetings, stakeholder interest in more extensive involvement was clear. Throughout the SBEADMR development and analysis, the GMUG invested much effort to inform, consult, and involve interested individuals; to explain the purpose and need; to seek input and comment on the science, ecology, tools and monitoring for the project and to incorporate information that stakeholders felt was important to consider. Extensive documentation, draft information, question and answer documents, implementation tools, science references and resource reports were maintained and posted on the project website and opportunity to comment and receive input/response were afforded to promote understanding, consideration and collaboration on the SBEADMR. Yet direct contact with stakeholders through a variety of public workshops, field trips, and a third-party-facilitated Working Group demonstrated the Forest Service's commitment to move from inform/consult closer to involve/collaborate on the spectrum of public participation with respect to the SBEADMR planning process.

Public meetings, workshops, a science meeting and a field trip were convened and facilitated by the Public Lands Partnership (PLP)[2] to foster deeper understanding and seek comment into the tools, analysis, issues and options related to the project and the analysis.

The objectives of the first workshop (December 3, 2013 in Montrose, CO) were to develop stakeholder knowledge of the beetle and the infestation; promote learning about the project and beetle; and to develop more public involvement and collaboration. Speakers and talks explained the extent of the infestation; the ecology of the beetle and the paths of expansion of the infestation; introduced and explained the rationale for the SBEADMR project proposal and provided opportunities for further exploration and comment on the issues that were identified during scoping. Resource and science experts were on hand and the meeting was hosted and facilitated by the Public Lands Partnership. Approximately 90 people attended this meeting.

A second day-long workshop/meeting was convened and facilitated by PLP on May 13, 2014, in Montrose, Colorado. The objectives of this workshop were to provide: an overview of the spruce beetle epidemic and sudden aspen decline within the context of the SBEADMR; the basic science and analysis approaches used in the EIS; an overview of the adaptive implementation approach to implement SBEADMR after a decision is made; discuss the responsive actions that were being taken to address issues and concerns identified in the prior meeting; and to discuss the involvement of collaborators/stakeholders during implementation. At this meeting, stakeholders were also provided descriptions of the alternatives that were being developed based on the identified project issues and concerns. Approximately 89 people attended this meeting and stakeholders were again invited to provide peer-reviewed science that they want considered in the project and to provide suggestions/feedback/comment on the tools that were introduced for the project.

As a result of the previous workshops/meetings, stakeholders identified a desire to further explore current science related to the project. The Rocky Mountain Research Station worked to develop a panel of scientific experts from various scientific backgrounds and perspectives to address an array of pertinent science associated with the project. A day-long science workshop was hosted in Montrose, CO, on August 19, 2014. The following science was presented and discussed:

- Balancing the ecology with social and economic values.
- Aspen ecology, values and current condition.
- The combined influence of beetles, fire, blowdown and salvage on regeneration in spruce dominated forests.
- Climate projections, climate effects on disturbance and how management and disturbance may alter forest carbon storage.

[2] The Public Lands Partnership (PLP) was formed in 1992 as an informal forum to address public land issues in west central Colorado via diverse public stakeholder engagement and dialogue.

- Fire behavior after bark beetles.
- Snow dynamics and watershed response after bark beetles.
- The future landscape and framing objectives.

The science meeting and presentations were professionally video-taped to record the information for reference and to make the information available for other stakeholders who were not able to attend. Approximately 112 people attended.

A public field trip to areas of the Forests that are affected by the spruce beetle was hosted on September 4, 2014. The focus of the field trip was to help stakeholders to see the effects of the infestation on-the-ground and to discuss elements of the previous workshops and the science meeting as it applies to the affected forest. It also provided the opportunity to look at the potential to apply the tools proposed within the project and their potential application to affected stands. 60 stakeholders and 39 Forest Service staff participated in the field trip.

As a result of the public workshops, science meeting and the field trip, additional refinement of the issues and concerns and incorporation of additional science and desired research projects were incorporated into the analysis and documentation for the project.

Recognizing a desire on the part of stakeholders to continue dialogue and potential benefits for further involvement and/or collaborative work, Uncompahgre/Com and PLP offered to convene and facilitate a working group for SBEADMR. The Working Group is its own entity; however, it is facilitated by the Public Lands Partnership as part of their efforts to "bring together varied interests to work on local natural resources issues." The Working Group met throughout the 2014 and 2015 and continues to meet. Stakeholders discussed a variety of topics, and representatives of the Forest Service have attended to provide technical information regarding the SBEADMR DEIS, forest management and other topics of interest to the Group.

After incorporating information from the science workshop into the draft analysis of the alternatives, the Draft EIS was released for public comment on May 29, 2015 for an initial comment period extending until July 14, 2015. In response to multiple requests for a comment extension, the comment period was extended until July 31, 2015. The GMUG received 97 comment letters, 47 of which were original letters and 48 of which were form letters. These were coded into approximately 1,030 unique comments. Responses to comments are included in Appendix H.

Individuals and groups continued to provide input to the Forest Service regarding the SBEADMR project throughout the planning process. Although this input was submitted outside formal scoping and comment periods, the GMUG continued to consider such input for refining the Draft and Final EIS.

Additionally, the GMUG has entered into an agreement with the Rocky Mountain Research Station and Colorado State University/Colorado Forest Restoration Institute to address science questions and monitoring needs for the project.

There is mutual interest from the public and the GMUG for active public involvement throughout the implementation of any action alternatives for SBEADMR. The proposed framework for such is detailed in *Chapter 2, Adaptive Implementation Approach* and *Appendix E*.

Issues

The following issues were raised by either the public during the scoping period, or by the Interdisciplinary Team (IDT) working on the analysis of potential effects related to the proposed action. The IDT conducted a comment analysis, tracked all comments submitted from the public during scoping, and indicated which concerns should be identified as substantial issues or not, and the reasons for that determination. The IDT reviewed the comment analysis; the comment analysis is part of the project record.

Issues serve to highlight effects or unintended consequences that may occur from the proposed action and alternatives, giving opportunities during the analysis to reduce adverse effects and compare trade-offs for the decision-maker and public to understand.

The IDT separated issues into two groups: substantial and minor. Substantial issues were defined as those which offer points of debate, or raise unresolved concerns directly or indirectly caused by implementing the proposed action. Substantial issues informed the development of the action alternatives and/or focused the scope and extent of the analysis of environmental effects that may occur from implementation of any of the alternatives.

Minor issues were identified as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. Some of the minor issues helped to focus the scope and extent of the effects analysis, as well. The Council on Environmental Quality (CEQ) NEPA regulations (40 CFR 1500.4(g) and 1501.7) explains that minor issues can be excluded from detailed analysis in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…"

The IDT identified the following substantial issues from comments received during the scoping period:

Issue 1. Roads

There were many comments concerning roads and the effects of roads on the natural environment, such as habitat fragmentation, sediment input into streams and riparian areas, decreased water quality, and detrimental effects to soils, vegetation, and wildlife, as well as possibly serving as vectors for increased occurrences of invasive or noxious weeds and non-native plant species. Several respondents stated the proposed project should:

1. Avoid building new roads due to possible impacts to physical resources. Alternative 3 addresses this issue in part by minimizing the building of new roads compared to Alternative 2. The effects of road construction on myriad resources are analyzed in both of the alternatives.
2. Use best management practices to minimize impacts from new roads. This issue is addressed in project design features, *Appendix B.* The effects of implementing best management practices are disclosed in Chapter 3 for both alternatives.
3. Close and restore/decommission new roads when the roads are no longer needed. This issue is incorporated into both action alternatives with the commitment to decommission all roads within 5 years of the close of the associated timber sale. The effects of decommissioning new roads are disclosed in Chapter 3 for both alternatives.
4. Limit treatments to infrastructure areas only, thereby limiting the need for new roads. Alternative 3 addresses this issue in part by minimizing the building of new roads compared to Alternative 2. An alternative that limited treatments exclusively to a defensible space buffer around infrastructure was considered but dismissed from detailed analysis, as discussed in Chapter 2.

Issue 2. Effectiveness of Resiliency Treatments and the Need for Treatment

Many respondents expressed their support to limit widespread spruce and fir tree mortality that is caused by the Engelmann spruce bark beetle, and to reduce the impacts of sudden aspen decline by increasing aspen regeneration. However, some respondents were concerned with the effectiveness of resiliency treatments in spruce. Other people raised the philosophical question of whether we should be treating aspen decline at all, stating that aspen decline is a natural process.

Effectiveness of Treatments in Spruce and Aspen Forests

There were several comments that questioned whether the proposed treatments in spruce forests would result in forests that are more resilient to future insect outbreaks, or if treatments in aspen forests would be effective at promoting regeneration in aspen stands. Several respondents stated the proposed project should:

1. Avoid treatments in spruce stands that have not been attacked by the Engelmann spruce bark beetle because resiliency treatments are ineffective and may actually adversely affect the areas treated by exposing stands to increased risk of windthrow and reducing potential and existing regeneration. Only remove dead and dying spruce. This issue is analyzed for both of the action alternatives in Chapter 3.
2. Consider the likely success of treatments in dying aspen stands. This substantial issue is analyzed for each of the action alternatives in Chapter 3.
3. Treat SAD only in infrastructure areas. This issue contributed to the development of Alternative 3, which proposes treatment of aspen forests affected by SAD in infrastructure areas only.

Need for Treatments in Aspen Stands

There were several comments that questioned the need for the proposed treatments in aspen forests. Several respondents stated the proposed project should not treat aspen stands at all because SAD is a natural process and no treatments are needed; others stated that aspen decline is a part of natural succession, and no management response is required. Other respondents questioned the need for treatments in aspen stands not affected by SAD. This issue is analyzed for all action alternatives in Chapter 3.

Issue 3. Expanded Treatments to Provide Socioeconomic Benefits

Several respondents commented on the need for the project to support local communities by maximizing mechanical treatments that would produce wood products, in order to contribute to those economies. Some people commented that the potential treatment area needs to be expanded beyond the acreage described in the scoping documents, in order to be truly effective at addressing the large landscape scale of the spruce beetle epidemic. Several respondents stated the proposed project should:

1. Mechanically treat the greatest amount of acres possible in order to gain the maximum reduction in Engelmann spruce beetle and SAD impacts, and to provide the greatest amount of wood products for local industry, thus providing more economic input in local communities. Both action alternatives employ the maximum operational capacity of the Forest Service to implement treatments. However, the desire to “maximally reduce spruce beetle and SAD impacts” is in direct conflict with the desire to produce the greatest amount of wood products for local industry. In spruce, salvage produces more volume/acre, but it does nothing to address potential future impacts in as-yet-unaffected stands. Promoting regeneration in aspen stands where SAD is present minimizes impacts of SAD but does nothing for local industry, considering there is no present market. Therefore, the action alternatives include a balanced approach to meet safety, resiliency, and recovery objectives; recovery includes economic recovery of the product.

2. Analyze the socioeconomics of proposed commercial timber sales concerning cost/benefits to local economies and reforestation. This issue is analyzed for both of the alternatives in Chapter 3.
3. Analyze timber sale contract provisions that hamper efficient wood products production. This issue is already determined by other laws, regulations, and policies.

Issue 4. Treat Only for Human Health and Safety Purposes

Several people commented that the potential treatment area described in the scoping document is too large, and should concentrate on areas that need or that would benefit from treatments that would promote public safety. This issue contributed to the development of Alternative 3, which proposes treatments limited to the wildland urban interface.

Other Related Efforts

Under existing NEPA decisions, the GMUG is currently implementing additional vegetation management treatments that partially overlap with watersheds where SBEADMR activities are proposed. These existing decisions include the Cochetopa Hills Vegetation Management Project (2014), Escalante Forest Restoration Project (2013), La Garita Beetle Response (2013), Long Slough (2013), and the Grand Valley Spruce Beetle SAD Treatments (2011). NEPA analysis is underway for both the Divide Salvage and Highway 149 South Salvage. The SBEADMR IDT conducted a GIS analysis of treatments associated with the other existing and proposed NEPA decisions, as well as other reasonably foreseeable future vegetation activities, in order to determine which future activities may occur in watersheds where SBEADMR activities are proposed. They identified a total of 4,760 acres of commercial timber activities and a maximum of approximately 171,000 acres of noncommercial fuels activities that may be implemented in the timeframe of SBEADMR implementation. A detailed summary of such treatments are included in *Chapter 3, Cumulative Impacts – Activities & Analysis Approach.* The cumulative impacts of these related efforts, as well as other reasonably foreseeable activities, are disclosed in Chapter 3.

(This page intentionally blank)

CHAPTER 2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

Introduction

This chapter describes and compares the alternatives considered for the Spruce Beetle Epidemic and Sudden Aspen Decline Management Response project. It includes a description and map of each alternative considered. This section also presents the alternatives in comparative form, defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public.

Changes between the Draft and Final EIS

Since the publication of the DEIS, in response to public comments, the Forest Service made the following changes to the action alternatives:

- Refined original "opportunity areas" to define more specific spatial extent for potential treatments in both action alternatives and facilitate more quantitative, thorough effects analysis. This prioritization process is detailed in Appendix F.
    a. For commercial treatments, this resulted in a change from the original 164,000-278,000 acres of potential commercial treatment areas analyzed to the final subset of 46,000-113,000 acres analyzed as Priority Treatment Areas (PTAs).
    b. For noncommercial treatments, this resulted in a change from the original 101,000-132,000 acres of potential noncommercial treatment areas analyzed to the final subset of 56,000-77,000 acres analyzed as PTAs.
    c. The ratio of maximum treated acres to analyzed acres now ranges from a maximum of 1:2 in Alternative 2 to 1:1 in Alternative 3.
- Summarized and depicted on maps the PTAs, associated proposed road construction, and hazard trees by each of the six Geographic Areas (GAs) on the GMUG National Forests. Maps are located in Appendix G and in higher resolution on the web at: http://www.fs.usda.gov/project/?project=42387.
- Developed proposed road system in order to delineate specific locations of the maximum proposed road construction and facilitate a more quantitative, thorough effects analysis.
    a. For Alternative 2, this resulted in a change from the original maximum of 320 miles of road construction proposed (both temporary and designed) to the final proposal of a maximum of 178 miles of new road construction.
    b. For Alternative 3, the total proposed road construction remained the same at 80 miles.
- Determined that all roads constructed to implement SBEADMR treatments would be decommissioned within five years of the close of the associated commercial timber sale.

The retention of any of these roads for a longer period is not analyzed in this NEPA document.

- Modified size of hazard tree buffer for roads and other infrastructure to approximately 150 feet (height of average tree + 20%) where adjacent slopes are <40% grade. The original 300-foot buffer would be used in the event of hazard trees in areas where adjacent slopes are >40%. Maps of the hazard tree treatments by GA are located in Appendix G and in higher resolution on the web at http://www.fs.usda.gov/project/?project=42387.
- Removed vague language regarding potential treatment locations and replaced with specific information.
- Alternative 4 was eliminated from detailed analysis.
- Incorporated a public notice and comment period for vegetation treatments during the course of SBEADMR implementation. This change is also incorporated into Appendix E.
- Explicitly identified decision-making triggers for adaptive implementation of vegetation treatments. See Table 6.
- Identified spruce-fir prescriptions based on both existing stand conditions/mortality levels and potential future continued mortality. As mortality increases, areas presently identified for resiliency prescriptions would become areas appropriate for salvage operations. This "adapted/potential future treatment type" for a high-mortality scenario in each of the identified PTAs is also analyzed in Chapter 3.
- Added the following appendices:
    a. Appendix F - Process to Identify Priority Treatment Areas
    b. Appendix G - Maps & PTA Tables
    c. Appendix H - Response to Public Comments
    d. Appendix I – Watershed Condition Class & Cumulative Effects Analysis
- As a result of the administrative review of the Final EIS and per the Reviewing Officer's instructions, the Forest Service made a number of corrections and clarifications to the EIS prior to submitting to the EPA on May 27, 2016 for publication in the Federal Register on June 3, 2016, including clarification regarding the 150-foot hazard tree buffer distance along roadways (p. 50). Additional corrections, clarifications, and additions are noted at the beginning of Chapter 3, in Appendix B (Design Features) and in Appendix E (Adaptive Implementation Process). The entirety of the Reviewing Officer's instructions are available on the project website and in the project record.

Alternatives Considered in Detail

Several commenters on the DEIS raised procedural concerns related to the range of alternatives, noting that because the maximum acres treated were the same amongst the action alternatives, the distinction between alternatives was not enough to provide a reasonable range for comparison. It is true that the maximum operational capacity of the GMUG to implement activities over the timeframe identified in the NEPA (8-12 years) is utilized in both action

alternatives, as the scope and scale of the purpose and need is vast. Yet an adequate range of alternatives is not merely established by varying the measurable quantity of the action, in this case, by varying the total treated acres. In the SBEADMR DEIS, the action alternatives had different objectives which corresponded with differing silvicultural prescriptions for differing stand conditions as well as different geographic locations. In the DEIS and FEIS, Alternative 2 meets the 3 objectives in the purpose and need: recovery of economic benefit; promoting resiliency in spruce and aspen stands; and increasing public safety; it proposed to do so throughout a wide geographic extent of the GMUG. Alternative 3 was created to geographically concentrate all activities in the WUI; by analyzing this alternative, the Forest Service could consider whether this concentration could better meet the public safety objective. Finally, Alternative 4 in the DEIS did not include green spruce stand treatments/resiliency cuts.

The FEIS documents the environmental consequences associated with two action alternatives and the No Action Alternative. The two action alternatives are the Agency Preferred Alternative (Alternative 2) and the WUI Alternative (Alternative 3). A third action alternative from the DEIS (Alternative 4) was not carried forward for additional analysis, as it would not meet the purpose and need of the project.

Alternative 1 (No Action Alternative)

The National Environmental Policy Act (NEPA) requires the study of the No Action Alternative and directs that this alternative be used as a basis for comparing the effects of the Proposed Action and other alternatives.

The No Action Alternative assumes that no implementation of the proposed action or the other action alternative would take place within the project area. This alternative represents no attempt to actively respond to the issues, purpose and need for action, or concerns identified during public scoping for this project. There would be no effort to modify existing conditions, unless authorized by other decisions. Other management actions including vegetation management projects are authorized and would likely continue to be authorized within the project area and timeframes analyzed in this EIS. These other projects would proceed under separate NEPA analyses. Other related projects which are currently authorized are noted in Chapter 1 under "Other Related Efforts."

Activities Common to All Action Alternatives

The following sections provide additional information regarding activities common to all action alternatives.

Scope and Scale of Treatments

On the GMUG, approximately 223,000 cumulative acres have experienced spruce beetle mortality and 229,000 acres have experienced Sudden Aspen Decline. Due to budget

constraints, the scale of the epidemic, and the magnitude of affected and potentially affected acres across all terrain of the forest, the Forest Service cannot treat all affected acres. Although landscapes of various extent are analyzed in this EIS to afford flexibility for land managers to respond in real-time to rapidly changing forest conditions, the Forest is proposing and analyzing treatments of a maximum of 120,000 acres, or 4% of the GMUG, in equal proportions between commercial and noncommercial treatments. These treatments would be implemented over an approximately 8-12 year implementation span. Annual acres treated are limited by personnel and budget constraints in the Forest Service.

All commercial treatment would occur on lands identified as suitable for timber production as defined by the Forest Plan (GMUG Forest Plan Amendment, 1991, pages F-1-F-7). Spruce-fir and spruce-aspen mix are considered for commercial treatment. At the time of the analysis, there is no existing market for aspen; unless a market were to emerge during the implementation timeframe of this project, commercial treatments in aspen would not be likely to occur. In order to commercially treat aspen areas analyzed in SBEADMR, the GMUG would need to determine that this NEPA document sufficiently disclosed the effects of such treatments.

Priority Treatment Areas Defined

Priority treatment areas (PTAs) in SBEADMR are the maximum extent of geographic area analyzed for potential treatments. Starting with the original opportunity areas within the Draft EIS, the GMUG and CSU Science Team developed a comprehensive spatial modeling process to bring focus and prioritization to the project. After optimizing for a variety of resource and operational variables, each PTA was validated by GMUG specialists with professional knowledge of the ground (See Appendix F for further detail). Whereas the project area ranged from 300,000-718,000 acres in the Draft EIS, the sum total of the PTAs, potential roadside hazard trees, and additional road construction in the Final EIS now range from 127,000 acres to 208,000 acres.

As in the Draft EIS, a *subset* of the analysis area (PTAs) for Alternative 2 would be treated over the life of the SBEADMR project. Only 60,000 acres of commercial treatment would occur, and only 60,000 acres of noncommercial treatment would occur. The GMUG intentionally selected PTAs that total approximately 2-3x the extent of actual treatments in order to monitor and adapt the treatment type and location to the changing forest conditions. However, once the IDT took into account the other vegetation types within the *noncommercial* PTAs – non-target vegetation that wouldn't be treated—the total noncommercial PTA acres dropped to 77,000 acres. Therefore, approximately 1 out of every 1.3 acres analyzed for noncommercial treatment in Alt 2 would be completed. In contrast, in Alternative 3, the PTAs are limited to the WUI, and this considerably reduced the total analysis area. Unlike Alternative 2, in which a subset of PTAs would be treated, each PTA in Alternative 3 would be treated.

As noted in the Draft EIS, the original opportunity areas—and hence, the PTAs—are limited to spruce and aspen forest types outside of Wilderness, Research Natural Areas, Special Interest Areas, Cultural Areas, and National Natural Landmarks. Additionally, Colorado Roadless Areas (CRAs) are not included, as the limited agency capacity will be applied most effectively to conduct active management treatments to less controversial areas. Treatments in CRAs would be proposed and authorized under separate NEPA processes.

Adaptive Implementation & Continued Public Involvement

The Forest Service cannot significantly alter the current infestation or rate of decline in spruce stands, but management of associated hazards, economic opportunities, and resilience, as detailed in the purpose and need, are the core of this project. Nor can it accurately project the ultimate location and scale of eventual beetle activity. To achieve the purpose and need in the context of rapidly changing conditions in spruce and aspen stands across the landscape, SBEADMR relies on an adaptive implementation framework to prioritize the sequence and determine precise layout of successive treatments within the analyzed PTAs. Treatment design, incorporating additional monitoring questions, reviewing the effects of previous treatments, and adjusting management towards desired conditions and away from undesirable conditions would also be conducted via the adaptive implementation approach. At 36 C.F.R. § 220.3 (2010), adaptive management is defined as "a system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that will best ensure that those outcomes are met or re-evaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain". Specific decision-making triggers for adaptive implementation are identified in Table 6, below. Some triggers related to meeting desired conditions, and other pertain to maintaining impacts within established legal and/or project limits.

Public involvement is critical throughout implementation, and is explicitly incorporated into the approach, as detailed below and in *Appendix E.*

The adaptive implementation and monitoring framework defines a) a cycle of checkpoints and b) an associated toolbox, discussed in further detail below.

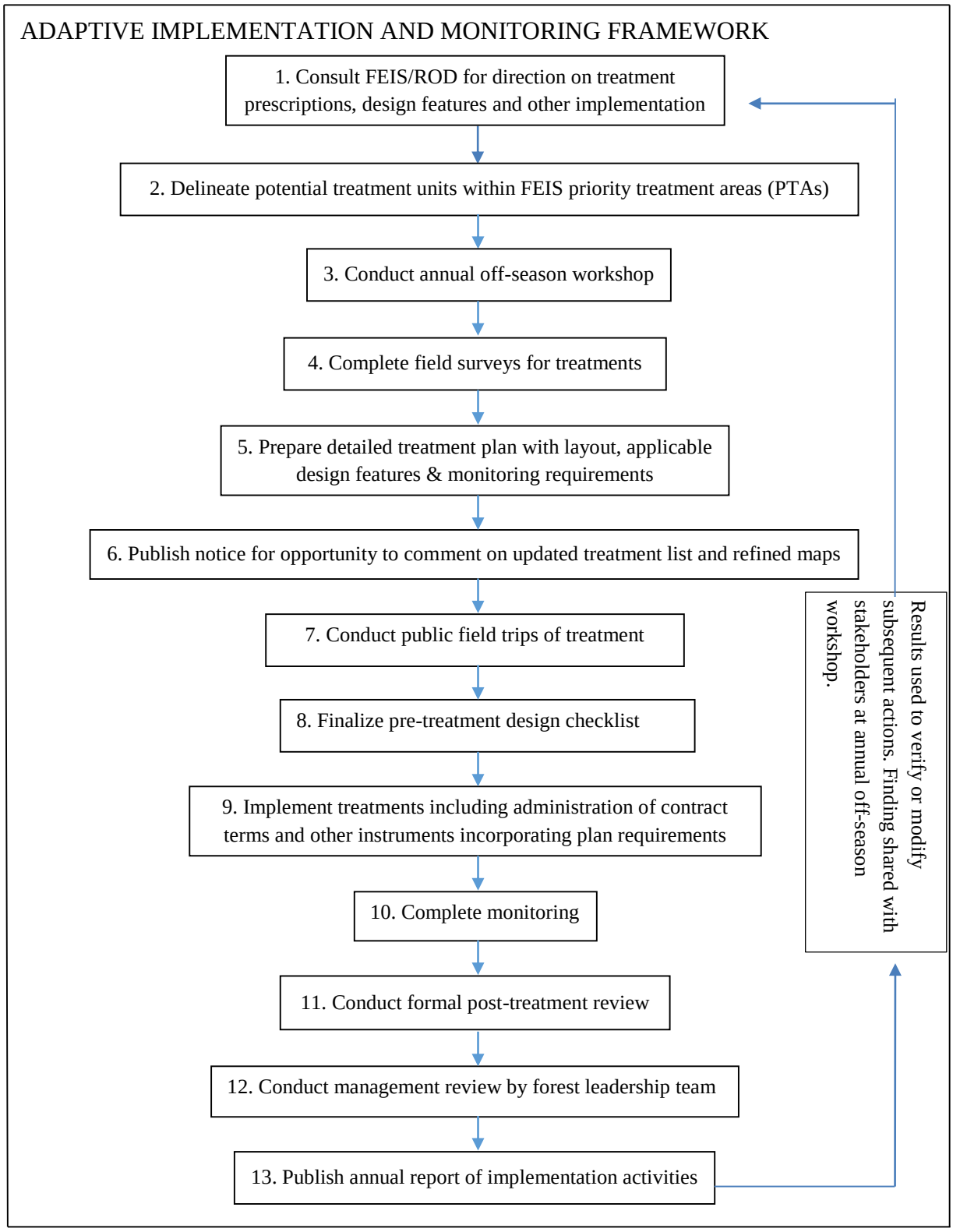

Figure 7. Adaptive implementation and monitoring framework for SBEADMR

Checkpoints

The checkpoints in the adaptive implementation cycle would involve public stakeholders, a science team, and Forest staff. Figure 7 indicates how stakeholders, the Forest Service, and the Science Team will work together to complete all five parts of the Adaptive Implementation & Public Involvement Framework.

Checkpoints for the adaptive implementation will include five major components:

1) Public notice and comment on annual basis for upcoming cycle of treatments;
2) Pre-Implementation treatment planning;
3) Post-Treatment implementation review focusing on design feature compliance;
4) Annual monitoring review/evaluation and new science summary with stakeholders and science team;
5) Annual Management Review.

The GMUG recognizes that a landscape-scale project analysis such as SBEADMR is difficult for the public to comment on and to be assured that effects are adequately disclosed. Due to the adaptive nature of the proposal and in response to public comments on the Draft EIS, the GMUG will annually provide public notice and opportunity to comment on the upcoming specific set of SBEADMR treatments. Public comments will assist GMUG staff in determining the adequacy of the original effects analysis and of the original project components for each successive set of treatments.

Opportunities for stakeholders to influence implementation would be confined by the sideboards of the selected alternative, as outlined in the Final Record of Decision (ROD) and Environmental Impact Statement (EIS). Further, the Forest Service retains the authority to make final decisions related to location, extent and types of treatments planned and completed consistent with the ROD/EIS. However, if at any-time stakeholders have specific questions or concerns related to any aspect of implementation under SBEADMR, Forest staff would be responsive and take steps to accommodate stakeholder input to the greatest extent practicable. The process outlined here would be required by the ROD. See *Appendix E* for further detail.

Implementation Toolbox

The implementation toolbox defines the range of silvicultural and fire prescriptions and design features for treatment implementation and provides a mechanism for monitoring and documenting compliance. These tools would be used throughout the adaptive implementation cycle outlined above. The prescriptions and design features are incorporated into both action alternatives and effects analyses; however, the application of an individual prescription and a suite of design features will depend upon on-the-ground conditions at the time of implementation. These conditions, or triggers for use, are defined in Chapter 3, resource sections.

Most tools are detailed further in an associated referenced appendix. Tools include:

- Triggers for Adaptive Implementation – In response to public comments, decision-making triggers from the Draft EIS are explicitly identified in one table in the Final EIS. See *Table 6. Decision-Making Triggers for Adaptive Implementation in SBEADMR.*

- Silvicultural Prescription Matrix – would be used to identify which and how various stands will be treated to achieve management objectives. Detailed silvicultural prescriptions will be completed by a certified silviculturist by comparing current versus desired vegetative conditions. *See Appendix A.*

- Design Features – would be applied to treatments to minimize or avoid undesirable impacts to resources including, but not limited to, vegetation, soils, water, wildlife and cultural resources. Design Features are incorporated into both action alternatives and their effects analyses. The appropriate design features would be applied when surveys or management activities indicate a need to do so. It is also assumed that design features will be implemented as designed and in a readily visible way, effective. Analysis completed in this document assumes implementation of the appropriate design features *See Appendix B.*
- Pre-Treatment Checklist – tracking tool would document that all required surveys and compliance checks for an individual treatment have been completed. The checklist will also identify design features that would be applied to a particular treatment. For example, the presence of a Northern goshawk nest in a treatment area would trigger the avoidance/protective measures as specified in the design features of the EIS. As such, the checklist would assure treatments are implemented consistent with the EIS. The checklist will also be used to confirm compliance with the Forest Plan. *See Appendix C.*
- Annual Interdisciplinary & Management Review – a monitoring method that provides documentation that treatments are implemented as planned. The IDT review, combined with monitoring results and science team input, would provide feedback to forest managers about how to best design and implement future treatments in the treatment area. The results of this monitoring, in conjunction with best available science, will identify relevant improvements to procedures or exemplary practices to benefit future treatments authorized by the SBEADMR record of decision. *See Appendix D.*
- Public Engagement in Adaptive Implementation – the phases, principles, and activities of public engagement throughout the life of the SBEADMR project. The primary goal is to engage diverse groups and individuals so that they might identify common problems, interests, and potential solutions. *See Appendix E.*

NEPA Sufficiency

In some cases, changed conditions may bring into question whether the scope and range of effects disclosed in this analysis are exceeded. Typically, a change in a design feature to render it

more effective to protect resource values or to achieve desired outcomes would remain within the scope and range of the effects analysis. Elimination of a design feature intended to minimize effects would likely be outside the range and scope of the analysis. A change in assumptions analyzed in the EIS could also trigger a NEPA sufficiency review. For example, it was assumed that the level of impact to habitat supporting Canada lynx would stay within Forest-level caps identified in the Southern Rockies Lynx Amendment (SRLA). These caps would be tracked over the life of the project, and if tracking indicates a pending exceedance in any given year, no additional treatment would be permitted until additional NEPA and additional consultation with Fish and Wildlife Service was completed. Substantive changes would require the Forest to undertake an interdisciplinary review of the sufficiency of the NEPA documentation prepared for this treatment.

As noted above, public notice and comment period on an annual basis for out-year treatments will serve an important role to determine the continued sufficiency of this NEPA document.

During sufficiency reviews, the GMUG may determine the information in the original decision is still valid and is not in need of correction or supplement. However, if that review reveals a need for a correction, supplement or revision to the original decision, then the specific process to correct, supplement, or revise the analysis would be used, as specified in FSH 1909.15(18.2).

Table 6. Decision-Making Triggers for Adaptive Implementation in SBEADMR.
Red light triggers correspond with a legal standard/project standard that cannot be crossed, whereas a yellow-light trigger indicates that a resource is being affected negatively, signaling the need for increased mitigation of effects, a change in management approach, or slowing of the pace of implementation (Schultz & Nie, 2012).

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
Management of the Treatment for: Vegetation, Wildlife, Visuals Objectives										
Maintain structural diversity of vegetation at the watershed scale (diversity unit - 6th HUC).	5-12% or more of vegetation at 6th field watershed unit is in an old growth forest classification, where biologically feasible.	Habitat structural stages 4A, 4B and 4C.	Prior to treatment planning, determine the amount of live 4A, 4B and 4C in watershed.	Diversity unit - 6th field HUC	During treatment planning OR complete quick assessment at the watershed scale prior to treatment planning.	Amount of habitat structural stages 4A, 4B, 4C pre-treatment is less than 20%.	**Limited overstory mortality -** Design treatments to ensure minimum old forest classifications are maintained. **High overstory mortality** - retain pockets of live habitat structural stages 4A, 4B and 4C to the greatest extent practicable.	Amount of habitat structural stage 4A, 4B and 4C pre-treatment is less than 5%.	Same as yellow.	**LRMP**
Maintain soil productivity, minimize human-caused erosion and maintain integrity of associated ecosystems (III-73 01a)	Past activities and proposed activities would contribute to a combined detrimental soil disturbance that is above or approaching the 15% threshold of a treatment unit.	Percent of detrimental soil disturbance within a treatment unit (DSD includes: compaction, rutting, burn severity, displacement, surface erosion and mass movement).	Implement Design Features WQSP-4, 5A, 5B, and 7B in accordance with requirements of the treatment design checklist. Spot check treatment units using accepted soil monitoring protocols.	Treatment	Pre-treatment checklist and, as triggered, post-treatment monitoring	Pre-treatment review in FACTS (treatment database) confirms past ground-based activities in proposed treatment area.	Complete pre-treatment survey to determine detrimental soil disturbance percentage. Work with IDT to design treatment to maintain the cumulative detrimental effects from project implementation	Upon completion of pre-treatment survey and considering net impact of proposed treatment, it is determined that net detrimental soil disturbance post-treatment would exceed	Modify treatment boundaries and/or exclude this treatment until further soil restoration activities completed.	LRMP

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
							and rehabilitation should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.	15% of the activity area.		
Eliminate/minimize soil damage from machine pile burning	Bare soil, rilling, gullying, and soil movement within machine pile burn scars	Percent of machine pile burn scars, and area within each burn scar, without vegetation or showing signs of rilling, gullying, or soil movement.	Monitor a sample of pile burn scars for bare soil and--on scars located on slopes and in swales--for the presence of rills, gullying, or soil movement.	Treatment	Within 3 years of pile burning	>100 sq ft of burn scar consisting of bare soil; minor rilling or gullying present within or adjacent to burn scar; minor deposition of soil downslope of scar.	Treatment of bare soil and erosion according to District protocols, may include one or two of the following: addition of mulching, scarification, inoculation with adjacent soils, seeding, etc.	>200 sq ft of burn scar consisting of bare soil; multiple rills, or gullying, or gullying 2-3" deep within burn scar; significant deposition of soil downslope of scar.	Same as yellow.	
Lynx-Specific Management										
<30% of lynx habitat in an LAU in a stand initiation structural stage/ silviculturally treated to remove cover for snowshoe hare and does not yet provide winter snowshoe hare	Harvest, road construction or other anthropogenic or natural disturbances within lynx habitat, including single-storied stands with	Acres per LAU	Pre-treatment, assess current extent of single-storied stands in the LAU that are in SISS due to bark beetle, as well as those stands in SISS due to management, or other natural	Lynx Analysis Unit	Pre-treatment checklist; Annual reporting	25% of lynx habitat in LAU in a stand initiation structural stage (SISS) condition.	Discontinue or reduce acres of treatment in suitable lynx habitat. Stands with extensive over-story mortality (>90%) that lack an understory can continue to be treated since	Fire or spruce beetle results in widespread loss of the understory, leaving >30% percent of the LAU in a stand initiation structural stage.	Discontinue treatments in suitable lynx habitat. Stands with extensive over-story mortality (>90%) that lack an understory can continue to be treated since they are already	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
habitat. SRLA Standard VEG S1.	>90% overstory mortality.		disturbance. Annually, track acres of management actions and/or natural disturbances reported in FACTS or INFRA (Forest Service databases). To ensure compliance with design Feature WFRP-16.				they are already considered unsuitable via SRLA. Plan any future actions so 30% threshold is not exceeded.		considered unsuitable via SRLA.	
<15% of lynx habitat in an LAU would be regenerated by vegetation management (over 10-year period beginning in 2009). SRLA Standard VEG S2.	Vegetation management that regenerates stands.	Acres treated over 10-year period in LAU	Management actions reported in FACTS. Even-aged treatments - entire stand.	Lynx Analysis Unit	Annual	Vegetation management has regenerated 10% of lynx habitat in LAU. Fuel treatments are exempt from the trigger.	Discontinue or reduce acres of treatment to ensure new (out-year) proposed treatment areas do not exceed the 15% threshold in the LAU.	Vegetation management has regenerated 15% of lynx habitat in LAU. Fuel treatments are exempt from the trigger.	Discontinue treatments in suitable lynx habitat. Stands with extensive over-story morality (>90%) that lack an understory can continue to be treated since they are already considered unsuitable via SRLA.	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.
<3% of lynx habitat on the Forest will be thinned. Pre-commercial thinning and similar practices intended to reduce seedling/sapling	Actions with intent to reduce seedling/sapling density.	Acres treated	Management actions reported in FACTS	Forest-wide	Annual	2.5% of Forest thinned.	Plan acres of out-year treatments such that they do not exceed the 3% Forest-wide cap.	3% of Forest thinned	Discontinue pre-commercial thinning to ensure forest-wide cap is not exceeded. If additional thinning is needed to accomplish	Compliance with Southern Rockies Lynx Amendment - Endangered Species Act.

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
density limited to: 200 feet of structures; research studies; conifer removal in aspen; based on new, peer-reviewed information accepted by the FWS and the FS; and in accordance with exception 5 to Veg S5 of the SRLA.									resource objectives, reinitiate consultation as required by the SRLA.	
Watershed Management										
To ensure HUC12 disturbance is less than 25 percent, maintain disturbances from mechanical harvest treatments and roads to less than 25 percent of the HUC12 area. Other natural events (wildfire) could also affect watershed	Weighted[3] acres of mechanical harvest, road construction or other anthropogenic or natural disturbances within the watershed.	Acres per HUC12 watershed	Track acres of management actions and/or natural disturbances reported in FACTS or INFRA (Forest Service databases). To ensure compliance with design Feature WQSP-10.	HUC 12 Watershed	Pre-treatment checklist item	20% of HUC 12 affected.	Discontinue or reduce acres of treatment in watershed so 25% threshold not exceeded.	Wildfire and cumulative management activities result in 25% of HUC12 affected.	Discontinue treatments in suitable watershed until recovery has occurred.	LRMP, Watershed Conservation Practices Handbook.

[3] *See Appendix I, Watershed Cumulative Effects Analysis for explanation of weighting process.*

Desired Condition	Indicator(s)	Unit of Measure	Methods	Scale	Frequency	Yellow Light Trigger	Adaptive Action	Red Light Trigger	Adaptive Action	Regulatory Requirement
integrity and will be tracked when they occur.										

Treatments

Resiliency in the Context of Vegetation Management

Resilience is the capacity of a system to tolerate disturbance without shifting to a qualitatively different state that is controlled by a different set of processes (Resilience Alliance 2012); i.e., the ability of a system to retain its function, structure, identity and feedbacks in the face of disturbance and environmental change (Walker et al. 2004).

A resilient forest ecosystem is a forest that contains the diversity of composition, size, density and pattern that enables it to cope with changing disturbance processes**.** Such an ecosystem is capable of providing various ecosystem services such as wildlife and aquatic habitat for a variety of species, clean water, recreation, and carbon sequestration in the short and long term.

Spruce Recovery and Resiliency

The spruce recovery goals would be met via removal of dead and dying trees (salvage) followed by regeneration from on-site seed sources, re-sprouting of aspen, or tree planting where adequate natural seed sources are lacking. As detailed in the silvicultural prescription matrix (*Appendix A*), recovery treatments would be designed to retain advanced regeneration and green trees to the maximum possible extent.

Resiliency goals in spruce stands would be met by removal of single trees or group selections of trees where bark beetle impacts are light or in areas yet unaffected by beetles. Resiliency treatments are designed to mimic natural gap dynamics that maintain or encourage multi-storied attributes, with the same considerations for retention of advanced regeneration as noted above. These treatments would be completed in accordance with the Southern Rockies Lynx Amendment, and they are considered a conservation measure for lynx (USDA Forest Service 2008, SRLA). Cuts typically cover only 20-40% of a given treatment unit.

Aspen Resiliency

Aspen and aspen-spruce treatments would consist of coppice cutting, mastication, prescribed fire or removal of single spruce or groups of spruce within a stand dominated by aspen. The treatment goal is to regenerate or maintain aspen; site disturbance through treatment activities and removal of aspen canopies typically stimulates regeneration of aspen from the existing root system. Efforts would be made to prioritize treatments based upon likelihood of aspen persistence, given climate projections and current modeled future distribution by elevation (Rehfeldt et al. 2015).

Adapted Future Action

As a green spruce stand becomes increasingly affected by spruce beetle, the appropriate treatment would trend from an initial planned resiliency prescription to a salvage operation. Because of this changing condition in spruce stands and the corresponding change in the type of appropriate silvicultural prescription, the FEIS explicitly notes the acres of treatment type based on forest conditions as detected today and also projects the acres of potential treatment type (all salvage) based on the maximum potential extent of the spruce beetle epidemic within the project area. Although unlikely that spruce beetle would extend to the entirety of the stands analyzed in the SBEADMR project area, the current condition and this maximum potential extent of a future diseased condition provided bounds for specialists to analyze the effects of treatment given a) current and b) changed conditions.

With respect to aspen, the changing stand condition does not precipitate such a difference in silvicultural application. Rather, when stands exceed 50% overstory mortality, research indicates that regeneration treatments are less successful. If prior to treatment application, overstory mortality were to exceed that threshold for a given stand analyzed in the SBEADMR project area, instead of modifying the prescription, the Forest Service would likely not attempt implementation. Therefore, the bounds of effects analysis for aspen range between the effects of the No Action alternative and the effects of the action alternatives.

Hazard Tree Treatments

Roadside corridors are identified and analyzed in the FEIS for *potential* hazard tree removal. It is important to note that roadside treatments, unless analyzed as part of a PTA, would be limited to the hazard trees. The roadside corridor is limited as follows:

- Where slopes are >40%: 300 foot buffer from both sides of the road (600 feet total buffer).
- Where slopes are <40%: 150 foot buffer from both sides of the road (the average tree height plus 20%; 300 feet total buffer). The actual roadside clearing distance will be based on the height of the tallest tree plus 20%, and that distance is expected to be less than 150 feet in most cases. A maximum of 150 feet is identified to provide bounds for project analysis.

Mechanical Treatments

- Commercial treatments would occur in lands identified as suitable for timber production by the GMUG 1991 Forest Plan Amendment (USDA Forest Service, 1991, Appendix F).
- Non-commercial mechanical treatment methods would include mastication of understory conifer utilizing vertical or horizontal shaft masticators, hand or machine cutting of

understory conifer followed by lop and scatter of the slash, hand or machine cutting of understory conifer followed by piling/burning of slash, mastication of aspen as a coppice treatment, and hand or machine cutting of aspen followed by either lop and scatter or piling/burning of the slash as a coppice treatment. Mechanical treatment on slopes greater than 40% would be limited to chainsaws.

- Most tree removal would be accomplished using a variety of contracting methods including commercial timber harvest, service contracts, and stewardship contracts. To a lesser extent, Forest Service work crews or cooperators would be used to thin trees and reduce fuels in areas where contracting is not feasible.
- All commercial mechanical treatments and non-commercial mechanical treatments involving large equipment would occur on slopes less than 40%. For slopes greater than 40%, mechanical treatments would be limited to chainsaws.
- Openings from mechanical treatments in beetle-infected spruce stands or dying aspen stands may exceed 40 acres. Per the 1991 GMUG Amended Forest Plan, the maximum size of openings creating by the application of even-aged silviculture is 40 acres (p. III-43); however, larger openings are permitted in the event of natural catastrophic conditions, such as insect or disease attack. Per the National Forest Management Act, Forest Plan maximum size for openings to be cut in one harvest operation shall not apply to the size of openings harvested as a result of natural catastrophic conditions such as fire, insect and disease attack, or windstorm (16 U.S.C. 1604(g)(3)(F)(iv)).
- Non-commercial mechanical treatments in stands dominated by aspen but having an spruce-fir component mapped as lynx habitat will be limited as follows: within secondary lynx habitat (defined as within 300 meters or 984 feet of primary habitat), removal of spruce-fir in mixed Aspen-spruce stands will not occur. Primary habitats are stands composed of primarily spruce-fir that support habitat elements necessary to support lynx or their prey.
- Within critical habitat for Gunnison sage-grouse, sagebrush will be avoided when conducting non-commercial treatments.
- Precommercial thinning in live multi-story mature or late successional conifer forests will be subject to the Southern Rockies Lynx Amendment, Standard VEG S6 – Exceptions 1,3 and 4 and VEG S5 Exception 1 and 3.

Prescribed Fire Treatments

- Prescribed fire treatments include broadcast burning and pile burning.
- Broadcast burning would be accomplished with aerial or hand ignitions. Individual burn units would range in size from as small as 50 acres to more than 5,000 acres.
- Most broadcast burning would be applied in areas with an aspen component. Some broadcast burning may be applied in salvaged single-story spruce stands where little/no

regeneration is present in order to reduce slash fuel loadings and as a pre-planting site preparation measure.

- Pile burning would be conducted in conjunction with other, mechanical treatments to remove excess fuels created by the treatment. Piles would be either created at landings or constructed throughout treatment units.

- Any treatments that have prescribed fire as a component, whether broadcast or pile burning, will have a Burn Plan developed for them. Burn Plans are required by agency policy and are guided by the FS Manual 5140 as well as the Interagency Prescribed Fire Planning and Implementation Procedures Guide (April 2014). Burn Plans are approved by the Agency Administrator (Forest Supervisor or District Ranger) and contain treatment-specific requirements regarding fuels, topography, and weather conditions under which the burn can be ignited, as well as required fire behavior to meet both the desired objectives and to maintain control of the burn. Burn Plans also contain burn objectives, complexity analysis, size and type of management organization, contingency plans, safety issues and associated mitigations, ignition and holding plans, and smoke management considerations. Additionally, a Smoke Permit from the State of Colorado, Department of Environmental Health, Air Pollution Control Division, would be obtained for any prescribed burn. The Smoke Permit contains 'permit conditions' under which the burn must be ignited; these include maximum daily acres, wind direction, dispersion index, daily ignition cutoff times, and mitigation measures related to smoke management.

- Within critical habitat for Gunnison sage-grouse, sagebrush will be avoided when conducting prescribed fire.

Access

The existing road network would be used to the maximum extent possible to access the proposed treatments and to remove forest products. For commercial treatments, existing roads would be supplemented by constructing new temporary roads only when necessary; criteria are indicated below. No road construction is proposed for noncommercial treatments. Where necessary for resource protection, existing roads would be reconstructed. Per Forest direction, there would be no increase in open road density.

Road Maintenance

National Forest System roads being used for the project that are in functioning condition would be maintained during the project implementation. Maintenance preserves the function of the road but generally does not include improvements. Maintenance activities generally include: blading; brushing; removal of roadside hazard trees; repair and/or replacement of road surfaces; cleaning, repair, or installation of drainage structures such as culverts, ditches, and dips; dust abatement; removal and installation of closure barriers, and installation or repair of signs.

Maintenance activities generally do not disturb ground outside the existing roadway (toe of fill to top of cut) other than removal of material around culvert inlets and cleaning of outlet ditches.

Road Reconstruction

Reconstruction generally includes work to improve and restore roads, or to bring them back up to the original design standard. Improvements would provide for serviceability for project haul vehicles, as well as for proper hydrologic function and stream protection in accordance with applicable Best Management Practices. Actions can include surface improvement; construction of drainage dips, culverts, riprap fills or other drainage or stabilization features with potential disturbance outside the established roadway (toe of fill to top of cut); realignment; and widening of curves as needed for log trucks and chip van passage. Reconstruction also includes the actions included in the Maintenance category, including removal of roadside hazard trees. Reconstruction includes the replacement of unsustainable existing roads with new, designed roads, as well as decommissioning of the prior unsustainable road.

Road Construction

New road construction alignments to access priority treatment areas have been developed. For the Final EIS, the GMUG developed a proposed road system using the following criteria:

- Skid distances from PTAs were greater than ¼ mile to an existing road

Expected actions for road construction include vegetation clearing, excavation and/or embankment, blading and shaping, out-sloping, drainage dips, and water-spreading ditches, and may include importing of armoring and surfacing rock material as needed. More embankment and drainage structures would be utilized when there are adjacent resource concerns (perennial and intermittent stream crossings, high soil erosion hazard, steeper side slopes, etc.). Note that because all new roads in the action alternatives would be decommissioned within 5 years of the closure of the associated SBEADMR timber sale, all road construction analyzed in SBEADMR is temporary.

Road Decommissioning

In response to public comments on the Draft EIS, all roads constructed for SBEADMR will be decommissioned within 5 years of the close of the associated commercial sale. Retention of any SBEADMR road in the National Forest System would require an additional, separate project-level NEPA analysis and decision, and must be informed by a travel analysis process.

Furthermore, existing roads used for project implementation that are *not* identified as National Forest System roads would also be decommissioned within 5 years of the close of the associated commercial sale.

Decommissioning involves a combination of the following rehabilitation tools: removing bridges and culverts, eliminating ditches, out-sloping the roadbed, ripping and scarifying of the road surface to reduce compaction and promote native vegetation, reseeding/replanting native vegetation, removing ruts and berms, effectively blocking the road to normal vehicular traffic where feasible under existing terrain conditions, and building cross ditches and water bars. When bridges and culverts are removed, associated fills shall also be removed to the extent necessary to permit normal maximum flow of water and reconstruction of the floodplain and stream channel as needed.

Right-of-way Acquisition

SBEADMR's identified system of existing haul roads for commercial treatments anticipates a limited number of roads under private jurisdiction would provide more efficient access to a commercial treatment. These account for <1% of anticipated haul routes. These roads would require a Forest Service right-of-way or access agreement to allow for access and haul of forest products. Where appropriate, public easements would be pursued; at a minimum, administrative access would be needed for treatment implementation.

Other Public Roads

Vegetation treatments along and adjacent to county- and State-managed public roads are included in the action alternatives. Where SBEADMR implementation efforts could potentially interfere with traffic or operations of these public roads, coordination with the applicable agency is necessary. This includes construction of new intersections and access aprons that would tie into existing public roads. Coordination would address signing and traffic control, permitting, alignment, and construction standards necessary for new aprons and intersections, at a minimum.

Connected Actions Related to Roads

Available water and rock material sources within and adjacent to the treatment area would be utilized to support road work. Roads providing access to and from these sites would also be maintained and reconstructed when applicable.

Alternative 2 (Agency Preferred Action)

Size and Geographic Location of Treatments

Alternative 2 analyzes 207,615 acres of potential disturbance acres. 190,014 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 17,388 acres as potential hazard tree treatments outside of PTAs, and 213 acres are for potential new road disturbance outside of PTAs. Of the PTA acres, approximately 59% (112,768 acres) are identified as commercially

suitable timber acres, and 41% (77,246 acres) are identified for noncommercial treatment. See Table 7, Table 8, and Table 9. Maps of Alternative 2 are located in Appendix G (Maps G-1 to G-18) and online at: http://www.fs.usda.gov/project/?project=42387.

As noted in *Activities Common to All Alternatives*, maximum commercial treatments would total 60,000 acres and maximum noncommercial treatments would total another 60,000 acres, for a total of 120,000 maximum treated acres. Therefore, for commercial treatments, approximately 1 of every 2 acres analyzed for commercial treatment in this alternative would be treated. For noncommercial, approximately 1 of every 1.3 acres analyzed for noncommercial treatment would be treated.

Table 7. Alternative 2: Summary of Analysis Acres

Proposed Activity	**Total Acres**
Hazard Trees Outside PTAs	17,388
New Roads Outside PTAs	213
Priority Treatment Areas	190,014
Commercial	*112,768*
Noncommercial	*77,246*
Grand Total Analysis Acres	**207,615**

Table 8. Alternative 2: Summary of Analysis Acres by Geographic Area & Activity Type.
The Adapted Future Action -All Salvage treatment type is identified in order to provide bounds for analysis. Proposed broad treatment types are based on the current level of mortalities in a stand, but as mortality from spruce beetle increases, more treatments would correspondingly shift to salvage.

	Outside PTAs		*Commercial PTA & Treatment Type*					*Noncommercial PTA & Tx Type*			
Geographic Area	**Hazard Trees**	**New Roads**	**Combination**	**Resiliency**	**Salvage**	**Adapted Future Action - All Salvage**	**Total Commercial PTA**	**Burn & Mechanical**	**Mechanical Only**	**Total Noncomm PTA**	**TOTALS by GA**
Grand Mesa	1,075	19	8,808	6,163	486	*15,457*	**15,457**	14,548	830	**15,378**	**31,929**
Gunnison Basin North	3,696	49	6,897	6,663	1,825	*15,385*	**15,385**	21,560	0	**21,560**	**40,691**
Gunnison Basin South	4,794	44	11,334	4,419	12,061	*27,815*	**27,815**	7,954	0	**7,954**	**40,607**
North Fork Valley	2,258	25	3,356	5,025	544	*8,925*	**8,925**	7,176	864	**8,039**	**19,247**
San Juans	2,023	42	7,773	2,595	1,830	*12,198*	**12,198**	348	0	**348**	**14,611**
Uncompahgre Plateau	3,542	34	14,997	17,634	357	*32,988*	**32,988**	23,966	0	**23,966**	**60,531**
TREATMENT TOTALS	**17,388**	**213**	**53,166**	**42,499**	**17,103**	***112,768***	**112,768**	**75,552**	**1,694**	**77,246**	**207,615**

Table 9 indicates the cover type by PTA treatment category. These are also illustrated on maps G-13 through G-18 in Appendix G.

Table 9. Alternative 2: Cover Type by PTA Treatment Category

Treatment Category	Cover Type	Acres	% of Row Total
Commercial		**112,768**	**59%**
	Aspen	4,950	4%
	Aspen Spruce Mix	37,038	33%
	*Other**	*2,660*	*2%*
	Spruce	68,121	60%
Noncommercial		**77,246**	**41%**
	Aspen	69,114	89%
	Aspen Spruce Mix	8,132	11%
Grand Total PTA Acres		**190,014**	**100%**

**Other* cover types within the commercial Priority Treatment Areas would not be treated.

** In addition to the vegetation cover types targeted for noncommercial treatment listed here (aspen and aspen-spruce mix), other cover types in the noncommercial Priority Treatment Areas could be incidentally treated in order to facilitate implementation of prescribed burns in the targets. Approximately 6,257 acres are identified in detail and analyzed for treatment in the Fuels section, Chapter 3.

Silvicultural Prescriptions

The full suite of identified silvicultural prescriptions are included in Alternative 2. See Appendix A.

Access

In order to access proposed commercial treatments and remove forest products, Alternative 2 includes the following maximum roadwork. These represent maximum anticipated miles that may be constructed and maintained under this alternative, and are based on the maximum acreage analyzed for commercial treatment in Alternative 2. This roadwork would be conducted in accordance with the descriptions provided above (See *Activities Common to All Action Alternatives / Access).*

Table 10. Alternative 2 Maximum Road Treatments

	No Action	Alt 2
Road construction (miles)	0	178
Road reconstruction (miles)	0	538
*Existing system roads**	*0*	*356*
Existing non-system roads	*0*	*182*
Road decommissioning	0	360
Road maintenance (miles)*	0	714

**Assumed that 1/3 of system roads used for hauling would be reconstructed prior to use and the remaining 2/3 would simply be maintained.*

Alternative 3 (WUI Focus Alternative)

Alternative 3 shifts the geographic extent of treatments exclusively to 1) the wildland urban interface (WUI) and 2) outside the WUI, proximal to additional human infrastructure.

All treatment types and methods would remain the same as in Alternative 2, but would be limited to the identified geographic extent.

Size and Geographic Location of Treatments

Alternative 3 analyzes 127,023 acres of potential disturbance acres. 102,159 of these acres are identified and analyzed as Priority Treatment Areas (PTAs), 24,695 acres as potential hazard tree treatments outside of PTAs, and 169 acres are for potential new road disturbance outside of PTAs. Of the PTA acres, approximately 45% (45,967) are identified as commercially suitable timber acres, and 55% (56,192) are identified for noncommercial treatment. See Table 11, Table 12, and Table 13. Both noncommercial and commercial PTAs in Alternative 3 total less than 60,000 acres, so treatments of hazard trees may or may not make up the difference. Depending on the extent of hazard trees within the identified roadside corridors over the life of the project, fewer total acres may be treated in Alternative 3, ranging from ~46,000-60,000 acres commercially to 56,192-60,000 acres noncommercially. Maps of Alternative 3 are located in Appendix G (Maps G-18 to G-36) and on the web at: http://www.fs.usda.gov/project/?project=42387.

As noted in *Activities Common to All Alternatives*, maximum commercial treatments would total 60,000 acres and maximum noncommercial treatments would total another 60,000 acres, for a total of 120,000 maximum treated acres.

Table 11. Alternative 3: Summary of Analysis Acres

Proposed Activity	**Total Acres**
Hazard Trees Outside PTAs	24,695
New Roads Outside PTAs	169
Priority Treatment Areas	102,159
Commercial	*45,967*
Noncommercial	*56,192*
Grand Total Analysis Acres	**127,023**

Table 12. Alternative 3: Summary of Analysis Acres by Geographic Area & Activity Type.

The Adapted Future Action -All Salvage treatment type is identified in order to provide bounds for analysis. Proposed broad treatment types are based on the current level of mortalities in a stand, but as mortality from spruce beetle increases, more treatments would correspondingly shift to salvage.

			Commercial PTA & Treatment Type					*Noncommercial PTA & Tx Type*			
Geographic Area	**Hazard Trees Outside PTAs**	**New Roads Outside PTAs**	**Combination**	**Resiliency**	**Salvage**	**Adapted Future Action - All Salvage**	**Total Commercial PTA**	**Burn & Mechanical**	**Mechanical Only**	**Total Noncomm PTA**	**TOTALS by GA**
Grand Mesa	1,516	28	5,283	3,605	376	*9,264*	**9,264**	11,809	830	**12,639**	**23,448**
Gunnison Basin North	5,241	45	1,986	2,245	732	*4,963*	**4,963**	15,173	0	**15,173**	**25,421**
Gunnison Basin South	7,413	20	1,637	999	1,259	*3,896*	**3,896**	3,049	0	**3,049**	**14,378**
North Fork Valley	2,817	20	1,761	4,293	56	*6,111*	**6,111**	5,117	841	**5,958**	**14,906**
San Juans	2,516	22	3,137	1,076	652	*4,864*	**4,864**	348	0	**348**	**7,751**
Uncompahgre Plateau	5,192	34	8,766	7,886	218	*16,869*	**16,869**	19,025	0	**19,025**	**41,120**
Treatment Totals	**24,695**	**169**	**22,571**	**20,103**	**3,293**	***45,967***	**45,967**	**54,521**	**1,671**	**56,192**	**127,023**

Table 13 indicates the cover type by PTA treatment category. These are also illustrated on maps G-31 through G-36 in Appendix G.

Table 13. Alternative 3: Cover Type by PTA Treatment Category

Treatment Category	Cover Type	Total Acres	% of Parent Row
Commercial		**45,967**	**45%**
	Aspen	2,864	6%
	Aspen-Spruce Mix	18,008	39%
	Other*	1,005	2%
	Spruce	24,089	52%
Noncommercial**		**56,192**	**55%**
	Aspen	50,804	90%
	Aspen-Spruce Mix	5,388	10%
Grand Total PTA Acres		**102,159**	**100%**

**Other* cover types within the commercial Priority Treatment Areas would not be treated.

**In addition to the vegetation cover types targeted for noncommercial treatment listed here (aspen and aspen-spruce mix); other cover types in the noncommercial Priority Treatment Areas could be incidentally treated in order to facilitate implementation of prescribed burns in the targets. Approximately 4,750 acres of these "other" cover type acres are identified in detail and analyzed for treatment in the Fuels section, Chapter 3.

Access

In order to access proposed commercial treatments and remove forest products, Alternative 3 includes the following maximum roadwork. These represent maximum anticipated miles that may be constructed and maintained under this alternative, and are based on the maximum acreage analyzed for commercial treatment in Alternative 3. This roadwork would be conducted in accordance with the descriptions provided above (See *Activities Common to All Action Alternatives / Access).*

Table 14. Alternative 3 Maximum Road Treatments

	No Action	Alt 3
Road construction (miles)	0	80
Road reconstruction (miles)	0	336
*Existing system roads**	*0*	*248*
Existing non-system roads	*0*	*88*
Road decommissioning	0	168
Road maintenance (miles)*	0	497

**Assumed that 1/3 of system roads used for hauling would be reconstructed prior to use and the remaining 2/3 would simply be maintained.*

Summary of Alternatives

Table 15 provides a summary of the areas analyzed for both action alternatives and significant features of each alternative. The total area is represented in a variety of different subset breakouts.

Table 15. Summary of Alternatives.

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Alternative	Alternative 3 WUI Focus
Priority Treatment Areas (PTAs)			
Total PTA [1]	**0**	**190,014 acres**	**102,159 acres**
Commercial PTAs	0	112,768 acres (59% of total)	45,967 acres (45% of total)
Noncommercial PTAs	0	77,246 acres (41% of total)	56,192 acres (55% of total)
Priority Treatment Areas by species			
Commercial [2]			
Aspen	0	4,950 (4% of commercial PTAs)	2,864 (6% of commercial PTAs)
Spruce	0	68,121 (60% of commercial PTAs)	24,089 (52% of commercial PTAs)
Aspen-Spruce Mix	0	37,038 (33% of commercial PTAs)	18,008 (39% of commercial PTAs)

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Alternative	Alternative 3 WUI Focus
Other *(in mapped PTAs, but would not be treated)*		2,660 (2% of commercial PTAs)	1,005 (2% of commercial PTAs)
Noncommercial			
Aspen	0	69,114 (89% of noncommercial PTAs)	50,804 (90% of noncommercial PTAs)
Aspen-Spruce Mix	0	8,132 (11% of noncommercial PTAs)	5,388 (10% of noncommercial PTAs)
Geographic limitations that resulted in the PTAs	N/A	Anywhere spruce, aspen, and spruce/aspen mix vegetation types occur on the GMUG outside of Colorado Roadless, Wilderness, and other special designations. These 718,000 acres then further refined via prioritization exercise, as detailed in Chapter 2 and Appendix F.	Spruce, aspen, and spruce/aspen mix treatments would occur under the same parameters as Alternative 2 except they would only occur within the Wildland Urban Interface areas as defined in this FEIS:1 mile buffer from communities, developed sites, and administrative facilities; and within ski area boundaries.
Treatments Types Available			
Public Safety Treatments (Y/N)			
Activities for Public Safety: Hazard trees – Dead/diseased spruce and aspen within 150 feet of communication sites; dispersed recreation sites; developed campgrounds and recreation sites; electrical power and above-ground telephone line corridors; and roads open to the public. Incidental species other than spruce and aspen may need to be removed, if pose same hazard. Buffer would increase to 300feet on uphill side of steep slopes. PTAs identified within WUI as defined in the FEIS	No	Yes	Yes
PTAs within WUI	0	102,159	102,159
Additional Hazard Tree Acres (outside PTAs)	0	17,388	24,695

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Alternative	Alternative 3 WUI Focus
Mechanical Treatments (Y/N)			
Mechanical Treatments: •Include contract commercial timber harvest (salvage), service contracts, stewardship contracts or agreements and to a lesser extent, Forest Service work crews or cooperators •Near communities and infrastructure, heavy fuels created by treatment would be masticated or piled and burned •Commercial mechanical treatments and non-commercial mechanical treatments involving large equipment on slopes < 40% •Non-commercial mechanical with chainsaws on slopes < or >40% •Cut and chunk, chipping, and hand-cut pile-burn in remote areas •Coppice cutting (in aspen)	No	Yes	Yes
Fire Treatments (Y/N)			
•Prescribed fire for aspen regeneration purposes •Disposal of activity fuels •Pile burning as needed to reduce slash.	No	Yes	Yes
Spruce Prescriptions Note: More detailed silvicultural prescriptions are in *Appendix A*.			
Activities in spruce	None	Recovery (salvage) prescription for >90% overstory mortality Stands with more live component treated for resiliency: - Resiliency prescription for stands with <40% overstory mortality - Recovery and resiliency prescription for >40% <90% overstory mortality	Same as Alt. 2.

Description	Alternative 1 No Action	Alternative 2 Agency Preferred Alternative	Alternative 3 WUI Focus
Activities in aspen with spruce-fir understory		Mature aspen stand w/ < 50% SAD: Removal of live aspen to trigger sprouting (coppice). Young healthy aspen stands w/ < 50% SAD: selective removal of spruce-fir to set back successional process in the stand. Prescribed fire as needed to encourage aspen regeneration. Pile burn as needed to reduce fuel loading.	Same as Alt. 2.
Aspen Prescriptions Note: More detailed silvicultural prescriptions are in *Appendix A*.			
Activities in pure aspen	None	Coppice cutting and prescribed fire to promote regeneration in aspen with <50% overstory mortality, on opportunistic basis in aspen with >50% overstory mortality	Same as Alt. 2.
Activities in mixed conifer with aspen component[6]	None	Selective removal of spruce-fir and/or other conifer species to allow additional aspen. Broadcast burn in and around mixed stands with aspen to encourage aspen regeneration. Pile burn as needed to reduce fuel loading.	Same as Alt. 2.
Access			
Road reconstruction, (miles) *Includes both existing system and non-system roads*	0	538	336
Road construction (miles)	0	178	80
Decommissioned roads (miles)	0	*(360)*	*(168)*
Road maintenance (miles)	0	714	497

[1]Note that due to inaccuracies of vegetation type mapping, minor amounts of treatment could occur outside the actual GIS polygons used in analysis if the vegetation type, stand conditions and management area are such that treatment is warranted by the matrix. Acres rounded to nearest 1,000.
[2]As noted throughout this FEIS, commercial treatments would only occur on suitable timber lands as defined by the 1991 Forest Plan Amendment (USDA Forest Service, 1991, Appendix F).

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of the project, duplicative of the alternatives or are already components of the alternatives considered in detail, or determined to be components that would cause unnecessary environmental harm. Two alternatives were considered but dismissed from detailed consideration for reasons summarized below.

Alternative 4 was eliminated from further analysis. Whereas the alternative was developed for the Draft EIS in order to exclude resiliency treatments in spruce-fir, the effects analysis indicated that the omission of spruce-fir resiliency treatments would not meet the resiliency aspect of the purpose and need for the project. One of the stated goals of the project is to promote regeneration and create multiple age classes of trees in healthier spruce-fir stands. "The distribution of size and density is skewed toward larger trees with higher amounts of canopy cover across all vegetation types, meaning that most of the stands on the GMUG are comprised of older trees, which are generally larger. Large acreages of vegetation in this condition is at risk to [sic] loss, as disturbance events, including insects, disease and effects of climate occur…the lack of resiliency treatments in spruce stands means that this alternative would not meet the intent of the Western Bark Beetle Strategy. Because stands that are not currently affected would receive no treatment, it would effectively leave all of the unaffected stands vulnerable to continued and future outbreaks of spruce beetles" (DEIS, page 289). Rather than addressing public concerns about resiliency effectiveness with a distinct alternative, these concerns are addressed in both Appendix H, Response to Comments, and the silviculture section of Chapter 3.

Another proposed alternative – *Alternative with No Net Increase in Roads* -- was dismissed from detailed consideration in the Draft EIS but was incorporated into both action alternatives in the Final EIS. This alternative would use a combination of existing roads and construction of new designed and temporary roads to implement commercial treatments. However, all would be decommissioned after use, with no net increase in permanent roads after project completion.

Both action alternatives in the Final EIS have been modified to only authorize construction of temporary roads; all constructed roads and reconstructed non-system roads would be decommissioned within five years of the associated timber sale closure. This modification responds to public concerns raised in issue 1 that supported the proposed action but stated that no net increase in roads should occur.

Alternative Using Only Existing Roads for Treatment Implementation

This alternative would mirror Alternative 2, except only existing roads would be used for spruce and aspen treatments. This alternative would avoid construction of new temporary and designed roads, reducing the area available for treatment relative to the proposed action. This alternative would address the concerns raised in issue 1 and would address comments that stated no new roads should be constructed.

This alternative was eliminated from detailed study because the IDT determined that the impacts of roads could be adequately addressed by:

a) design features common to all alternatives, guided by the Forest Service Manual and National Best Management Practices. An additional feature common to all alternatives in the Draft EIS was to decommission 80% of newly constructed roads, limiting 80% of road impacts to fairly short-term duration. In the Final EIS, all action alternatives would decommission 100% of newly constructed roads as well as reconstructed non-System roads, thereby limiting all road impacts to short-term duration and reducing net road impacts over the long-term.

b) effects analysis of residual impacts, taking into consideration the effective application of design features.

Alternative with Additional Treatment Areas

This alternative has the same goals and treatments as the proposed action, however, it proposes to increase the effort put toward meeting those goals. This alternative increases the total acres treated in the proposed action and broadens the geographic scope in which those treatments could occur. This alternative was developed to address the concerns of wood products industry and local communities to better reconcile the treatment scale to the landscape scale of the epidemic.

In this alternative, 8,000-12,000 acres would be treated through commercial treatments, and 6,000-12,000 acres would be treated annually through non-commercial treatments, rather than 4,000-6,000 acres and 3,000-6,000 acres of commercial and non-commercial treatments (respectively) as described in the proposed action. The potential treatment area would cover all fifty-one Lynx Analysis Units on the Forest, rather than just the twenty-four LAUs in which the activities of the proposed action would be focused in alternative 2. It would be likely that more miles of roads would be constructed for this alternative.

This alternative was eliminated from detailed study because it is economically unfeasible given current and proposed Forest Service staffing resources. Specifically, the proposed annual treatment targets of this alternative exceed the current and feasible future staffing capacity of the GMUG required to design and administer the individual treatments. The action alternatives

already contain a maximum estimate of the current and foreseeable Forest Service capacity to design and administer treatments.

Alternative that does not treat any lynx habitat

In comments on the DEIS, the public identified a number of variations on the theme of avoiding treatments in lynx habitat, asking the Forest Service to consider an alternative/s that would avoid areas that contain the Primary Constituent Elements for lynx critical habitat; avoid lynx habitat; avoid lynx linkage areas; avoid areas with sufficient dense horizontal cover; avoid areas with abundant and spatially well-distributed patches of mature, multi-storied spruce-fir stands.

With respect to lynx, silvicultural treatments to promote age class diversity where such diversity is lacking, when conducted in accordance with the SRLA, is considered a conservation measure; as such, excluding all suitable lynx habitat and/or lynx linkage areas wouldn't make sense from a conservation perspective. Regarding an alternative to avoid treatment in mature, multi-storied stands, at the LAU scale, the GMUG generally lacks seedling, sapling, and pole size trees. The 2013 Lynx Assessment again affirms that in order to maintain forage habitat and connectivity, a range of seral conditions is needed. Natural succession and disturbances such as the spruce beetle epidemic can facilitate age class diversity; so can active management where appropriate. The effects analysis indicates that the action alternatives move the analyzed stands closer to the potential natural vegetation communities/desired condition for age class diversity (see the silviculture and wildlife sections of Chapter 3). With respect to protecting areas of abundant, dense horizontal cover, the silvicultural prescriptions across all action alternatives explicitly include such protection; see Appendix E.

Alternative that applies treatments only within 1,000 feet of infrastructure

An alternative that would treat areas adjacent to infrastructure in buffers no greater than a few hundred meters, as proposed by members of the public throughout the development of the DEIS and the FEIS, was considered but dismissed from further analysis by GMUG staff. Treatments within a few hundred meters of infrastructure provide for immediate defensible space, which better enables firefighting crews to protect the infrastructure in the event of a WUI wildfire. However, as pointed out by GMUG fire specialists in meetings with the public, such treatments are not sufficient to enable fire managers to manage spruce fires for resource benefit and/or to manage the fire perimeter so that it does not continue across the landscape indefinitely, impacting additional structures or values. Defensible space is considered a "last resort", and they only pertain to defense of a structure from a passing fire. If a wildfire in spruce-fir is proximal enough to infrastructure that defensible space were utilized by firefighters, fire managers would simultaneously be working to entirely suppress such a wildfire. Spruce-fir typically burns as a stand-replacing, crown fire, and only iterative treatments across the landscape, radiating from the defensible space perimeter and continuing throughout the full extent of the WUI, would provide

for strategic, tactical defense locations that could enable fire managers to manage wildfire away from values at risk without engaging full suppression. Because treatments within a few hundred meters of infrastructure do not meet the purpose and need to a) increase safety of infrastructure and firefighters while increasing the likelihood to safely manage wildfires for resource benefit (vs full suppression), this proposal is not further considered. Furthermore, while it may provide for some timber volume of live and dead trees, thereby meeting purpose and need of "recovery", such a proposal would be too small in scale to foster resiliency of spruce and aspen stands. See also response to comment 22-27.

Comparison of Alternatives

Table 16 summarizes general effects of alternatives as described in detail in Chapter 3.

Table 16. Comparison of Environmental Consequences of Alternatives.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
General Consequences	No decrease in the threat to public safety, infrastructure and firefighters from falling trees and increased fire hazard due to mortality related to spruce beetle and SAD; More difficult to safely manage spruce-fir fires in the WUI to protect values at risk and outside of the WUI for resource benefit. No additional economic benefit for industry from commercial treatments; Spruce-fir areas with high mortality and limited to no regeneration and/or seed source may not recover spruce-fir component for long-term. Sudden Aspen Decline would continue unchecked; areas with little to no regeneration may not recover aspen component for long-term.	Safety: Surface, ladder, and canopy fuels would be reduced across 4%of the Forest due to project implementation, resulting in a concomitant reduction in potential fire behavior and enhanced protection of 6.5% of the Forests' WUI and other infrastructure values. Recovery: $52.3 million could be gained in labor income annually to local communities. Resiliency: Increase diversity of age class structure in stands of spruce-fir/spruce-aspen mix where little/no mortality is present, affecting up to 5% of these cover types.	Safety: Effects same as Alternative 2 except condensed and confined in the WUI, enhancing protection of 10% of the Forests' WUI and other infrastructure values. Recovery: $50.1 million could be gained in labor income annually to local communities. Resiliency: Increase diversity of age class structure in stands of spruce-fir/spruce-aspen mix where little/no mortality is present, affecting 2.5% of these cover types.
Fuels Consequences	No impacts due to project implementation; resources would be subject to natural processes and only projects approved under other decisions	Surface, ladder, and canopy fuels would be reduced across 4%of the Forest due to project implementation, resulting in a concomitant reduction in potential fire behavior and enhanced protection of 6.5% of	Effects same as Alternative 2 except condensed and confined in the WUI, enhancing protection of 10% of the Forests' WUI and other infrastructure values.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
		the Forests' WUI and other infrastructure values. Additional areas of aspen regeneration, would be created leading to an increase in areas where fires would slow or go out Enhanced opportunities for firefighters to safely remain engaged while suppressing or managing fires for resource benefit.	
Silviculture Consequences	No impacts from project implementation; resources would be subject to natural processes. Spruce-fir areas with high mortality and limited to no regeneration and/or seed source may not recover spruce-fir component for long-term; Sudden Aspen Decline would continue unchecked; areas with little to no regeneration may not recover aspen component for long-term.	Resiliency treatments would effectively reduce the amount of standing live trees by use of single tree and group selection and contribute to increased age-class diversity in treated stands. Recovery treatments would remove trees that have been killed or will die within a very short timeframe, leading to fewer numbers of standing snags across the landscape. There would be a reduction to downed woody debris in the immediate and over the longer term in the treated stands. The reduced amount of downed wood in the treated stands would likely lead to greater establishment of natural regeneration.	Treatments remain the same under alternative 3 as alternative 2 with the shift to only treating suitable timber lands in the WUI. Treatment focused in the WUI would lead to a greater number of acres of WUI treated. Stands outside the WUI would remain untreated. Age-class diversity in aspen would not be promoted outside of the WUI.
Economic Consequences	No direct effects on the local economy would occur as a result of the No Action. However, economic consequences of inaction may include increased cost of managing wildfires and protecting values at risk from wildfires; cost of damage to infrastructure from fallen hazard trees.	$52.3 million could be gained in labor income annually The project could cost the Forest Service $34.7 million in timber and restoration costs, not accounting for economic value gained through restoring ecosystem services, reduced safety risks and increased ability to manage fires. The anticipated revenue from timber harvest would be approximately $13.6 million, for a net present value of $21.0 million.	$50.1 million could be gained in labor income annually The project could cost the Forest Service $44.2 million in timber and restoration costs, not accounting for economic value gained through restoring ecosystem services, reduced safety risks and increased ability to manage fires. The anticipated revenue from timber harvest would be approximately $13.1 million, for a net present value of $31.0 million.
Roads Consequences	No additional roads.	More miles of road would be constructed, reconstructed, maintained, and decommissioned than in Alternative 3. Overall, the transportation system would improve to a greater extent than in Alternative 3, as more existing, non-system roads used for SBEADMR implementation would be subsequently decommissioned. Furthermore, more of the existing system roads would receive needed maintenance. All new roads	Fewer miles of road would be constructed, reconstructed, maintained, and decommissioned than in Alternative 2. All new roads constructed would be decommissioned, leading to no long-term change to public access from the project.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
		constructed would be decommissioned, leading to no long-term change to public access from the project.	
Canada lynx – General	No effect to lynx or its habitat. Opportunities to move forested vegetation toward Potential Natural Vegetation through active management would not occur. The trajectory of spruce-fir and aspen stands will continue based upon natural processes, including impacts resulting from spruce beetle and Sudden Aspen Decline.	Actions will result in an **adverse effect** mainly due to the scope and scale of management actions, impacts to understory vegetation in Multi-story spruce fir stands, and cumulative impacts. Impacts as allowed by the 2008 incidental take statement issues by Fish and Wildlife Service for implementation of the SRLA. A few LAUs, as stated below may exceed acres impact caps **if** every acre within PTA received active management. Since maximum treatment under SBEADMR is limited to 60,000 acres commercial mechanical and 60,000 acres non-commercial this is unlikely to occur. Decision-making triggers have been established to ensure caps are not exceeded. See additional detail below concerning specific requirements of the SRLA.	Same as Alternative 2. See below for specific differences.
Canada Lynx - Habitat Connectivity within LAU *SRLA Direction:* • Objective All O1 • Objective VEG O1 • Objective VEG O2 • Objective VEG O3 • Objective VEG O4 • Guideline G11	No change from baseline.	**Grand Mesa LAUs** – maintain or moves toward Potential Natural Vegetation but percent change less than 10%. **Gunnison Basin North LAUs -** – maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **Gunnison Basin South LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **North Fork Valley LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **San Juan LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 5%. Exception is Alpine LAU at 16% change. **Uncompahgre Plateau LAUs -** maintains or moves toward Potential Natural Vegetation but percent change less than 10%.	**Grand Mesa LAUs** – maintain or moves toward Potential Natural Vegetation but percent change less than 3%. **Gunnison Basin North LAUs -** – maintains or moves toward Potential Natural Vegetation but percent change less than 3%. **Gunnison Basin South LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 3%. **North Fork Valley LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 3%. **San Juan LAU** – maintains or moves toward Potential Natural Vegetation but percent change less than 3%. Exception is Alpine LAU at 16% change.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
			Uncompahgre Plateau LAUs - maintains or moves toward Potential Natural Vegetation but percent change less than 5%.
Canada Lynx - Conversion of no more than 15% of lynx habitat *SRLA Direction:* Standard VEG S2 Standard VEG S5	No change from baseline.	Current stand conditions – all meet VEG S2 standard. Adapted/potential future treatment (all salvage) stand conditions – Alpine and Spring Creek LAU could exceed.	Current stand conditions – all meet VEG S2 standard. Adapted/potential future treatment (all salvage) stand conditions – Spring Creek LAU could exceed.
Lynx Linkage Zone *SRLA Direction:* Objective All O1	No change from baseline.	Poncha Pass – 1.3% affected North Pass – 1.5% affected. Slumgullion Pass – 28.9% affected. Based on management toward PNV and retention of advance regeneration, connectivity in linkage zone will be maintained.	Poncha Pass – 0.8% affected North Pass – 0.9% affected. Slumgullion Pass – no acres affected.
Snowshoe hare and red squirrel habitat *SRLA Direction:* Standard VEG S5 Standard VEG S6 Guideline VEG G5	No change from baseline.	Hare habitat: 7,968 acres affected; 3,973 acres of high quality (>35% DHC). Forest cap is 4,995 acres under SRLA. Squirrel habitat: abundance declines once stands reach 60% overstory mortality after 3 years. Further decline when stand exceed 90%. High mortality areas retention of live mature spruce is management priority. Removal of mature dead trees small but additive effect.	Hare habitat: 5,071 acres affected; 2,536 acres of high quality (>35% DHC). Forest cap is 4,995 acres under SRLA. Squirrel habitat: Same as Alternative 2.
Gunnison sage-grouse	No change from baseline. Within critical habitat, encroachment of conifers into meadows will continue to reduce habitat important to sage-grouse. Aspen areas adjacent to sagebrush that are affected by SAD or are becoming decadent will continue to decline. Brooding and rearing habitat in these areas will not be improved.	Critical habitat Acres Affected: 7,365 mostly in the Gunnison Basin – North and South GA. Treatment targets removal of encroaching conifer into meadows and improving aspen stands adjacent to sage-brush areas. **Effects**: While actions taken benefit sage-grouse and improve critical habitat, there will be short-term disturbance from human activity and machinery during treatment. Use of design features will avoid or minimize these effects making them discountable resulting in a "may effect but is not likely to adversely affect" Gunnison sage-grouse nor result in adverse modification to designated critical habitat.	Critical Habitat Acres Affected: 6,926 mostly in the Gunnison Basin – North and South GA. Treatment targets removal of encroaching conifer into meadows and improving aspen stands adjacent to sage-brush areas. Effect determination is the same as Alternative 2.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
Forest terrestrial sensitive species	There would be no direct impacts to terrestrial wildlife because no human-induced vegetation management would occur. Thus, there would be no human-caused direct mortality, species disturbance and displacement, or habitat conversion. Resources would be subject to natural processes. The effects of natural processes associated with spruce bark beetle and SAD upon habitat are positive for some species in the short-term and negative for others. Beetle infested areas may slowly convert into more open habitat for a period of time to the detriment of amphibians and certain avian species (boreal owl), and some mammal species (American marten), but this same impact would be beneficial to others (goshawk and olive-sided flycatcher in terms of foraging habitat).	Direct effects to wildlife include visual and noise disturbance causing temporary displacement. Indirect effects include habitat degradation and loss as a result of treatment activities, and potentially longer term displacement of species from areas where habitat is converted to an unsuitable condition. Wildlife design features are incorporated into the project by design as part of the proposed action. Certain design features will lessen negative effects while others will maintain some habitat components for all species across the landscape. Wildlife habitat management objectives are incorporated into the project. Thus, in the long term, treatments will benefit some species. Wildlife habitat management objectives are included for Canada lynx, American marten, big game species and northern goshawk.	Effects would be similar as Alternative 2 except impacts to habitat would occur within the WUI. Areas outside the WUI proposed for treatment under alternative 2 would not be treated. Natural processes, as described in the no action alternative, would continue to influence wildlife resources outside the WUI. Overall, impacts would not be as widespread.
Water and Soils Consequences	No impacts due to project implementation; resources would be subject to natural processes	Most effects will be insignificant to moderate, localized and short to moderate term. Impacts would not change current watershed condition class scores. In the Upper Spring Creek subwatershed (140200060601) on the Uncompahgre Plateau, the large extent of area that could be treated with commercial timber harvest would result in sufficient basal area removed to measurably affect water yield if all of these acres were treated within a short period of time.	Reduced effects compared to Alternative 2, most effects will be insignificant to moderate, localized and short to moderate term. Impacts would not change current watershed condition class scores. Similar to Alternative 2, there could be measurable changes to water yield in the Upper Spring Creek subwatershed on the Uncompahgre Plateau, if all treatment acres identified were implemented within a short timeframe.
Botany	No impacts due to project implementation; resources would be subject to natural processes	Effects would be limited by use of design features, project implementation checklist and	Effects would be limited by use of design features, project implementation checklist and implementation monitoring.

Resource Areas	Alternative 1 No Action	Alternative 2 Agency Preferred Action	Alternative 3 WUI Focus
		implementation monitoring. For sensitive plant species, the action may affect individuals, but is not likely to result in a trend toward Federal listing or loss of viability of affected species: *lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort,* and *park milkvetch, and peculiar moonwort* The action may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability of the *Colorado tansy aster*. More PTA acres are located in the vicinity of aquatic habitat features that many sensitive species are associated with, so there is higher potential for direct and indirect impacts to these species than in Alternative 2.	There would be lower potential for direct and indirect impacts to sensitive species associated with aquatic habitat features, as fewer acres of PTAs, hazard trees, and new road construction are located in their vicinity than in Alternative 2. Concentration of all activities in the WUI, where there is more pre-existing disturbance, means there would be less change between the baseline conditions and post-SBEADMR conditions in comparison to Alternative 2. Impacts to air quality would be slightly lower than Alt 2, with lower emissions associated with fewer burn acres and piles.

(This page intentionally blank)

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Changes between Draft and Final EIS

As noted in Chapter 2, the SBEADMR Interdisciplinary Team (IDT) and Science Team engaged in a multi-month process between the Draft and Final EIS to refine original "opportunity areas," which defined a narrower, more specific spatial extent for potential treatments and the associated temporary road system in both action alternatives. This prioritization process is detailed in Appendix F. This change facilitated a more quantitative, thorough effects analysis. The following are examples of the subsequent changes to the effects analysis:

- Minor amounts of vegetation types other than spruce and aspen are included to allow for the development of effective, controllable prescribed fire units. Objectives and effects for each of these "incidental" vegetation types are included in the effects section in order to provide thorough effects disclosure; however, these incidental vegetation types are not central to the goals of the FEIS.
- The Draft qualitatively discussed the effects of each silvicultural prescription on vegetation structural stages, while the Final discloses the actual shift in structural stages in 6 geographic areas for each alternative and compares the results to the desired conditions.
- A section specifically addressing the Continental Divide National Scenic Trail has been added in response to public comments. The section takes a careful consideration of potential impacts to existing and proposed re-routes of the CDNST from SBEADMR action alternatives. Design feature SVR-6 has been expanded; see Scenic Resources section.
- Geographic Areas, Lynx Analysis Unit (LAU) and Lynx Linkage Areas (LLA) level analysis by alternative on key risk factors affecting lynx - Habitat connectivity, treatment induced conversion of habitat from suitable to unsuitable, influence of roads, influence of snow compaction, and influence on snowshoe hare and red squirrel habitat.
- Identification of specific Priority Treatment Areas and transportation system enabled more specific identification of the watershed and soil resources that could be affected by SBEADMR treatments.

In response to public comment on the Draft and further IDT discussion, additions and clarifications were made to the Final EIS effects analysis, including but not limited to:

- A more in-depth discussion on reforestation was added with references to local data regarding regeneration rates.
- Impaired waterbodies in the affected watersheds are listed in the Final EIS.
- Inclusion of 10-county GMUG analysis area in economic impact analysis;

- Acres of designated critical habitat for Gunnison sage-grouse that are potentially affected under each alternative were analyzed.
- Greenback cutthroat trout were added to the analysis since seven watersheds have streams that could be affected by the project.
- The IDT reconsidered the maximum number of slash piles per acre based on operational capacity, which resulted in a change from a maximum of 270,000 machine piles in the Draft to a maximum of 138,000 in the Final. Similarly, the maximum number of hand piles was estimated to be 200,000 in the Draft and is only 100,000 in the Final.
- Maximum anticipated timber volume is slightly lower in the Final, considering the spatial extent of existing high-mortality areas and lower mortality areas in the final PTAs. While the Draft included a maximum estimate of 1,200,000 ccf from the SBEADMR EIS, the Final includes a maximum estimate of 840,000 ccf.
- A section specifically addressing the Continental Divide National Scenic Trail has been added in response to public comments. The section takes a careful consideration of potential impacts to existing and proposed re-routes of the CDNST from SBEADMR action alternatives.
- The cumulative effects analyses were updated for all resources, with quantitative consideration of the cumulative potential impacts of past, present, and reasonably foreseeable actions on air quality, watershed conditions, and lynx habitat.

Based on public comments on the Draft and further IDT discussion, design features were clarified and many were added, including but not limited to the following:

- Based both on recent experience on the GMUG with piling of slash generated from salvage, resiliency, and non-commercial treatments and comments regarding impacts to soils, the maximum size of machine piles was reduced to minimize soil impacts and the number of piles/acre was reduced. Additional design features were also developed to ensure monitoring and response to any soil damage or exotic species invasions related to machine pile burning.
- An additional design feature was incorporated into the action alternatives to explicitly address treatments within vicinity of Wilderness. No treatments are proposed in Wilderness, but the design feature ensures that boundaries are adequately and accurately identified as part of pre-treatment design.
- Design features were expanded to explicitly cover scenic quality and visual resources within the foreground and middle-ground of proposed reroutes on the Continental Divide National Scenic Trail.

As a result of the administrative review of the Final EIS and/or per the Reviewing Officer's instructions, the Forest Service made a number of corrections and clarifications to the EIS prior to submitting to the EPA on May 27, 2016 for publication in the Federal Register on June 3, 2016, including:

- Corrected Table 224, p. 473 regarding presence of Canada lynx in the project area. This has also been corrected in the Biological Assessment.

- Clarified lynx analysis methodology assumptions (p. 481). This has also been included in the Biological Assessment.
- Included the Battlement Mesa Lynx Linkage Area (p. 519-520). This has also been included in the Biological Assessment.
- Revised Table 293 (p. 603-615) to provide a more clear crosswalk between the project and each of the Southern Rockies Lynx Amendment objectives, standards, and guidelines. This has also been revised in the Biological Assessment.
- Included a more specific discussion of effects of the action alternatives to the Recreation Opportunity Settings on the Continental Divide National Scenic Trail and identified potential reroutes (p. 743-744, 746).
- Included more specific, pertinent non-federal actions in the cumulative effects: actions considered and analysis approach discussion (p. 755). This has also been included in the Biological Assessment.

Additional corrections, clarifications, and additions are noted at the beginning of Chapter 2; in Appendix B (Design Features) and in Appendix E (Adaptive Implementation Process).The entirety of the Reviewing Officer's instructions are available on the project website and in the project record.

Introduction

This chapter first discusses the affected environment at the Geographic Area scale. Each subsequent resource section then further details the affected environment as appropriate. Subsequently, the environmental consequences of the alternatives on the resource components of the physical, biological, and social environment in the SBEADMR Project Area are disclosed. Environmental consequences are described in terms of the beneficial/adverse, short and long-term direct/indirect and cumulative effects. Effects are quantified where possible, although qualitative discussion is often necessary. Elements that are not affected or minimally affected by the alternatives such as noise and topography are not discussed. This chapter provides the scientific and analytical basis for the comparison of alternatives presented in Chapter 2.

Direct and indirect effects of the proposed action and its alternatives were analyzed over the planning period (8-12 years). Cumulative effects take into account past, present, and reasonably foreseeable activities from actions other than the SBEADMR Project, in addition to direct and indirect effects of the SBEADMR Project. The area analyzed for cumulative effects is the project area for all resources unless otherwise noted. Cumulative effects are disclosed under each resource topic. It is important to note that the amount (e.g. acres, miles, etc.) of a certain activity in any alternative is approximate (based on inventory and survey estimates). See Chapter 3, *Cumulative Impacts – Actions Considered & Analysis Approach.*

The resource components described in this chapter are arranged in three sections:

- Physical Environment
- Biological Environment
- Social Environment

Design features (Appendix B) are incorporated into all action alternatives and associated effects analyses. The design features were developed from laws, regulations, Forest Service Manual or Handbook policy, standard contract language, Forest Service-approved best management practices, or Forest Plan guidelines. These items are considered to be standard management practice as provided by the aforementioned sources, as they have been proven effective during implementation of similar vegetation treatments as proposed in this EIS. These features derive from decades-long practices and/or more recent best available science. These design features translate legal provisions and scientific principles into solid, commonsense stewardship actions that support continued sustainable resource use (USDA Forest Service 2006c)

Design features are subject to change resulting from 1) change in policy or management direction (e.g. amendments or revision of the Forest Plan, federal listing of a species, etc.) and 2) when new science indicates design feature should be modified or replaced to improve effectiveness. Potential changes would be evaluated during annual Management Reviews.

Geographic Areas - Grand Mesa

Vegetation

Aspen and spruce-fir cover types each occupy approximately 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area. The large extent of aspen is the result of large scale fires in the late 1800s (Sudworth 1900), that affected most of the Grand Mesa Geographic Area. As a result, the majority of this geographic area is currently in mid seral conditions.

Approximately 84 percent of the forest and woodland cover types are in the mature size class. There is very little early seral condition in any cover type on the Grand Mesa Geographic Area. When comparing the compositions of current vegetation cover types to PNV types, there is very close comparison, a further indication that current cover types are predominantly in mature conditions.

The majority of the current forest and woodland vegetation conditions – 91 percent - have dense canopy closures (> 40 percent canopy closure).

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along

successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The Grand Mesa Geographic Area, and particularly the spruce-fir and aspen cover types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, and stays moist throughout most fire seasons. Additionally, as mentioned previously, these vegetation types are largely in a mid-seral condition and may not currently have the fuel loading, or fuel structure, to support significant fire behavior or growth.

Though current conditions may not be conducive to fire occurrence and growth, many of the spruce-fir stands are maturing, developing closed canopies, exhibiting increased mortality, and are beginning to develop surface fuel loads, as well as understory ladder fuels. The spruce beetle epidemic on the Grand Mesa is currently mild but will have an impact on fuel complexes as additional trees die, fall to the forest floor, and new vegetation grows into the resulting openings. As the natural maturing process, and the impact of beetle kill, continues, the spruce-fir stands will become more flammable on the Grand Mesa.

Most aspen stands currently have limited potential to carry fire, though they are aging and some trees, and even whole stands, are beginning to die and fall, and there is conifer encroachment in many of the aspen understories.

The impacts of climate change to both spruce-fir and aspen could more quickly contribute dying trees, surface fuels, and drying conditions, further accelerating the potential of these vegetation types to support fire.

There is significant Wildland Urban Interface in the Ward Lake area, near Powderhorn Ski Area, as well as in other scattered areas within and adjacent to the spruce-fir and aspen vegetation types on the Grand Mesa. There are also major powerline corridors that cross the Grand Mesa.

There is very little early seral condition on the Grand Mesa, primarily as a result of the climatic conditions in the area and the 130+ years since past major disturbances. As many stands mature and become more susceptible to fire it would be beneficial to create patches of early seral vegetation types across the landscape to reduce the potential for, and size of, the inevitable large fires that will occur in the next 50-100 years. Increased early seral vegetation conditions would also be beneficial for the development of young, healthy stands as well as wildlife habitat.

Gunnison Basin North & South

Vegetation

Lodgepole pine is the most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 20 percent of the Geographic Area, and is a component of the species mix on an additional 9 percent of the Geographic Area. Lodgepole pine occurs naturally only on the Gunnison Basin Geographic Area portion of the GMUG.

Aspen is the second most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 14 percent of the Geographic Area, and is a component of the species mix on an additional 13 percent of the Geographic Area.

The large extent of lodgepole pine and aspen is the result of large scale fires in the past (Johnston et al. 2001). As a result, the majority of this geographic area is currently in mid seral conditions.

Current vegetation classification shows approximately 46 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent are in mature size class (mostly in the spruce-fir cover type). As mentioned above, photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists.

The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

There is very little early seral condition in any cover type on the Gunnison Basin Geographic Area.

When comparing the compositions of current vegetation cover types to PNV types, the forest types total percentages are approximately equivalent. The majority of the Geographic Area is in mid seral stages currently dominated by lodgepole pine and aspen, however much of these areas will eventually succeed to spruce-fir and Douglas-fir. The biggest difference occurs in the grass/forb types. Much of the current grass/forb cover type is classified as early seral stages of sagebrush and willow PNV types.

The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The Gunnison Basin, and particularly the aspen and spruce-fir vegetation types, has very low fire occurrence due largely to high elevations, significant snow accumulation at the higher elevations, and cool summers. Additionally, there has been significant natural fires in the 1800s, resulting in many aspen stands that are aging and just beginning to develop the fuel loadings and understories to support fire.

Just over half of the vegetation is in the mature age class, mostly consisting of spruce-fir, and much of this consists of dense, closed canopy spruce-fir. As the spruce-fir ages further there will be an increase in surface fuels and understory ladder fuels. Young spruce-fir is also encroaching into many of the aspen stands. The effects of the current beetle epidemic, which is very widespread and intense in the spruce-fir type in the geographic area, and the potential impacts of climate change, will move both the spruce-fir and aspen vegetation types to a more flammable conditions over the next few decades. There is very little early seral vegetation in the Gunnison Basin.

There are numerous Wildland Urban Interface areas in or adjacent to the Gunnison Basin aspen and spruce-fir types, including Crested Butte, Lake City, and numerous scattered small communities and subdivisions, the Crested Butte ski area, as well as several powerline corridors and communication sites.

Some modeling has shown a significant increase in both future fire occurrence, size, and intensity for the Gunnison Basin due to potential impacts from climate change. In order to increase the landscapes resistance to these kinds of future disturbances there should be an effort put forth to increase the extent and health of aspen stands on the landscape and to break up the rapidly declining spruce-fir vegetation type with earlier seral stages. These efforts would be most effective near Wildland Urban Interface areas in and adjacent to the aspen and spruce-fir vegetation types but there would also be value in scattering treatments across the landscape to create resiliency and to help modify the landscape scale fuels complex, which is rapidly trending toward increased flammability.

North Fork Valley

Vegetation

Aspen is currently the dominant tree species occurring on the North Fork Valley Geographic Area, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area.

The large extent of aspen is the result of large scale fires in 1878 to 1879, with less extensive burning occurring in 1883 to 1885 and again in 1890 to 1892 (Sudworth 1900), that affected the northern two-thirds of the North Fork Valley Geographic Areas. As a result, the majority of this geographic area is currently in mid seral conditions.

Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type). There is very little early seral condition in any cover type on the North Fork Valley Geographic Area. When comparing the compositions of current vegetation cover types to PNV types, the forest types and bare areas are approximately equivalent. The biggest differences occur in the grass/forb types; however, much of the current grass/forb cover type is also the early seral stage of forest PNV types. Grass/forb PNV types are classified on only a very small amount (< one percent) of the North Fork Valley Geographic Area.

The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The North Fork Geographic Area, and particularly the spruce-fir and aspen vegetation types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, and stays moist throughout most fire seasons. Additionally, a large portion of the area burned in the late 1800s, resulting in vast aspen stands that have remained relatively healthy, and lack flammability. Much of the vegetation is in a mid-seral stage and is not exhibiting flammability at this time, though with increased spruce beetle activity and the potential impacts of climate change, flammability is expected to increase.

Aspen stands are slowly being encroached on by spruce and fir but due to soil type and moisture conditions this process appears to be happening more slowly than in other locations.

There are scattered Wildland Urban Interface areas within and adjacent to the spruce-fir and aspen, in this Geographic Area, though most of them are small.

There is very little early seral vegetation in this Geographic Area. With the extent, and age, of existing aspen there are significant opportunities to maintain healthy aspen, as well as to increase the amount of early seral aspen on this landscape. Limited opportunities also exist for managing

for diversity and resiliency in the spruce-fir type. Both of these opportunities would result in both decreased flammability and risk on this landscape, as well as healthier vegetation and improved wildlife habitat.

San Juan

Vegetation

Spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juans Geographic Area.

Grass/forb types and bare/rock each comprise 19 percent of the San Juans Geographic Area. The majority of these types are in alpine areas (elevations > 11,000 feet), with 56 percent of the grass/forb types and 86 percent of the bare/rock occurring at these elevations.

The San Juans Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types. Approximately 86 percent of the forest and woodland cover types are in mature size classes. There is very little early seral condition in any cover type on the San Juans Geographic Area. Lack of age data does not allow differentiation between late-mid and late seral conditions in the dominant forest types.

The lack of recent disturbances (fire, insect and disease mortality, harvest) is also reflected in current forest and woodland vegetation conditions – 85 percent have dense canopy closures (> 40 percent canopy closure).

When comparing the compositions of current vegetation cover types to PNV types, the forest types and bare areas are approximately equivalent. The biggest differences occur in the willow and grass/forb types. There is currently less of the willow cover type and more grass/forb types on the landscape that would be expected. These conditions occur in alpine areas and are partly a result of limitations in both the current vegetation and the PNV type data. Additional evaluation is needed to determine if this shift in cover type has a relationship to past management activities, such as livestock grazing.

The trend across all vegetation cover types on the San Juans is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Fire and Fuels

The San Juan Geographic Area, and particularly the spruce-fir and aspen cover types, has very little fire occurrence. Much of this Geographic Area is high elevation, receives significant winter moisture, has cool summer temperatures, is largely north facing, and stays moist throughout most fire seasons. Additionally, as mentioned previously, these vegetation types are largely in a late mid-seral condition and are just beginning to develop fuel loadings and fuel structures that could support significant fire behavior or growth, given seasonal moisture conditions are conducive.

There are several Wildland Urban Interface areas as well as several communication sites and utility corridors, within, and adjacent to spruce-fir and aspen in this Geographic Area, including Telluride, Mountain Village, Ouray, and the Telluride Ski Area, as well as many scattered small subdivisions.

Spruce-fir and aspen stands in this Geographic Area have not experienced disturbance in at least 150-200 years and are mature and dense. As the spruce-fir ages further, increasing mortality can be expected, which will lead to increasing surface fuels, development of ladder fuels (young trees) in the understory, and increasing flammability. With additional spruce beetle mortality and the potential impacts of climate change this increased flammability could be accelerated. Fires that may occur in the future could exhibit extreme fire behavior, high resistance to control, and grow to large size, as was the case with the West Fork and Papoose Fires on the adjacent San Juan and Rio Grande National Forests in 2013. Aspen stands are aging and becoming encroached on by spruce and fir, resulting in a slow increase in flammability. Climate change may accelerate this process by drying stands out, and increasing mortality, and the accumulation of dead material, on the surface.

Some of the Wildland Urban Interface areas could have wildfire risk reduced by rejuvenating aspen stands in areas adjacent to the values at risk. Creating more diverse and resilient spruce-fir conditions in some locations would also have a long term benefit to fire management by reducing landscape scale flammability.

Uncompahgre Plateau

Vegetation

Gamble oak and mixed mountain shrub cover types currently occupy just over a quarter of the NFS lands. Aspen currently dominates a quarter of the NFS lands. Conifer forest and woodland cover types (pinyon-juniper, ponderosa pine, spruce-fir, Douglas-fir, blue spruce, lodgepole pine) combined make up 38 percent of the current vegetation cover on the Uncompahgre Plateau. Lodgepole pine does not naturally occur on the Uncompahgre Plateau, but was planted in the 1960s.

Most of the spruce-fir, aspen, mixed conifer, ponderosa pine, Gambel oak and mixed mountain shrub cover types within the total Geographic Area occur on NFS lands. Most of the pinyon-juniper, cottonwood, sagebrush, willow and grass/forb cover types within the total Geographic Area occur off NFS lands on either BLM or private land.

Current vegetation conditions are a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66 percent are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).

The lack of fire disturbance that has resulted from approximately 100 years of fire suppression efforts is also reflected in current vegetation conditions. Seventy-one percent of the forest and woodland cover types have dense canopy closures (> 40 percent canopy closure). There are very little early seral conditions in any cover type on the Uncompahgre Plateau. This imbalance is most pronounced in cover types that had a history of more frequent fires, such as ponderosa pine, oak-serviceberry and pinyon-juniper-oak-serviceberry types.

When comparing the compositions of current vegetation cover types to PNV types, it appears that aspen and oak currently occupy more area than would have been expected historically. This is somewhat misleading, however; because aspen and oak are both earlier seral stages to conifer dominated forest types (i.e., spruce-fir-aspen, ponderosa pine-oak), and given time, these deciduous cover types will succeed to conifer cover types.

The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands (Manier et al. Draft 2003). A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

Fire and Fuels

The Uncompahgre Plateau Geographic Area has the highest fire occurrence on the GMUG National Forest. The Plateau is surrounded on 3 sides by low elevation, dry, desert-like conditions and is dominated by drier vegetation types, particularly pinyon-juniper, oakbrush, and ponderosa pine, at the mid-elevations. These vegetation types regularly support wildfires that burn upslope into higher elevation vegetation zones, such as aspen, and occasionally into spruce-fir. Major fire disturbances occurred in the late 1800's resetting a large area of the Plateau back to aspen and other early seral vegetation types.

Fire exclusion since the late 1800's has had a significant impact on the extent and composition of the drier vegetation types, particularly ponderosa pine. Due to fire exclusion, many of the higher elevation ponderosa pine stands have been encroached into by spruce and fir that was previously confined to wetter drainages which were sheltered from fire. There is very little pure spruce-fir on the Uncompahgre Plateau; most spruce-fir contains older aspen from earlier successional stages. The aspen is aging, beginning to die, and is being replaced by the spruce-fir.

Though spruce beetle occurrence on the Plateau is moderate at this time the stands are maturing and increasing beetle mortality, and increasing fuels, in the future is likely. Much of the subalpine fir in these stands has died over the past several years and surface fuels are subsequently beginning to build up at an increasing rate. With the decline of aspen, encroachment of spruce fir into aspen stands and into the more flammable ponderosa pine stands, and increasing beetle mortality, coupled with the potential impacts from future climate change, the Uncompahgre Plateau is becoming increasingly vulnerable to large scale, stand replacing fire.

There are scattered, generally small, Wildland Urban Interface areas, as well as numerous utility corridors and communication sites located throughout and adjacent to the spruce-fir and aspen types on the Uncompahgre Plateau.

Rejuvenation or restoration of aspen stands across areas of the Plateau would be highly beneficial from a fire management standpoint, as well as for wildlife habitat and the future health of aspen itself. Creating more diverse, resilient, spruce-fir stands would also be beneficial for long term fire management.

Physical Environment

This section will describe the affected environment and environmental consequences for each resource of the physical environment (Soil and Water and Transportation).

Watershed and Soil Resources

This section discusses the components of the GMUG watershed and soils resources that may be affected by the proposed activities. Components include watershed condition class, water quality, water yield, stream flow regimes, fens, wetlands, groundwater, soil erosion and compaction potential, soil productivity, and effects to aquatic and riparian habitats.

The information in this document is based on published sources, GMUG planning documents, and GMUG GIS data. GMUG watershed and soils resources staff was consulted; Forest direction documents including the 1991 Forest Plan and regional and national Forest Service Handbooks were reviewed; as were pertinent reference literature regarding the effects of proposed treatments. Descriptions and basic analyses using the GMUG GIS library were

conducted to determine existing conditions and relative risk to watersheds and soils. Field surveys to identify soil and water resource areas of concern and appropriate design features and BMPs to be implemented will be conducted prior to implementation for each treatment.

Changes between Draft EIS and Final EIS

- Identification of more specific Priority Treatment Areas and transportation system allows for more specific identification of the watershed and soil resources that could be affected by SBEADMR treatments.
- Affected Environment and Effects sections are organized with a general discussion followed by Geographic Area specific discussion.
- Discussion of the soils resource is better integrated with water resources in the Final EIS.
- Impaired waterbodies in the affected watersheds are listed in the Final EIS.
- Watershed and soil design features were clarified in the Final EIS.
- A more detailed analysis of potential effects to watershed condition and stream health is provided in the Final EIS.
- An “Equivalent Roaded Acre” procedure is used in the Final EIS to analyze potential for cumulative watershed effects instead of the straight 25 percent threshold for mechanical activity in a watershed used in the Draft EIS.

Compliance with Regulatory Direction

Federal regulatory direction guiding this project include Federal Executive Order 11988 – Floodplain Management (Environmental Protection Agency, 2012b), Federal Executive Order 11990, "Protection of Wetlands," (Environmental Protection Agency 2012c) and the Clean Water Act of 1977 (Environmental Protection Agency 2012a). State regulatory direction that applies to watershed protection in this project is the *5 Code of Colorado Regulations* issued by the Colorado Department of Public Health and Environment, Water Quality Control Commission under their authority from Environmental Protection Agency (EPA) through the CWA (Colorado Water Quality Control Commission 2012).

Forest Service Direction includes the Forest Service Manual sections 2532.02 and 2532.03 for watershed and Forest Service Manual 2550 for soil, the National Best Management Practices (BMP) Program, the Watershed Conservation Practices Handbook (FSH 2509.25) and the GMUG Forest Plan. The relevant Forest Plan goals that are applicable to water resources and soils for this project are listed below.

Riparian and Stream Area Management

- Design and implement activities in management areas to protect and manage the riparian ecosystem.
- Manage riparian areas to reach the latest seral stage possible within the stated objectives.
- Prescribe silvicultural and livestock grazing systems to achieve riparian area objectives.
- Locate, and construct all roads to maintain the basic natural condition and character of riparian areas.
- Prevent or remove debris accumulations that reduce stream channel stability and capacity.
- Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover.
- Maintain sediment yield within threshold limits. The effects on water and sediment yields from vegetation manipulation and road construction projects will be determined through the use of appropriate modeling and/or quantification procedures to determine sediment yield threshold limits and water yield change potentials.
- Treat disturbed areas resulting from management activities, to reduce sediment yields to the natural erosion rates in the shortest possible time.
- Prevent soil surface compaction and disturbance in riparian ecosystems. Allow use of heavy construction equipment for construction, residue removal, etc. during periods when the soil is least susceptible to compaction or rutting.
- Maintain or enhance the long-term productivity of soils within the riparian ecosystem.
- Prevent or reduce debris accumulations in riparian areas that reduce stream channel stability and capacity.
- Identify at the treatment level upland areas that are immediately adjacent to Riparian (Prescription 9A) Management Areas. Adjacent upland areas are those portions of a management area which, when subjected to management activities, have a potential for directly affecting the condition of the adjacent Riparian Management Area. The magnitude of effects is dependent upon slope steepness, and the kind, amount, and location of surface and vegetation disturbance within the adjacent upland unit.

Soil and Water Resource Management

- Maintain instream flows and protect public property and resources.
- Improve or maintain water quality to meet State water quality standards. However, where the natural background water pollutants cause degradation, it is not necessary to implement improvement actions. Short-term or temporary failure to meet some parameters of the State standard, such as increased sediment from road crossing construction or water resource development may be permitted in special cases.

- Rehabilitate disturbed areas that are contributing sediment directly to perennial streams as a result of management activities to maintain water quality and re-establish vegetation cover.
- Prevent soil surface compaction and disturbance. Allow use of heavy construction equipment for construction, residue removal, etc. during periods when the soil is least susceptible to compaction or rutting. Limit use of herbicides, insecticides, rodenticides, or other chemical agents as part of management activities to times and places where possible transport to or by surface water has a low probability of occurrence. Follow all label requirements concerning water quality protection. Maintain soil productivity, minimize man-caused soil erosion, and maintain the integrity of associated ecosystems.
- Obliterate and rehabilitate those existing travel ways identified for return to resource production.

Compliance with regulatory requirements will be met by the use of design features and best management practices (BMPs) as described in Appendix B. Pre-treatment surveys will be conducted and results used to guide layout of management activities. Field reconnaissance and planned management activities will determine the appropriate design features and BMPs to implement. Annually, one treatment will be randomly selected and evaluated to ensure that the appropriate design features and BMPs were selected for the treatment, were implemented and functioned as designed (See Appendix D).

Criteria used to Determine Impacts

The relative risks of additional impacts from treatments are evaluated based on the following characteristics:

- Percent of the watershed with treatment areas
- Existing road density and estimated proposed road acres
- Number of existing and proposed stream crossings
- Percent of watershed within and outside Forest System Land
- Area of fens, wetlands, and riparian areas in or near treatment areas
- Area of soil with “severe” or “very severe” Erosion Hazard Rating in or near treatment areas
- The amount of past (within 25 years) and on-going disturbances, such as grazing, timber harvest, and wildland fires, etc. in the watershed.

Affected Environment

Information on soil and water resources in the affected watersheds, including watershed condition class, water quality, water yield, stream flow regimes, and fens, wetlands, groundwater, and soils characteristics is provided in the following documents:

- 1991 Final supplemental Environmental Impact Statement: Grand Mesa, Uncompahgre, and Gunnison National Forests (Amended FEIS)
- 1991 Amended Land and Resource Management Plan: Grand Mesa, Uncompahgre, and Gunnison National Forests (Amended LRMP)
- 2006 Proposed Land Management Plan Comprehensive Evaluation Report: Grand Mesa, Uncompahgre, and Gunnison National Forests (2006 LRMP Report)
- 2001 Ecological Types of the Upper Gunnison Basin (2001 Eco Types Report)
- 2012 Inventory of Fens in a Large Landscape of West-Central Colorado (2012 Fen Inventory)
- 2005 Aquatic, Riparian, and Wetland Ecosystem Assessment (Assessment Report)
- 2012 Colorado Water Quality Control Commission 303(d) list

This and new information are incorporated by reference and summarized for this analysis.

Watershed

Watershed Condition Class

The GMUG reclassified watershed condition class as part of a 2011 national effort. The process is outlined in the *Watershed Condition Framework and Technical Guide* (USDA Forest Service 2011g and 2011h). The Watershed Condition Framework (WCF) is a 12-indicator model that considers both aquatic and terrestrial physical and biological indicators. The indicators are grouped into four process categories (Table 17).

Table 17. Indicators in each Watershed Condition Class Process Category

Process Category	Aquatic - Physical	Aquatic - Biota	Terrestrial - Physical	Terrestrial - Biota
Weighting Factor	30 %	30 %	30 %	10 %
Indicators	Water Quality Water Quantity Aquatic Habitat	Aquatic Biota Riparian Vegetation	Roads & Trails Soils	Fire Regime Forest Cover Rangeland Vegetation Terrestrial Invasives Forest Health

Indicators within each Process Category are individually rated according to a standardized rule set, the scores are then averaged to give a rating of Class 1 (functioning properly), Class 2 (functioning at risk) or Class 3 (impaired function) for each process category. The Process

Category scores are then combined based on a weighting factor to determine a score for each watershed. A watershed rated between a score of 1.0 and 1.6 is a Class 1 watershed. A watershed rated between a score of 1.7 and 2.2 is a Class 2 watershed. A watershed rated between a 2.3 and 3.0 is a Class 3 watershed (USDA Forest Service 2011g).

A watershed is considered to be functioning properly (Class 1) if the physical attributes are appropriate to maintain or improve biological integrity, i.e. the watershed is functioning in a manner similar to natural wildland conditions (USDA Forest Service 2011g). Class 2 and Class 3 watersheds have impaired function because some physical, hydrological, or biological thresholds have been exceeded. This can occur due to natural processes, such as wildland fire or large slope failures, but are more typically caused by human related disturbance, such as roads close to streams, overgrazing by domesticated animals, invasive species, or presence of aquatic non-native species.

The identified priority treatment areas and hazardous tree removal corridors lie within 188 watersheds on the GMUG. Of these, 116 are Class 1; 70 are Class 2, no watersheds are Class 3, and 2 are watersheds where watershed condition was not rated because of the small percentage of NFS land within them (USDA Forest Service 2011h). Of the 116 Class 1 watersheds, 42 have a Watershed Condition Class score of 1.6 and are at a higher risk of moving from Class 1 (Functioning Properly) to Class 2 (Functioning at Risk) due to natural (wildland fire) or human (roads or timber harvest) causes. These are called borderline Class 1/Class 2 watersheds. None of the watersheds on the GMUG have a score higher than 2, so there are no borderline Class 2/Class 3 watersheds. The affected watersheds and their Watershed Condition Class rating are listed below in the Geographic Area descriptions. Note some watersheds are located in more than one Geographic Area.

Surface Waterbodies and Stream Health

Surface water conditions vary tremendously across the GMUG, depending on geology, topography, microclimate, soil type, and other factors. The 1991 LRMP (USDA Forest Service 1991a) notes that there are an estimated 3,657 miles of perennial streams, 1,390 miles of major (named) intermittent streams, and 5,815 miles of minor (unnamed) intermittent streams within the Forests' boundaries. Miles of streams in each watershed are listed in the project file.

Healthy streams maintain good hydrologic function and provide resilience to watershed conditions. Stream health depends largely on channel widths and depths, bank stability, and quality of cover and substrate. The WCF indicator "Aquatic Habitat Condition" indicates overall stream health in a watershed in terms of three attributes: "Habitat fragmentation", "Large woody debris", and "Channel shape and function". The "Habitat fragmentation" attribute concerns breaks in aquatic habitat caused by temperature, aquatic organism passage blockages or dewatering. The "Large woody debris" attribute is concerned with the lack of large wood in stream systems and changes due to riparian management activities that would reduce large wood

recruitment. The "Channel shape and function" attribute is concerned with channel width-to-depth ratios and floodplain connectivity. More details about this indicator and attributes can be found in the Watershed Condition Analysis (Appendix I). The data for this WCF indicator is summarized below in Figure 8 and in the Geographic Area descriptions. The detailed data is included in the project file.

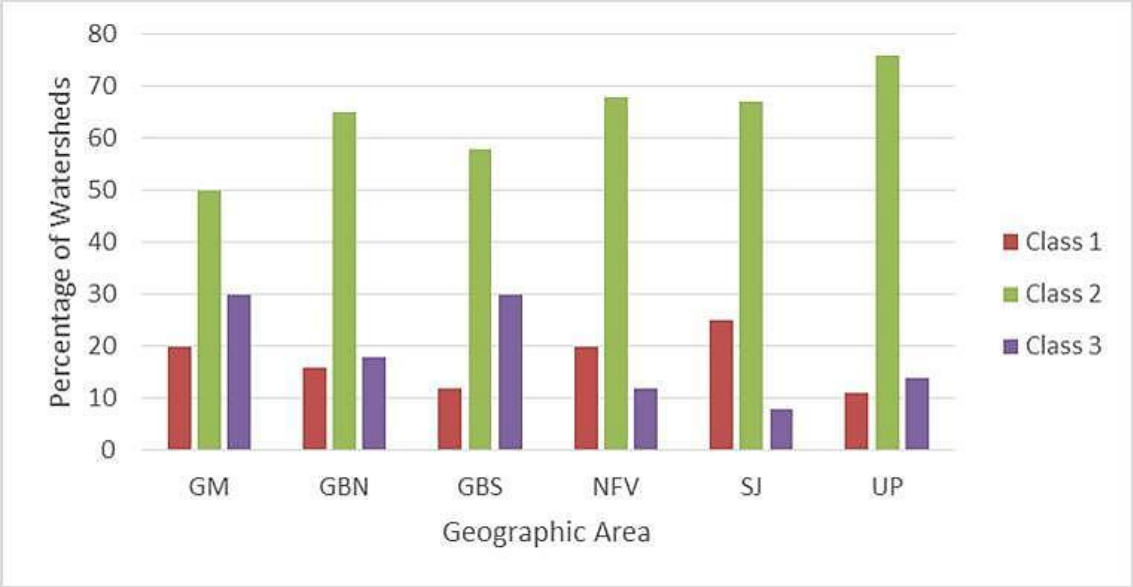

Figure 8. Percentage of Watersheds in each Geographic Area Rated as Class 1, Class 2, or Class 3 for WCF "Aquatic Habitat Condition" Indicator.

Classified Uses and Impaired Waters

Water quality standards and classified uses for surface waters are established by the Colorado Department of Public Health and Environment, Water Quality Control Commission. Classified uses in Colorado include agriculture, aquatic life (cold or warm), domestic water supply, and recreation. Water quality standards and classified uses for waterbodies within the GMUG are listed in Commission Regulation No. 35 "Classifications and Numeric Standards for Gunnison and Lower Delores River Basin" (Colorado Water Quality Control Commission 2015a and 2015b).

Although surface water quality is generally excellent within the Forests' boundaries, the State of Colorado identified segments in 21 streams totaling approximately 141 miles that do not meet water quality standards, generally due to metals concentrations related most often to historic mining activities (Colorado Water Quality Control Commission 2012). Impaired streams and their impairments identified within the project watersheds are listed in the Geographic Area descriptions below.

Stream Connectivity

Dams associated with manmade impoundments affect stream connectivity and aquatic organism passage. Small dams on non-NFS land and instream structures, such as "perched" culverts at road-stream crossings and irrigation diversions, also exist, fragmenting the stream network and blocking fish passage.

Unpaved road surfaces are a long-term source of sediment input into waterbodies. The proximity of a road to a waterbody increases the potential for sediment input. Roads within water influence zones (WIZs) and road-stream crossings are typically higher contributors of sediment input to waterbodies. There are approximately 4,683 road crossings on perennial and intermittent streams across the GMUG. This number includes only road-stream crossing on Forest System Lands and roads both open and closed to motorized use. Overall there are 6,103 road crossings on all land ownerships within the Forest boundary. This number includes all existing open roads of all jurisdictions that cross perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths. The average number of road crossings per mile of stream within the Forest boundary is 0.37 and there are 689 miles of road within the WIZ (within 100 feet from a stream). Watershed specific statistics of road crossings and miles of road in the WIZ are listed in the project file.

Water Yield

The water provided by streams that flow from the GMUG is an important resource utilized for drinking water supplies, irrigation, stock watering, fisheries, and recreation in the surrounding area. Most of the HUC12 watersheds encompassing the GMUG are Municipal Supply Watersheds. The GMUG produces approximately 2.8 million acre-feet of runoff that feeds approximately 3,600 miles of streams and supports about 11,650 surface acres of lakes and reservoirs (2006 LRMP Report). Annual water yield depends upon the density or coverage of the forest, the type of forest vegetation, whether most of the forest is living or dead, as well as many other factors including climate, weather patterns, geology, slope, soils, stream channel conditions and riparian area conditions.

Forested land helps conserve moisture by providing shade and cooler temperatures which provide for less overall evaporation. Floodplains, wetlands and fens store substantial volumes of surface and shallow groundwater, which supports dense vegetative cover. The transpiration of moisture back to the atmosphere contributes to rain and snow development in the area.

At higher elevations, snow is the predominant form of precipitation. In the Rocky Mountains, as much as 75 percent of annual precipitation is in the form of snow (Elder 2006). The tree canopy, whether living or dead, intercepts a significant volume of snowfall. Snow sublimates (changes directly from a solid to a vapor) in subfreezing temperature. The increased surface area of snow in the tree canopy results in an estimated loss of 20 to 35 percent of the total snowfall to sublimated interception (Lisle, et. al 2010, Elliot 2010).

Beetle induced mortality of large numbers of multi-age spruce and fir trees has the potential to impact watershed-scale runoff properties due to changes in snow accumulation and melt, evapotranspiration and interception (Mikkelson et al. 2013). Studies of previous infestations in Colorado and elsewhere (e.g. Cahill 1951, Bethlahmy 1974, and Potts 1984) have shown increases in water yield that persisted up to 25 years after the beetle outbreak. Beetle-killed trees retain their needles for a year or two after infestation, intercepting and retaining snow in much the same way as live trees. As needles drop, less snow is intercepted and as trees fall, open areas increase with resulting increases in snowpack thickness. It may take one to fifteen years for the increase in water yield from uncut beetle-killed trees to match water yield in clearcut areas (Hubbard 2014). However, studies of the recent mountain pine beetle infestation in Wyoming and Colorado have not found compelling evidence of watershed-scale runoff changes from beetle-induced tree mortality (Lukas and Gordon 2010, Biederman et al. 2014, Biederman et al. 2015). Reasons for the lack of watershed-scale increases in water yield are thought to be slower transitioning of stand structure due to phased mortality in beetle-affected stands (Mikkelson et al. 2013), the more even distribution of mortality across affected stands that allows penetration of wind and solar radiation to increase snowpack sublimation (Biederman et al. 2015), and increased transpiration from surviving understory vegetation (Lukas and Gordon 2010, Biederman et al. 2014). Given the confounding and unknown factors such as percentage of infested area, evaporation rates, and climate, it is difficult to extrapolate from the stand level to predict watershed-scale changes in water yield or peak flows from beetle induced tree mortality (Elder 2006, Mikkelson et al. 2013).

Over the long term, a change in vegetation type in beetle affected stands can result in changes in water yield. In areas where aspen replace spruce, and in spruce/aspen stands where the spruce over-story dies, some change in water yield could be expected. Aspen also modifies hydrological dynamics in ways that benefit biota and streamflow. Results of modeling based on rates of water movement by season in various tree species suggested significantly greater water yield from aspen than from conifer forests (Humphries 1984).

Municipal Supply Watersheds

The Forest Service recognizes state delineated “Source Water Areas” as “Municipal Supply Watersheds” per the definition in FSM 2542 (SWAP MOU with CDPHE, 2014). These areas are managed for multiple use outputs while providing protection of water quality to meet municipal water supply needs. Nearly all of the GMUG watersheds are Municipal Supply Watersheds. In fact, all of the identified priority treatment areas and hazard tree removal corridors in 162 of the 188 project watersheds are located within a delineated Source Water Area. The percentage of treatment areas located in a delineated Source Water Area for each affected watershed are listed below in the Geographic Area descriptions.

Floodplains, Wetlands, Fens, and Riparian Areas

Floodplains are natural inundation areas for floods that reduce flood stages and velocities. Most streams have a floodplain, although it may be intermittent and narrow. Floodplains store water, serve as natural sponges to moderate the release of high waters and act as filters to trap sediment and pollutants. They are important because the loss of floodplain function can change the timing and peak of stream flows, allow more sediment deposition in stream channels, and reduce riparian habitat.

Riparian areas and floodplains were mapped based on aerial photo interpretation and field surveys. There are 128,019 acres of mapped riparian areas, including floodplains, within the GMUG. Treatment-level field surveys will be conducted prior to implementation to delineate floodplains.

Wetlands control runoff and water quality, recharge ground water and provide special habitats. Actions that may alter ground cover, soil structure, water budgets, drainage patterns and long-term plant composition can impair these characteristics.

Fens are a subset of wetlands which are groundwater dependent and accumulate peat (USDA Forest Service 2010). Fens are rare features and host a number of rare plant species. The hydrologic conditions supporting fens and wetlands can be readily impacted by roads and other ground disturbing activities.

Another subset of wetlands are wet meadows that are topographic depressions which are periodically saturated and show evidence of standing water as a result of snow melt and/or rain events. These land features act as ephemeral drainages and provide areas of groundwater recharge that support groundwater dependent ecosystems such as fens and springs.

The National Wetland Inventory completed by the U. S. Fish and Wildlife Service mapped wetlands but digital data is only available for portions of the Grand Mesa and Gunnison areas of the GMUG (US Fish and Wildlife Service 2014). Many of the wetland areas mapped by the Fish and Wildlife Service are also included in the GMUG riparian GIS layer. Since 2008, GMUG staff conducted an inventory of the number and location of fens and associated wetlands and evaluations of the condition of fens and associated wetlands (Johnston 2012). Fens were initially identified through aerial photo interpretation followed by statistically valid field surveys based on local conditions including geology, elevation, aspect, climate, and soil types.

The number and acreages for wetlands and fens are approximate and are derived from the GMUG GIS library. Floodplains are not documented separately from riparian areas. Treatment-specific field surveys will be conducted to determine actual conditions and potential treatment impacts. The type, number and acres of wetlands and fens present in the GMUG are shown in Table 18. Acres of fens and wetlands that are near identified priority treatment areas and hazard tree removal corridors within the project watersheds are listed in the Geographic Area descriptions below.

Table 18. Wetlands, Fens and Riparian Areas within the GMUG.

Wetland Type	Number Present	Total Acres[1]
Fen and Associated Wetland	3,376	8,071
Riparian Area	N/A	111,177
Sources: GMUG GIS library Some acres may be counted as both wetlands and riparian areas.		

Springs are defined as *"place where ground water flows naturally from a rock or the soil onto the land surface or into a body of surface water"* (Wilson 1998). Springs are managed as a subset of wetlands due their unique characteristics. Also, springs are a primary factor for determination of a groundwater dependent ecosystem (a subset of wetlands). The Watershed Conservation Practices Handbook states "avoid any loss of rare wetland such as fens and springs," (USDA Forest Service 2006b). There are at least 508 springs within the GMUG.

Water Influence Zones (WIZ) are those lands that interface between water and drier uplands. WIZs are some of the most ecologically diverse habitat types and provide bank stability, sediment filtering, streamside shading and nutrient input into streams and lakes. The GMUG 1991 LRMP lists the minimum horizontal width of the WIZ for various water related features as described in Table 19. WIZs include floodplains and riparian areas. Use of mechanical equipment and proposed treatments are restricted in WIZs to protect habitat and allow WIZs to perform their natural functions.

Table 19. Minimum Horizontal Width of Water Influence Zones (WIZ).

Feature	Outside Edge of WIZ	No Harvest or Mechanical Travel Zone
Fens and their associated wetlands	100 ft. minimum from edge of fen	100 ft. from edge of fen
Perennial Streams	100 ft. from stream bank	50 ft. from stream bank
Intermittent Streams, Reservoirs and Ponds	50 ft. from bank or high water line	25 ft. from bank or high water line
Wetlands ≥ ¼ acre	100 ft. from edge of wetland	50 ft. from edge of wetland
Springs/Seeps/Wetlands/ depressional recharge areas < ¼ acre	50 ft. from the source or edge of associated wetland, whichever is greater	25 ft. from the source of edge of associated wetland, whichever is greater
Ephemeral Streams and Swales[1]	25 ft. from the channel or topographic low	
Ditch	Edge of Right of Way	

[1] For the purpose of implementing protection measures, the term swale and ephemeral stream are considered to be synonymous. The measures are intended to avoid or minimize surface disturbance, not the nature of silvicultural treatments.

Climate Change

Predictions of how the Rocky Mountains' climate is changing are based on records of past measurements and various modelling predictions. Results of climate modelling are uncertain and sometimes conflict with each other. However, recent temperature and precipitation measurements suggest overall trends in these climate parameters.

Climate modeling in the Rocky Mountain region indicates that temperatures will likely increase by several degrees over the upcoming decades. Precipitation amounts will show more variable changes with the possibility of more precipitation in the northern part of the area and less in the south. Where there is more precipitation, more will arrive as rain during the cooler months and fewer summer storms will occur (Rocca 2014).

Changes in temperature and precipitation timing and amount have the potential to affect watershed and soils resources in many ways. The availability and timing of water yield will require changes in water storage operations (Day 2013). Warmer and drier summers could increase the potential for severe wildland fires resulting in greater erosion potential which reduces soil productivity and increases sediment loading to streams and waterbodies. Riparian and wetland features could receive less water, reducing their size and capability of sustaining water dependent plant and animal species.

Soils

The analysis area lies within the GMUG Soil Survey Areas originally published by the Natural Resource Conservation Service and available online at http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. Soils data for the GMUG was compiled into the GMUG GIS library. Soils data for this report was extracted from the GMUG GIS library.

All soils were mapped at a scale of 1:24,000, and are considered to be a 3rd order level of survey. Order 3 is a mapping intensity intended for areas with a single dominant use, where precise knowledge of small areas is not required. Because it is a 3rd order survey and given the inherent variability of soils, treatment proposals generally need to be reviewed to confirm slope, depth, drainage, and other soil and site characteristics that may affect a particular use.

The extremely varied geology, topography, climate, and vegetation in the treatment area results in a large number of soil types across the GMUG. Specifics of soil types and characteristics are too numerous to list, but pertinent characteristics and potential effects are discussed in this document. Surveys and analyses of soils characteristics will be conducted on all proposed units prior to treatments in accordance with the Pre-treatment Implementation Checklist.

Erosion

Soil erosion is the movement of soil particles by water, wind or ice. In forested sites on steep slopes, water is generally the most common driver of erosion. Erosion removes fertile topsoil, reducing soil productivity; creates gullies which can damage roads and trails; and can deposit sediment in waterbodies, wetlands, and fens, damaging habitat for vegetation and aquatic organisms. Undisturbed forested areas in Colorado typically have very low erosion rates. This is because snow is the predominant precipitation type, the soils have high infiltration rates, and mass movements are relatively inactive or infrequent (MacDonald and Stednick 2003). On the GMUG in general, the potential for the greatest erosion is on steeper slopes and potential decreases as the slope decreases (USDA National Resource Conservation Service undated).

The erosion hazard rating (EHR) is a rating of how erodible a soil is and is based on soil type, surface cover, slope gradients, slope lengths, and the historical climate for the. Soils with severe or very severe EHRs are most prone to erosion when surface cover is removed and the soil surface is disturbed, such as by timber harvest activities or roads. Tables listing the acres and percentage of delineated treatment areas (commercial priority treatment areas, non-commercial priority treatment areas, hazard tree removal corridors, and new roads outside of priority treatment areas) in each watershed that have EHR rating of "severe" or "very severe" by Geographic Area are in the project file. Figure 9 summarizes this information.

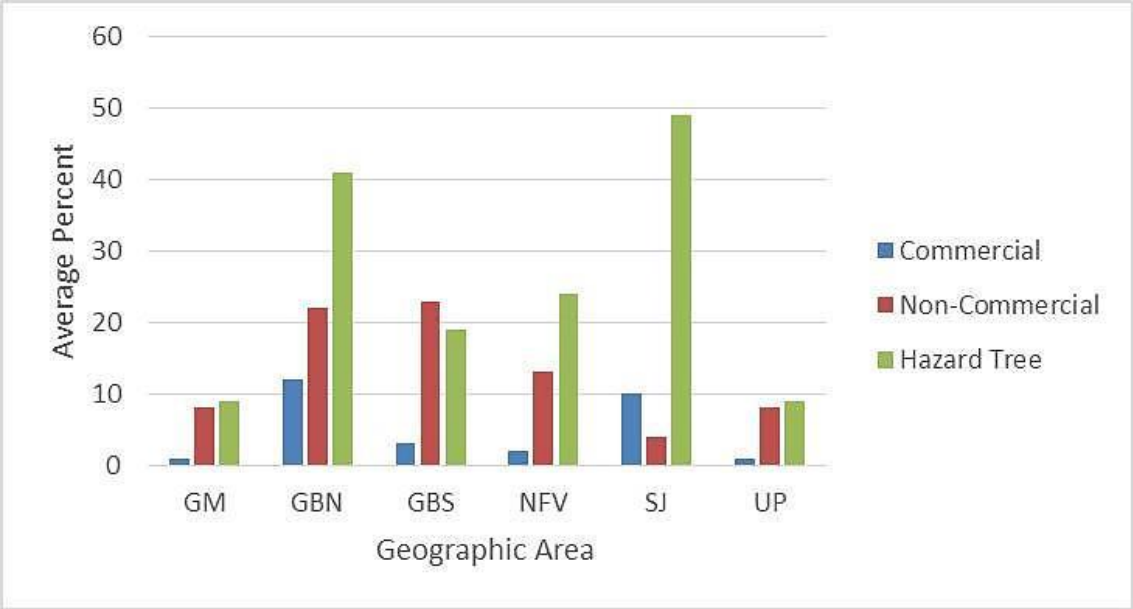

Figure 9. Average watershed percentage of severe or very severe EHR soil in SBEADMR treatment areas by Geographic Area.

To summarize this information:

- The percentage of the severe or very severe EHR soil areas is greatest in the hazard tree removal areas; however, these areas of hazard tree removal are generally small in each watershed.
- A greater average percentage of the non-commercial priority treatment areas are severe or very severe EHR soils than in the commercial priority treatment areas in all Geographic Areas except the San Juans. However, the San Juans average in commercial priority treatment areas is skewed by one watershed where 50% of the commercial treatment area acres are severe or very severe EHR. If that data point is removed from the analysis, the average percentage for commercial treatment areas in the San Juans goes down to 5 percent.
- More areas of severe or very severe EHR soils are found in treatment areas in the Gunnison Basin North, Gunnison Basin South, and North Fork Valley watersheds than in the Grand Mesa, San Juans, or Uncompahgre Plateau watersheds.

Other Soil Properties

Other important properties of soil are soil productivity and soil hydrologic function.

Soil productivity is the ability of the soil to supply the water and nutrients needed to sustain plant growth. Variables that influence soil productivity include soil physical characteristics, organic matter and soil biological activity. Soil physical characteristics include soil depth, soil pore space and bulk density. Soil porosity is the volume of pores in a soil that can be occupied by air, gas, or water and varies depending on the size and distribution of the particles and their arrangement with respect to each other. Organic matter in its various forms contributes to soil productivity by providing nutrients and moisture retention for soil organisms and plants. Humus is decomposed organic matter. Duff and litter are partially decomposed leaves, needles and twigs on the surface of soils. Large woody debris consists of woody stems greater than three inches in diameter. Decomposed large woody debris can supply moisture to plants after soils dry. Soil organisms, including fungi and bacteria, are required by and drive the nutrient cycling process by decomposing organic matter components and releasing the nutrients for use by plants. Soil organisms depend on organic matter for the nutrients they need to carry out their life processes. Decomposed large woody debris provides important habitat for the survival of mycorrhizae fungi. These fungi form a symbiotic relationship with tree roots, increasing water and nutrient uptake by the trees and the fungi.

Soil hydrologic function is the ability of the soil to absorb, store, and transmit water, both vertically and horizontally (USDA 2010b). Infiltration is the rate of water movement into the soil and is determined by soil; texture, cover, and porosity. Permeability is the rate at which water percolates or moves down through the soil and is primarily based on soil porosity. Two measures used for the soil productivity indicator (effective soil cover and soil porosity and compaction) are also used as measures for the soil hydrology indicator. The litter layer of soil cover absorbs water, increases storage capacity, and slows the velocity of overland flow. Soil

compaction can cause poor water infiltration, restricted percolation, and increased overland flow during high precipitation events (Poff 1996).

The WCF indicator "Soils Condition" indicates overall soil health in a watershed in terms of three attributes: "Soil productivity", "Soil erosion", and "Soil contamination". These attributes are rated based on the extent of soil alteration to reference soil condition that is evident in the watershed. More details about this indicator and attributes can be found in the Watershed Condition Analysis (Appendix I). The data for this WCF indicator is summarized below in Figure 10 and in the Geographic Area descriptions. The detailed data is included in the project file.

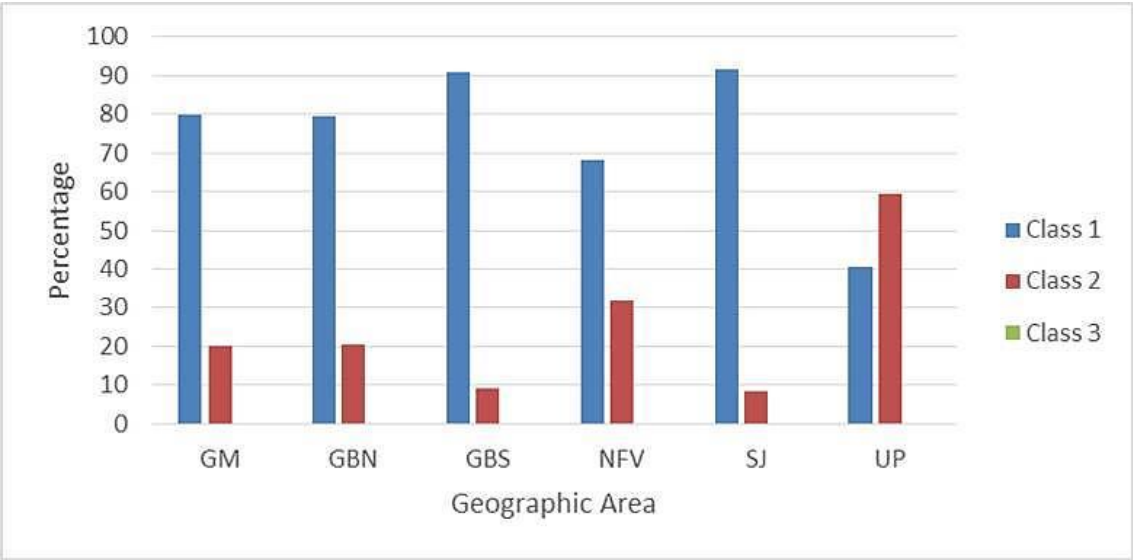

Figure 10. Percentage of Watersheds in each Geographic Area Rated as Class 1, Class 2, or Class 3 for WCF "Soils Condition" Indicator.

Mass Failure

Mass failures (also known as mass movement, soil slippage or landslides) can be triggered by natural or man-made disturbances. Mass failures can be triggered by changed conditions resulting from sequences of natural events, such as wildfire followed by high intensity precipitation events. Some areas on the GMUG have characteristics that contribute to a greater potential for instability and are considered to have a greater likelihood or susceptibility to mass failures based on those characteristics which typically include soil or bedrock features. This includes the area in the northeastern portion of Grand Mesa where the recent massive rock avalanche near Collbran occurred.

Affected Environment Descriptions for each Geographic Area

Grand Mesa

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the Grand Mesa Geographic Area lie within 21 watersheds (Table 20). Of these, eleven are Class 1, two are borderline Class 1/Class 2, seven are Class 2, and one watershed was not rated for watershed condition (Map G-37, Appendix G).

Table 20. Watershed Condition Class and Source Water Areas in Grand Mesa Watersheds

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140100051302	Big Creek	2	-	100
140100051305	Bull Creek	1	-	100
140100051307	Coon Creek	1	-	100
140100051304	Cottonwood Creek	2	-	100
140200050107	Dirty George Creek	1	-	100
140200050114	Dry Gulch-Gunnison River[2]	-	-	100
140100051301	Grove Creek	1	-	100
140100051102	Headwaters Buzzard Creek	1	Y	100
140200050702	Headwaters Kannah Creek	1	-	100
140100051103	Hightower Creek-Buzzard Creek	2	-	100
140200050106	Kiser Creek	2	-	100
140100051201	Leon Creek	1	Y	100
140100051308	Mesa Creek	1	-	100
140200050112	Negro Creek-Tongue Creek	1	-	100
140200050703	North Fork Kannah Creek	1	-	100
140200050109	Oak Creek	1	-	100
140100051101	Owens Creek	2	-	100
140200050111	Surface Creek	2	-	100
140100051202	Vega Reservoir	1	-	100
140200050108	Ward Creek	2	-	100
140200050706	Whitewater Creek	1	-	100

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area

[2] Watershed condition for Dry Gulch-Gunnison River (140200050114) was not assessed due to small amount of NFS land (4 %) in the watershed.

Surface Waterbodies and Stream Health

Table 21 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the Grand Mesa Geographic Area watersheds that have proposed treatments.

Table 21. Streams in Grand Mesa Watersheds.

Grand Mesa GA	Stream Miles	% of Total Miles
Perennial Streams	167	22.4
Intermittent Streams	332	44.4
Ephemeral Streams	248	33.2
Total	747	100

Table 22 summarizes the "Aquatic Habitat Condition" indicator for Grand Mesa watersheds. Most of the watersheds are rated as Class 2 for this indicator. The average rating for each of the three attributes is also Class 2. The "large woody debris" attribute has the poorest average rating score, followed by a "habitat fragmentation" and "channel shape and function". Of the six Geographic Areas, Grand Mesa watersheds have the second poorest average rating score for this indicator, tied with Gunnison Basin North and Uncompahgre Plateau.

Table 22. Summary of "Aquatic Habitat Condition" Indicator for Grand Mesa Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
4	10	6	1.9	1.9	2.1	1.7

Classified Uses and Impaired Waters

State identified impaired waterbodies in the Grand Mesa Geographic Area are listed in Table 23. All Potential Treatment Areas in these watersheds are located at least 500 feet from these waterbodies.

Table 23. 303(d) Listed Impaired Waterbodies in Grand Mesa Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGULG04a	Whitewater Creek	Water Supply, Aquatic Life Warm 2	Selenium, Manganese, and Sulfate	140200050706	Whitewater Creek	5.33 miles
COGULG07	Tongue Creek	Aquatic Life Cold 2	Iron and Selenium	140200050109	Oak Creek	0.01 miles
				140200050112	Negro Creek-Tongue Creek	6.44 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 597 road/stream crossings in watersheds in the Grand Mesa Geographic Area. This amounts to an average of 0.34 crossings per mile of stream. There are 48.7 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

All of the identified Hazard Tree Removal corridors and Potential Treatment Areas in the Grand Mesa Geographic Area are located within a delineated Source Water Area (Table 20).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 24 and Table 25 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 24. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Grand Mesa Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140100051302	Big Creek	2	9.2	40.1	2	7.8	34.8
140100051305	Bull Creek	5.5	17.9	59.9	5	15.2	56.1
140100051307	Coon Creek	1.4	7.2	7	1.4	7.3	10.1
140100051304	Cottonwood Creek	0.1	8.2	30.3	0.1	5.1	22.6
140200050107	Dirty George Creek	0	0	1.5	0	0	1.5
140200050702	Headwaters Kannah Creek	1.2	2.9	30.1	1.2	2.9	26.5
140200050106	Kiser Creek	2.7	8.1	26.1	2.7	8.1	26.1
140100051308	Mesa Creek	0	0.1	5.4	0	0.1	5.4
140200050111	Surface Creek	0.5	9.2	43.3	0.5	8.3	39.8

Table 25. Acres of Wetlands that Intersect or are Near an Identified SBEADMR Treatment Area by Alternative in Grand Mesa Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140100051302	Big Creek	0.2	0.7	10.8	0.2	0.7	10.1
140100051305	Bull Creek	0	0	0.1	0	0	0.1
140100051307	Coon Creek	0	1.4	1.2	0	1.4	1.2
140100051301	Grove Creek	0	0.1	10.7	0	0	3.8
140200050702	Headwaters Kannah Creek	10.1	5.2	39.2	0	0.6	20
140100051103	Hightower Creek-Buzzard Creek	0	0	0.3	0	0.3	0
140200050106	Kiser Creek	2.1	10.7	32.1	1.9	10	31
140100051201	Leon Creek	0	1.2	20.4	0	0.6	8.4
140100051308	Mesa Creek	1.1	0.2	1	0.8	0.2	1
140200050109	Oak Creek	0	0.4	2.9	0	0.4	2.9
140200050111	Surface Creek	0	0.1	2.4	0	0.1	2.4

Soils

Table 26 summarizes the "Soils Condition" indicator for Grand Mesa watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. The average rating for each of the three attributes is also Class 1. Of the six Geographic Areas, Grand Mesa watersheds have the best average rating score for this indicator, tied with Gunnison Basin South and San Juans.

Table 26. Summary of "Soils Condition" Indicator for Grand Mesa Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soils Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
16	4	0	1.1	1.2	1.2	1.0

Gunnison Basin North

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the Gunnison Basin North Geographic Area lie within 49 watersheds (Table 27). Of these, 15 are Class 1, 12 are borderline Class 1/Class 2, and 22 are Class 2 (Map G-38, Appendix G).

Table 27.Watershed Condition Class and Source Water Areas in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200030102	Agate Creek[2]	1	-	100
140200030304	Alder Creek	1	-	100
140200010208	Alkali Creek	1	-	100
140200020201	Antelope Creek	2	-	100
140200010111	Bear Creek-Spring Creek	1	Y	100
140200010112	Beaver Creek	1	Y	100
140200020401	Beaver Creek	1	-	100
140200010202	Brush Creek	1	Y	100
140200030602	Cabin Creek	1	-	100
140200020103	Carbon Creek	1	-	100
140200010207	Cement Creek	2	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200010204	Coal Creek	2	-	100
140200021003	Corral Creek-Gunnison River	1	Y	100
140200020705	Cow Creek-Soap Creek	1	Y	100
140200020701	East Elk Creek	2	-	100
140200030302	Gold Creek	2	-	100
140200030101	Headwaters Tomichi Creek	2	-	100
140200010105	Headwaters Willow Creek	1	-	100
140200030404	Hot Springs Creek	2	-	100
140200010108	Lottis Creek	1	Y	100
140200010210	Lower East River	1	Y	100
140200020106	Lower Ohio Creek	2	-	100
140200030305	Lower Quartz Creek	2	-	100
140200010113	Lower Taylor River	1	Y	100
140200010203	Middle East River	1	Y	100
140200020105	Middle Ohio Creek	2	-	100
140200030303	Middle Quartz Creek	2	-	100
140200010103	Middle Taylor River	1	-	100
140200020104	Mill Creek	1	-	100
140200010205	Oh-be-Joyful Creek-Slate River	2	-	100
140200010106	Outlet Willow Creek	1	Y	100
140200030401	Owens Creek-Tomichi Creek[2]	2	-	100
140200030105	Porphyry Creek-Tomichi Creek[2]	1	-	100
140200020702	Red Creek	2	-	100
140200010110	Rocky Brook-Spring Creek	2	-	100
140200040301	Ruby Anthracite Creek[3]	1	Y	100
140200030601	Sewell Gulch-Tomichi Creek	1	-	100
140200020107	Sheep Gulch-Gunnison River	2	-	100
140200020402	Steuben Creek	2	-	100
140200010107	Taylor Park Reservoir	2	-	100
140200010104	Texas Creek	1	-	100
140200010102	Trail Creek-Upper Taylor River	1	-	100
140200010201	Upper East River	1	Y	100
140200020101	Upper Ohio Creek	2	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200030301	Upper Quartz Creek	2	-	100
140200010101	Upper Taylor River	1	-	100
140200010206	Washington Gulch-Slate River	1	-	100
140200020403	Willow Creek-Blue Mesa Reservoir	2	-	100
140200030405	Wood Gulch-Tomichi Creek	2	-	100

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area

[2] Agate Creek, Owens Creek-Tomichi Creek, and Porphyry Creek-Tomichi Creek watersheds overlap into the Gunnison Basin South Geographic Area

[3] Ruby Anthracite Creek watershed overlaps into the North Fork Valley Geographic Area

Surface Waterbodies and Stream Health

Table 28 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the Gunnison Basin North Geographic Area watersheds that have proposed treatments.

Table 28. Streams in Gunnison Basin North Watersheds.

Gunnison Basin North GA	Stream Miles	% of Total Miles
Perennial Streams	594	24.4
Intermittent Streams	1014	41.7
Ephemeral Streams	823	33.8
Total	2430	99.9

Table 29 summarizes the “Aquatic Habitat Condition” indicator for Gunnison Basin North watersheds. Most of the watersheds are rated as Class 2 for this indicator. The average rating for each of the two attributes of the three is also Class 2. The “large woody debris” attribute has the poorest average rating score, followed by a “habitat fragmentation.” The average rating for the “channel shape and function” is Class 1. Of the six Geographic Areas, Gunnison Basin North watersheds have the second poorest average rating score for this indicator, tied with Grand Mesa and Uncompahgre Plateau.

Table 29. Summary of "Aquatic Habitat Condition" Indicator for Gunnison Basin North Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
8	32	9	1.9	1.9	2.2	1.5

Classified Uses and Impaired Waters

State identified impaired waterbodies in the Gunnison Basin North Geographic Area are listed in Table 30. GIS review of Potential Treatment Areas in these watersheds indicated that the Bear Creek Commercial PTA in the Cement Creek watershed directly intersected with the Cement Creek impaired segment for a few hundred feet, and was within 200 feet of the stream for approximately 1.5 miles. The boundary of this PTA was moved to provide at least a 300 foot buffer between the PTA and Cement Creek. All of the other Potential Treatment Areas in these watersheds are located at least 500 feet from the impaired waterbodies.

Table 30. 303(d) Listed Impaired Waterbodies in Gunnison Basin North Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGUUG06b	Cement Creek	Aquatic Life Cold 1	Benthic Macroinvertebrates	140200010207	Cement Creek	21.92 miles
COGUUG07	Slate River below Oh-Be-Joyful Creek	Aquatic Life Cold 1	Zinc	140200010205	Oh-be-Joyful Creek-Slate River	4.65 miles
COGUUG08	Slate River	Aquatic Life Cold 1	Cadmium, Zinc	140200010204	Coal Creek	0.015 miles
				140200010206	Washington Gulch – Slate River	8.95 miles
COGUUG09	Coal Creek	Aquatic Life Cold	Arsenic	140200010204	Coal Creek	3.03 miles
COGUUG10	Oh-be-Joyful Creek	Aquatic Life Cold 1	Zinc, Lead, Cadmium, Copper	140200010205	Oh-be-Joyful	2.17 miles

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
					Creek-Slate River	
COGUUG11	Coal Creek	Aquatic Life Cold 1	Arsenic, Zinc, Cadmium, Manganese	140200010204	Coal Creek	2.42 miles
COGUUG11	Elk Creek	Aquatic Life Cold 1	Cadmium, Lead, Zinc, Arsenic	140200010204	Coal Creek	2.42 miles
COGUUG12	Coal Creek	Aquatic Life Cold 1	Copper, Zinc, Cadmium	140200010204	Coal Creek	2.74 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 2008 road/stream crossings in watersheds in the Gunnison Basin North Geographic Area. This amounts to an average of 0.48 crossings per mile of stream. There are 248.8 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

All of the identified Hazard Tree Removal corridors and Potential Treatment Areas in the Gunnison Basin North Geographic Area are located within a delineated Source Water Area (Table 27).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 31 and Table 32 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 31. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140200010204	Coal Creek	0.1	7.3	15.2	0	0	0
140200020705	Cow Creek-Soap Creek	0	0.3	2.0	0	0.3	2
140200010103	Middle Taylor River	0	0	0.7	0	0	0.7
140200010110	Rocky Brook-Spring Creek	0	0	0.1	0	0	0.1
140200010104	Texas Creek	0.1	5.5	43.3	0.1	5.5	43.3
140200010102	Trail Creek-Upper Taylor River	0	1	10.5	0	1	10.5
140200010101	Upper Taylor River	0	1.2	18.9	0	1.2	18.9

Table 32. Acres of Wetlands That Intersect or Are Near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140200010112	Beaver Creek	19.6	0	0	1.5	0	5.9
140200030101	Headwaters Tomichi Creek	0	0	2.4	0	0	2.4
140200010108	Lottis Creek	0	0.2	1.9	0	0.2	1.9
140200010106	Outlet Willow Creek	0	0.6	8.3	0	0.6	8.3
140200010102	Trail Creek-Upper Taylor River	0	0.1	9.3	0	0.1	9.3
140200010201	Upper East River	0	0	0.3	0	0	0.3
140200010101	Upper Taylor River	0.7	2.1	3	0.7	2.1	3

Soils

Table 33 summarizes the “Soils Condition” indicator for Gunnison Basin North watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. The average rating for each of the three attributes is also Class 1. Of the six Geographic Areas, Gunnison Basin North watersheds have the second best average rating score for this indicator, tied with North Fork Valley.

Table 33. Summary of "Soils Condition" Indicator for Gunnison Basin North Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soils Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
39	10	0	1.2	1.2	1.2	1.1

Gunnison Basin South

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the Gunnison Basin South Geographic Area lie within 36 watersheds (Table 34). Of these, 15 are Class 1, 10 are borderline Class 1/Class 2, 10 are Class 2, and 1 watershed was not rated for watershed condition (Map G-39, Appendix G).

Table 34. Watershed Condition Class and Source Water Areas in Gunnison Basin South Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200030506	140200030506	1	-	100
140200030102	Agate Creek[2]	1	-	100
140200030503	Archuleta Creek	1	Y	100
140200030403	Barret Creek-Tomichi Creek	1	-	100
130100040301	Bear Creek-Sheep Creek	2	-	100
140200020606	Elk Creek-Lake Fork	1	-	100
140200020801	Headwaters Blue Creek[3]	1	-	100
140200020502	Headwaters Cebolla Creek	1	-	100
140200030501	Headwaters Cochetopa Creek	1	-	100
140200030504	Headwaters Los Pinos Creek	1	Y	100
140200030201	Headwaters Razor Creek	1	-	100
140200020202	Headwaters South Beaver Creek	1	-	100
130100040102	Horse Canyon	2	-	100
140200020602	Lake Sanc Cristobal-Lake Fork	1	Y	100
140200020802	Little Blue Creek	1	Y	100
140200030104	Long Branch Creek	1	Y	100
140200030103	Marshall Creek	2	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200020501	Mill Creek-Brush Creek	1	-	100
140200030402	Needle Creek	2	-	100
140200020604	Nellie Creek-Henson Creek	1	Y	100
140200020603	North Fork Henson Creek-Henson Creek	2	-	100
140200030509	Outlet Cochetopa Creek	1	Y	100
140200030202	Outlet Razor Creek	1	Y	100
140200030401	Owens Creek-Tomichi Creek[2]	2	-	100
140200030502	Pauline Creek	1	Y	100
140200021001	Pine Creek[4]	-	-	100
140200030105	Porphyry Creek-Tomichi Creek[2]	1	-	100
140200020506	Rock Creek	2	-	100
140200030508	Rock Creek-Cochetopa Creek	2	-	100
140200020503	Rough Creek-Cebolla Creek	1	-	100
140200020504	Spring Creek	1	-	100
140200030604	Stubbs Gulch	1	-	100
140200030505	Trail Creek-Cochetopa Creek	1	-	100
140200020607	Trout Creek-Lake Fork	1	Y	100
140200030507	West Pass Creek	2	-	100
140200020610	Willow Creek	2	-	100

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area

[2] Agate Creek, Owens Creek-Tomichi Creek, and Porphyry Creek-Tomichi Creek watersheds overlap into the Gunnison Basin North Geographic Area

[3] Headwaters Blue Creek watershed overlaps into the San Juan Geographic Area

[4] Watershed condition for Pine Creek (140200021001) was not assessed due to small amount of NFS land (< 1%) in the watershed.

Surface Waterbodies and Stream Health

Table 35 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the Gunnison Basin South Geographic Area watersheds that have proposed treatments.

Table 35. Streams in Gunnison Basin South Watersheds.

Gunnison Basin South GA	Stream Miles	% of Total Miles
Perennial Streams	351	23.8
Intermittent Streams	701	47.5
Ephemeral Streams	423	28.7
Total	1475	100

Table 36 summarizes the "Aquatic Habitat Condition" indicator for Gunnison Basin South watersheds. Most of the watersheds are rated as Class 2 for this indicator. The average rating for two of the three attributes is also Class 2. The "large woody debris" attribute has the poorest average rating score, followed by a "habitat fragmentation." The average rating for the "channel shape and function" is borderline Class 1/Class 2. Of the six Geographic Areas, Gunnison Basin South watersheds have the poorest average rating score for this indicator.

Table 36. Summary of "Aquatic Habitat Condition" Indicator for Gunnison Basin South Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
4	19	10	2.0	1.9	2.3	1.6

Classified Uses and Impaired Waters

State identified impaired waterbodies in the Gunnison Basin South Geographic Area are listed in Table 37. All Potential Treatment Areas in these watersheds are located at least 500 feet from these waterbodies.

Table 37. 303(d) Listed Impaired Waterbodies in Gunnison Basin South Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGUUG15	South Beaver Creek	Aquatic Life Cold 2	Benthic Macroinvertebrates	140200020202	Headwaters South Beaver Creek	9.22 miles
COGUUG24	Cochetopa Creek	Aquatic Life Cold 1	Benthic Macroinvertebrates	140200030501	Headwaters Cochetopa Creek	11.04 miles
				140200030506	140200030506	10.06 miles
				140200030507	West Pass Creek	0.01 miles
				140200030508	Rock Creek-Cochetopa Creek	1.21 miles
COGUUG32	North Fork Henson Creek	Water Supply	Manganese	140200020603	North Fork Henson Creek-Henson Creek	6.61 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 972 road/stream crossings in watersheds in the Gunnison Basin South Geographic Area. This amounts to an average of 0.45 crossings per mile of stream. There are 131.5 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

All of the identified Hazard Tree Removal corridors and Potential Treatment Areas in the Gunnison Basin South Geographic Area are located within a delineated Source Water Area (Table 34).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 38 and

Table 39 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 38. Acres of Fens that Intersect or are near an identified SBEADMR Treatment Area by Alternative in Gunnison Basin South Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140200020801	Headwaters Blue Creek	0	0	3.1	0	0	3.1
140200020602	Lake Sanc Cristobal-Lake Fork	0	1	23.4	0	1	23.4
140200020802	Little Blue Creek	0	0	7.8	0	0	4.7
140200030502	Pauline Creek	0.2	1.9	19.8	0.2	1	7.7
140200030507	West Pass Creek	0.4	0	0	0	0	0.4

Table 39. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Gunnison Basin South Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140200030503	Archuleta Creek	2.1	7.1	21.8	0.9	6	16.7
140200030104	Long Branch Creek	0.2	3.7	12.3	0.2	3.7	12.3
140200030103	Marshall Creek	11	7	27.9	10.8	5.2	19.8
140200030502	Pauline Creek	0.7	6.3	49.1	0.4	2.1	17.6
140200030507	West Pass Creek	0.5	2.9	11.5	0.3	0.8	5.9

Soils

Table 40 summarizes the “Soils Condition” indicator for Gunnison Basin South watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. The average rating for each of the three attributes is also Class 1. Of the six Geographic Areas, Gunnison Basin South watersheds have the best average rating score for this indicator, tied with Grand Mesa and San Juans.

Table 40. Summary of "Soils Condition" Indicator for Gunnison Basin South Watersheds

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soils Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
30	3	0	1.1	1.1	1.1	1.0

North Fork Valley

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the North Fork Valley Geographic Area lie within 25 watersheds (Table 41). Of these, 10 are Class 1, 6 are borderline Class 1/Class 2, and 9 are Class 2 (Map G-40, Appendix G).

Table 41. Watershed Condition Class and Source Water Areas in North Fork Valley Watersheds

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200040307	Anthracite Creek	1	-	100
140200040403	Bear Creek-North Fork Gunnison River	1	-	100
140200040202	Clear Fork East Muddy Creek	1	-	100
140200040101	Cow Creek	2	-	100
140200021204	Crawford Reservoir	1	Y	100
140200021004	Crystal Creek	2	-	100
140200021002	Curecanti Creek	1	Y	100
140200040404	Headwaters Hubbard Creek	1	-	100
140200040505	Headwaters Leroux Creek	1	-	100
140200040102	Headwaters West Muddy Creek	1	-	100
140200040203	Lee Creek	1	-	100
140200040204	Little Henderson Creek-East Muddy Creek	2	-	100
140200040201	Little Muddy Creek	1	-	100
140200021005	Mesa Creek-Gunnison River	2	-	100
140200021205	Middle Smith Fork	2	-	100
140200040407	Miller Creek	1	Y	100
140200021202	Muddy Creek	2	-	100
140200040306	Outlet Clear Creek	1	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200040405	Outlet Hubbard Creek	2	-	100
140200040103	Outlet West Muddy Creek	1	Y	100
140200040402	Raven Gulch	2	-	100
140200040303	Robinson Creek	1	-	100
140200040301	Ruby Anthracite Creek[2]	1	Y	100
140200040406	Terror Creek	1	Y	100
140200021201	Upper Smith Fork	2	-	100

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area

[2] Ruby Anthracite Creek watershed overlaps into the Gunnison Basin North Geographic Area

Surface Waterbodies and Stream Health

Table 42 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the North Fork Valley Geographic Area watersheds that have proposed treatments.

Table 42. Streams in North Fork Valley Watersheds.

North Fork Valley GA	Stream Miles	% of Total Miles
Perennial Streams	361	21.8
Intermittent Streams	671	40.5
Ephemeral Streams	623	37.6
Total	1,655	99.9

Table 43 summarizes the “Aquatic Habitat Condition” indicator for North Fork Valley watersheds. Most of the watersheds are rated as Class 2 for this indicator. The average rating for two of the three attributes is also Class 2. The “large woody debris” attribute has the poorest average rating score, followed by a “habitat fragmentation.” The average rating for the “channel shape and function” is borderline Class 1/Class 2. Of the six Geographic Areas, North Fork Valley watersheds have the second best average rating score for this indicator.

Table 43. Summary of "Aquatic Habitat Condition" Indicator for North Fork Valley Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
5	17	3	1.8	1.7	2.0	1.6

Classified Uses and Impaired Waters

State identified impaired waterbodies in the North Fork Valley Geographic Area are listed in Table 44. All Potential Treatment Areas in these watersheds are located at least 500 feet from these waterbodies.

Table 44. 303(d) Listed Impaired Waterbodies in North Fork Valley Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGUNF04	East Muddy Creek	Aquatic Life Cold 1	Iron	140200040103	Outlet West Muddy Creek	0.01 miles
				140200040202	Clear Fork East Muddy Creek	0.66 miles
				140200040203	Lee Creek	0.03 miles
				140200040204	Little Henderson Creek – East Muddy Creek	12.67 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 853 road/stream crossings in watersheds in the North Fork Valley Geographic Area. This amounts to an average of 0.28 crossings per mile of stream. There are 95.9 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

All of the identified Hazard Tree Removal corridors and Potential Treatment Areas in the North Fork Valley Geographic Area are located within a delineated Source Water Area (Table 41).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 45 and Table 46 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 45. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in North Fork Valley Watersheds.

		Alternative 2			Alternative 3		
HUC 12 Code	**HUC 12 Watershed Name**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**
140200040505	Headwaters Leroux Creek	0	0.7	8.2	0	0.7	8.2

Table 46. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in North Fork Valley Watersheds.

		Alternative 2			Alternative 3		
HUC 12 Code	**HUC 12 Watershed Name**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**
140200021002	Curecanti Creek	0.3	0.9	1.2	0.3	0.9	1.2
140200040404	Headwaters Hubbard Creek	1.9	0	0	1.9	0	0
140200040505	Headwaters Leroux Creek	0	0.8	0.5	0	0.8	0.5
140200040103	Outlet West Muddy Creek	0	0	0.1	0	0	0.1
140200040301	Ruby Anthracite Creek	0	0	6.8	0	0	6.8
140200040402	Raven Gulch	0	0.2	1.4	0	0.2	1.4

Soils

Table 47 summarizes the “Soils Condition” indicator for North Fork Valley watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. The average rating for each of the three attributes is also Class 1. Of the six Geographic Areas, Grand Mesa watersheds have the second best average rating score for this indicator, tied with Gunnison Basin North.

Table 47. Summary of "Soils Condition" Indicator for North Fork Valley Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soils Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
17	8	0	1.2	1.3	1.3	1.0

San Juans

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the San Juans Geographic Area lie within 25 watersheds (Table 48). Of these, 9 are Class 1, 6 are borderline Class 1/Class 2, and 10 are Class 2 (Map G-41, Appendix G).

Table 48. Watershed Condition Class and Source Water Areas in San Juans Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140300030107	Bear Creek	1	Y	100
140200060208	Beaver Creek-Dalles Creek	1	-	100
140200060205	Coal Creek-Uncompahgre River	1	Y	100
140300030105	Deep Creek	1	-	100
140300030108	Fall Creek	1	-	100
140300020103	Fish Creek	1	-	100
140300030302	Headwaters Beaver Creek	2	-	100
140200020801	Headwaters Blue Creek[2]	1	-	100
140200060101	Headwaters Cow Creek	1	-	100
140200020903	Headwaters Little Cimarron River	1	-	100
140300030401	Headwaters Naturita Creek[3]	2	-	2
140300030106	Headwaters San Miguel River	2	-	100
140200060203	Headwaters Uncompahgre River	2	-	100
140300030101	Howard Fork	1	Y	100
140300030102	Lake Fork	1	Y	100
140200060102	Lou Creek-Cow Creek	1	-	100
140200060201	Red Mountain Creek	2	-	100
140300030301	Saltado Creek	2	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200020901	Silver Jack Reservoir-Cimarron River	2	-	100
140300030103	South Fork San Miguel River	2	-	100
140300030305	Specie Creek-San Miguel River	2	-	100
140300030112	Summit Creek-San Miguel River	1	-	100
140300030303	Turner Creek-Beaver Creek	2	-	98
140200020902	Upper Cimarron River	1	Y	100
140200060206	West Fork Dallas Creek	1	Y	100

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area
[2] Headwaters Blue Creek watershed overlaps into the Gunnison Basin South Geographic Area
[3] Headwaters Naturita Creek watershed overlaps into the Uncompahgre Plateau Geographic Area

Surface Waterbodies and Stream Health

Table 49 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the San Juans Geographic Area watersheds that have proposed treatments.

Table 49. Streams in San Juans Watersheds.

San Juans GA	Stream Miles	% of Total Miles
Perennial Streams	348	29.3
Intermittent Streams	363	30.5
Ephemeral Streams	477	40.2
Total	1187	100

Table 50 summarizes the “Aquatic Habitat Condition” indicator for San Juans watersheds. Most of the watersheds are rated as Class 2 for this indicator and only two are rated as Class 3. The average rating for two of the three attributes is also Class 2. The “large woody debris” attribute has the poorest average rating score, followed by a “habitat fragmentation.” These watersheds have the best average rating score for “channel shape and function” which averages a Class 1 rating score. Of the six Geographic Areas, San Juans watersheds have the best average rating score for this indicator.

Table 50. Summary of "Aquatic Habitat Condition" Indicator for San Juans Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
6	16	2	1.7	1.8	2.1	1.3

Classified Uses and Impaired Waters

State identified impaired waterbodies in the San Juans Geographic Area are listed in Table 51. All Potential Treatment Areas in these watersheds are located at least 500 feet from these waterbodies.

Table 51. 303(d) Listed Impaired Waterbodies in San Juans Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGUUN02	Uncompahgre River	Aquatic Life Cold 1	Cadmium, Copper, Zinc	140200060201	Red Mountain Creek	0.02 miles
				140200060203	Headwaters Uncompahgre River	5.46 miles
COGUUN06a	Red Mountain Creek	Aquatic Life Cold 2	Zinc, Copper, Silver	140200060201	Red Mountain Creek	1.78 miles
COGUUN07	Gray Copper Gulch	Aquatic Life Cold 2	Copper	140200060201	Red Mountain Creek	2.31 miles
COGUSM02	Bear Creek	Aquatic Life Cold 1	Cadmium, Zinc	140300030106	Headwaters San Miguel River	4.17 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 680 road/stream crossings in watersheds in the San Juans Geographic Area. This amounts to an average of 0.33 crossings per mile of stream. There are 57.4 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

With the exception of some treatments in the Headwaters Naturita Creek and Turner Creek-Beaver Creek watersheds, all of the identified Hazard Tree Removal corridors and Potential Treatment Areas in the San Juans Geographic Area are located within a delineated Source Water Area (Table 48).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 52 and Table 53 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 52. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in San Juans Watersheds.

		Alternative 2			**Alternative 3**		
HUC 12 Code	**HUC 12 Watershed Name**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**
140200060208	Beaver Creek-Dalles Creek	0	0.3	1.2	0	0.3	1.2
140300030108	Fall Creek	0.5	0.4	1.2	0.5	0.4	1.2
140300030302	Headwaters Beaver Creek	2.7	4.3	25.5	0.1	1.3	26.5
140200020903	Headwaters Little Cimarron River	0	0.1	28.6	0	0.1	11.4
140300030106	Headwaters San Miguel River	8.7	0.9	0	8.7	0.9	0
140200060201	Red Mountain Creek	0.2	1	2.6	0.2	1	2.6
140200020901	Silver Jack Reservoir-Cimarron River	0.2	2.1	8.9	0.2	2.1	8.9

Table 53. Acres of Wetlands that Intersect or are near an SBEADMR Potential Treatment Area by Alternative – San Juans Watersheds

HUC 12 Code	HUC 12 Watershed Name	Alternative 2			Alternative 3		
		Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)	Intersect (acres)	< 100 ft (acres)	100 – 500 ft (acres)
140300030108	Fall Creek	1.4	0	0	1.4	0	0
140300030302	Headwaters Beaver Creek	3.3	2.4	11	0	0	6
140200020903	Headwaters Little Cimarron River	0.3	1.7	33.4	0.3	1.4	7
140300030106	Headwaters San Miguel River	7.5	0.2	3.1	7.5	0.2	3.1

Soils

Table 54 summarizes the "Soils Condition" indicator for San Juans watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. The average rating for each of the three attributes is also Class 1. Of the six Geographic Areas, San Juans watersheds have the best average rating score for this indicator, tied with Grand Mesa and Gunnison Basin South.

Table 54. Summary of "Soils Condition" Indicator for San Juans Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soils Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
22	2	0	1.1	1.1	1.1	1.2

Uncompahgre Plateau

Watershed Condition Class

The identified priority treatment areas and hazardous tree removal corridors in the Uncompahgre Plateau Geographic Area lie within 38 watersheds (Table 55). Of these, 17 are Class 1, 7 are borderline Class 1/Class 2, and 14 are Class 2 (Map G-42, Appendix G).

Table 55. Watershed Condition Class and Source Water Areas in Uncompahgre Plateau Watersheds.

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140300030706	Atkinson Creek	1	-	21
140300040403	Blue Creek	1	-	9
140300030702	Bucktail Creeks-San Miguel River	1	-	100
140300040402	Calamity Creek	1	Y	0
140300030605	Campbell Creek	1	Y	0
140300030306	Clay Creek	2	-	100
140200050204	Cottonwood Creek	2	-	100
140300030701	Cottonwood Creek	2	-	99
140200050305	Dry Fork Escalante Creek	2	-	98
140200050302	East Fork Escalante Creek	1	-	100
140200050304	East Fork Escalante Creek	1	Y	98
140200060403	Happy Canyon Creek	1	-	100
140200060501	Headwaters Dry Creek	1	Y	100
140300010301	Headwaters Little Delores River	1	-	0
140300030401	Headwaters Naturita Creek[2]	2	-	0
140300030602	Headwaters Tabeguache Creek	2	-	4
140300040301	Headwaters West Creek	2	-	0
140300030203	Lower Horsefly Creek	1	Y	100
140300040404	Maverick Canyon	1	-	0
140300030402	McKee Draw	2	-	0
140300030304	McKenzie Creek	2	-	100
140200050301	Middle Fork Escalante Creek	1	-	100
140300030202	Middle Horsefly Creek	1	-	100
140200050203	Middle Roubideau Creek	1	Y	100
140200060602	Middle Spring Creek	2	-	100
140200050303	North Fork Escalante Creek	1	-	100
140300040101	North Fork Mesa Creek	1	-	0
140300030601	North Fork Tabeguache Creek	1	-	3
140300040302	North Lobe Creek-West Creek	1	-	0
140200050202	Potter Creek	2	-	100

HUC 12 Code	HUC 12 Watershed Name	Watershed Condition Class	Borderline	Treatments in Source Water Area (%) [1]
140200050404	Rocky Pitch Gulch-Dominguez Creek	2	-	100
140200050401	Smith Creek-Big Dominguez Creek	1	-	100
140300040102	South Fork Mesa Creek-Mesa Creek	1	-	1
140300030604	Spring Creek	1	Y	0
140300030201	Upper Horsefly Creek	2	-	100
140200050201	Upper Roubideau Creek	1	-	100
140200060601	Upper Spring Creek	2	-	100
140300040304	Ute Creek-West Creek	1	-	0

[1] Percentage of proposed Alternative 2 treatment areas in watershed that are located in a CDPHE identified Source Water Assessment Area

[2] Headwaters Naturita Creek watershed overlaps into the San Juan Geographic Area

Surface Waterbodies and Stream Health

Table 56 lists the approximate miles and percentage of perennial, intermittent, and ephemeral streams in the Uncompahgre Plateau watersheds that have proposed treatments.

Table 56. Streams in Uncompahgre Plateau Watersheds.

Uncompahgre Plateau GA	Stream Miles	% of Total Miles
Perennial Streams	233	13.6
Intermittent Streams	857	50.1
Ephemeral Streams	619	36.2
Total	1709	99.9

Table 57 summarizes the “Aquatic Habitat Condition” indicator for Uncompahgre Plateau watersheds. Most of the watersheds are rated as Class 2 for this indicator. The average rating for two of the three attributes is also Class 2. The “large woody debris” attribute has the poorest average rating score, followed by a “channel shape and function.” These watersheds have the best average rating score for “habitat fragmentation” which averages a Class 1 rating score. Of the six Geographic Areas, Uncompahgre Plateau watersheds have the second poorest average rating score for this indicator, tied with Grand Mesa and Gunnison Basin North.

Table 57. Summary of "Aquatic Habitat Condition" Indicator for Uncompahgre Plateau Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Aquatic Habitat Condition Indicator	Habitat Fragmentation Attribute	Large Woody Debris Attribute	Channel Shape and Function Attribute
4	28	5	1.9	1.4	2.2	1.9

Classified Uses and Impaired Waters

State identified impaired waterbodies in the Uncompahgre Plateau Geographic Area are listed in Table 58. All Potential Treatment Areas in these watersheds are located at least 500 feet from these waterbodies.

Table 58. 303(d) Listed Impaired Waterbodies in Uncompahgre Plateau Watersheds.

CO WBID[1]	Waterbody Name	303(d) Impairment	Identified Pollutant	HUC 12 Code	Watershed Name	Length of Impaired Waterbody
COGULD02	Delores River	Aquatic Life Warm 1	Iron	140300040403	Blue Creek	0.07 miles
				140300040404	Maverick Canyon	0.04 miles
COGULD05	Roc Creek	Aquatic Life Cold 1	Copper, Iron	140300040102	South Fork Mesa Creek-Mesa Creek	1.95 miles

[1] CO WBID is the segment identification code assigned by Colorado Department of Public Health and Environment

Stream Connectivity

There are 993 road/stream crossings in watersheds in the Uncompahgre Plateau Geographic Area. This amounts to an average of 0.32 crossings per mile of stream. There are 106.6 miles of roads in the WIZ. These numbers include all existing open roads of all jurisdictions that cross or are near perennial, intermittent, and ephemeral streams, and ditches or other artificial water paths within the National Forest boundary.

Municipal Supply Watersheds

Of the six Geographic Areas, the watersheds in the Uncompahgre Plateau Geographic Area have the greatest amount of the identified Hazard Tree Removal corridors and Potential Treatment Areas not located within a delineated Source Water Area (Table 55).

Fens and Wetlands

A GIS analysis was completed to determine the extent of fens and other wetlands located in or near identified hazard tree removal and potential treatment areas or intersected by new roads outside of the potential treatment areas. The results of this analysis are presented in Table 59 and Table 60 below. If a watershed is not listed, there are no fens or wetlands near potential treatment areas in that watershed.

Table 59. Acres of Fens that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Uncompahgre Plateau Watersheds.

		Alternative 2			Alternative 3		
HUC 12 Code	**HUC 12 Watershed Name**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**
140200050304	East Fork Escalante Creek	0.6	1.2	0.1	0.6	1.2	0.1

Table 60. Acres of Wetlands that Intersect or are near an Identified SBEADMR Treatment Area by Alternative in Uncompahgre Plateau Watersheds.

		Alternative 2			Alternative 3		
HUC 12 Code	**HUC 12 Watershed Name**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**	**Intersect (acres)**	**< 100 ft (acres)**	**100 – 500 ft (acres)**
140200050204	Cottonwood Creek	0	0	1.1	0	0	1.1
140200050304	East Fork Escalante Creek	0	0.4	0.2	0	0.4	0.2
140300030602	Headwaters Tabeguache Creek	10.1	0.3	0	8.8	0.3	0
140200060602	Middle Spring Creek	0	0	0.8	0	0	1.3

Soils

Table 61 summarizes the “Soils Condition” indicator for Uncompahgre Plateau watersheds. Most of the watersheds are rated as Class 1 for this indicator and none are rated Class 3. Both the “Soil Productivity” and “Soil Erosion” attributes have an average rating score that is borderline Class 1/Class 2. Of the six Geographic Areas, Uncompahgre Plateau watersheds have the poorest average rating score for this indicator.

Table 61. Summary of "Soils Condition" Indicator for Uncompahgre Plateau Watersheds.

Number of Watersheds Rated:			Average Watershed Rating for:			
Class 1	Class 2	Class 3	Soil Condition Indicator	Soil Productivity Attribute	Soil Erosion Attribute	Soil Contamination Attribute
15	22	0	1.4	1.6	1.6	1.0

Effects Analysis

The effects analysis addresses the direct and indirect effects of commercial mechanical salvage, resiliency harvest, roads, mechanical noncommercial vegetation treatments, broadcast prescribed burning and slash pile burning effects on watershed and soil resources in the affected GMUG watersheds. The area analyzed for cumulative effects on watershed and soil resources is the 6th level HUC12 watersheds. The entire watershed is included because impacts to any area of the watershed can be transported in surface flow and impact downstream areas of the watershed as well as adjacent downstream watersheds. The temporal scope for this analysis includes both short-and long-term impacts. Short-term effects are defined that occur approximately within one to ten years following proposed vegetation treatments. Long-term effects are defined as those that occur approximately within 10 to 20 years, or more, following proposed vegetation treatments.

Analysis Assumptions Include:

- All of the identified Priority Treatment Areas acres would be treated.
- Forest Plan Standards and Guidelines will be followed (USDA Forest Service 1991c)
- Watershed Conservation Practices (FSH2509.25) will be followed (USDA Forest Service 2006a)
- National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (FS-990a) will be followed (USDA Forest Service 2012c)
- Design features would be implemented as designed. Project will follow state and federal laws; especially regarding construction in or near waterways and wetlands to control erosion.
- Sedimentation is the water-quality impairment most likely to result from the proposed activities. Roads, especially in close proximity to water are the dominant vector for sediment delivery to stream channels or wetland/fem resources.

- Potential changes in water yield are not quantifiable and will be based on the percentage of tree mortality within the watershed more than tree removal.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

This alternative is used as a basis for comparing the effects of the Alternative 2 and Alternative 3. The No Action Alternative assumes that no implementation of any elements of the Preferred Alternative or the WUI Alternative would take place within the project area.

Alternative 1 effects would include:

- Natural processes would continue to result in high mortality in spruce-fir dominated stands.
- Aspen stands located in at-risk areas on the landscape may continue to decline.
- There could be plant community changes, such as shifts from forested to non-forested communities as a result of both spruce bark beetle and sudden aspen decline.
- Vegetation structure would change over time through natural growth and mortality and events such as wildfires, storms, and insect and disease outbreaks.
- Water yield in beetle-impacted watersheds could slowly increase as trees die and fall and spruce/aspen communities shift to stands dominated by aspen.
- Ecosystem processes such as insects and disease in trees would continue in their current trends.
- Safety concerns would increase.
- Portions of the Forest transportation system would not receive maintenance and improvement treatments associated with the implementation of SBEADMR.
- If a wildfire were to occur, increased fuel loads from tree mortality could increase the risk of high severity fire.

It is important to note that the absence of management actions under this project does not mean that conditions in the area would remain static over time. This is related to the actions of nature coupled with the actions of humans. Because no treatments are proposed in this alternative, current conditions and existing trends in Watershed Condition Class, surface water quality, stream connectivity, floodplains, fens, wetlands, WIZs, soil productivity, physical characteristics, biological activity, and mass failure would continue.

Water yield changes at the stand scale in individual watersheds would be variable depending on the increasing number of beetle-killed trees reducing evapotranspiration and increasing ground-level snowpack and growth of understory vegetation. Surface organic matter would increase as

beetle-killed trees fall and decay. Erosion would remain minimal where ground cover is sufficient and could decrease in other areas as beetle-killed trees continue to fall.

A potential major indirect effect of Alternative 1 is the increased risk of high severity fire due to increasing fuel loads, if a wildfire were to occur. Although results of fire behavior modeling and studies of burned areas are not consistent, some results indicate that the potential for high severity fire is greater in areas with beetle-killed trees. Under Alternative 1, the acres of dead and dying trees will increase, providing more surface fuels on more acres for future fires. If proposed treatment areas were to be burned by wildfire in the future, a mix of burn severities would be anticipated depending on the topography, fuels, and climatic conditions. Moderate to high burn severities would likely result in an increase amount of bare soil, accelerated erosion, slow recovery of effective vegetation cover and loss of soil nutrients and soil microorganisms.

Large, high severity wildland fire occurring within a watershed could have sufficient negative effects to change the Watershed Condition Class score toward poorer watershed condition. Effects of high severity fire may include increases in surface runoff and sediment transport to streams, increases in nutrients in streams, loss of soil structure, loss of soil biota, potential changes to stream flow timing and volume, and increases in water temperature in streams.

Alternative 1 – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no change to Watershed Condition Class scores or soil characteristics will result from the implementation No Action Alternative. The direct and indirect effects of natural processes in combination with past, on-going, and future activities could result in cumulative effects to watershed condition, municipal water supplies or soil characteristics. Grazing, recreation, road construction and maintenance and other vegetation treatments, could impact soil erosion potential, soil productivity and structure, water quality, and water quantity.

Activities Common to All Action Alternatives

Pre-Treatment Checklist

The Pre-Treatment Design Checklist (Appendix C) was developed to assist in the planning of individual treatment areas. The Checklist identifies surveys and on-the-ground reviews required by law, regulation or policy. Treatment-specific surveys listed in the Pre-treatment Design Checklist will be completed during planning and development of a treatment. Survey data will guide placement of vegetation treatments and roads and will be used to identify specific design features or BMPs to be applied. Lessons learned and corrective actions resulting from Annual Treatment Review will be applied to out-year projects through a continuous learning process (See Chapter 2 – Adaptive Implementation Approach).

Checklist items for water and soil include: area of past disturbance in the HUC 12 watershed, identification of the WIZ and unstable and sensitive soil areas including wetlands and fens, completion of soil disturbance surveys, and evaluation of proposed road locations for road/stream crossings, WIZ, and potential impacts to groundwater-dependent ecosystems.

Design Features

Common to Alternative 2 and Alternative 3, design features were developed to conserve and protect water and soil resources during the implementation of the SBEADMR Project. Table 62 lists the objective of each design feature. Details and specifications for each are included in Appendix B. The majority of the design features are from the Forest Plan Standards and Guidelines, the Region 2 Watershed Conservation Practices Handbook, National Core Best Management Practices for Water Quality Management on National Forest System Lands, and Best Management Practices developed by the state of Colorado.

Table 62. Design Features for Water and Soil Resources.

Design Feature	Trigger for Use	Description	Effect
WQSP-1	All mechanical (ground-based) activity Prescribed burning	Maintain the organic ground cover of each activity area so that pedestals, rills, and surface runoff from the activity area are not increased.	Ensures maintenance of organic ground cover for purposes of soil function and reduced erosion
WQSP-2	All mechanical (ground-based) activity	Keep heavy equipment out of streams, swales, and wetlands.	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 3A	Construction of roads	Coordinate with engineers and forest hydrologist and fisheries biologist to ensure crossings are constructed to minimize streambank disturbance and sediment mobilization, allow for the passage of flood flows, debris and aquatic organisms for the life of the structure and crossing.	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 3B	Construction of roads	Decommission roads within five years after harvest activities are completed	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health

Design Feature	Trigger for Use	Description	Effect
WQSP-4	All mechanical (ground-based) activity	Keep ground vehicles out of wetlands	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 5A	All mechanical (ground-based) activity Prescribed burning	Limit detrimental soil disturbance to less than 15% of any activity area	Reduces compacted areas and maintains soil porosity, which is vital to maintain soil and hydrologic function
WQSP- 5B	All mechanical (ground-based) activity	Ground based equipment will be operated only when dry soil conditions exist i.e., soil is below the plastic limit or frozen conditions, i.e. at least 6 inches of frozen soil or at least 1 foot of packed snow is present. Avoid ground skidding on sustained slopes steeper than 40%	Reduces compaction and maintains soil porosity, which is vital to maintain soil and hydrologic function
WQSP-6	Construction of roads	Design all roads, trails, and other soil disturbances to the minimum standard for their use Use appropriate erosion control measures during construction	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 7A	Construction of roads	Minimize fill in floodplains to assure crossings allow flood flows to pass with minimal interruption	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 7B	All mechanical (ground-based) activity	Properly locate and drain skid trails	Reduces compacted areas, erosion and sedimentation
WQSP-8A	All mechanical (ground-based) activity	Site-prepare, drain, decompact, revegetate, and close landings, main skid trails, and other disturbed sites within 5 years of the end of the associated timber	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 9A	Construction of roads All mechanical (ground-based) activity	Restrict roads, landings, skid trails, and similar soil disturbances to designated sites.	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health. Reduces compacted areas and maintains soil porosity, which is vital to maintain soil and hydrologic function

Design Feature	Trigger for Use	Description	Effect
WQSP- 9A	Prescribed burning	Conduct prescribed burning when the forest floor is moist.	Limits areas of mineral soil exposure and soil hydrophobicity which increases surface water flow and erosion.
WQSP- 9B, C,D,E	Prescribed burning	Avoid building firelines in or around riparian areas, wetlands, fens or other sensitive water-dependent sites. Restore fire lines after use	Reduces excessive sedimentation which reduces water quality and stream health and decreases fen/wetland function for watershed health
WQSP- 9D	All mechanical (ground-based) activity	Limit mechanical earth moving to slopes less than 30%.	Slopes greater than 30% have greater chance of slipping/slumping and eroding.
WQSP- 10	All mechanical (ground-based) activity	Maintain weighted cumulative disturbance acres from past and present natural and anthropogenic events to less than 25 percent of the HUC12 area.[1]	Maintains or improves watershed condition and current health.
WFRP-3	All mechanical ground-based activity	Maintain 10 to 20 tons per acre of coarse woody debris within treatment units	Ensures maintenance of organic ground cover for purposes of soil function and reduced erosion
SP-4	Pile burning	Limit size, area and composition of slash piles and rehabilitate as needed after pile burning	Reduces impacts to soil and potential for soil sterilization from pile burning.

[1] 25% watershed disturbance limit is applied to the weighted sum of the area of existing "infrastructure disturbance", "vegetation disturbance", proposed SBEADMR vegetation treatments and proposed SBEADMR road construction.

Direct and Indirect Effects Common to All Action Alternatives

The types of treatments under Alternatives 2 and 3 are the same but the size of priority commercial and noncommercial treatment areas, hazard tree removal areas, and the potential miles of road construction and reconstruction vary. GMUG proposes to treat up to approximately 6,000 acres annually with commercial harvest and approximately 6,000 additional acres of non-commercial mechanical treatments and prescribed burning for a total of approximately 120,000 acres treated over the life of the SBEADMR project.

For purposes of analysis of direct and indirect effects of Alternatives 2 and 3, it is assumed that all identified priority treatment area acres, both commercial and noncommercial, hazard tree areas, and roads would be treated as proposed. This will result in an over-estimate of effects for Alternative 2 as in reality not all identified treatment areas will be treated. To reduce the potential of cumulative effects to watersheds, actual treatments and roads are restricted such that the SBEADMR treatments when added to past disturbance in the watershed will total no more

than 25 percent of the total watershed acres (see Adaptive Management Trigger Table and Cumulative Effects Discussion).

Both Alternative 2 and Alternative 3 include mechanical harvest of green (resiliency treatment) or dead (salvage) trees, mechanical fuels treatments, and prescribed burning treatments, including pile burning and broadcast burning, and varying lengths of road construction and reconstruction. The direct and indirect effects of each treatment type on watershed and soils resources are similar for each alternative and will be discussed once in this section.

Mechanical Salvage Harvest, Resiliency Harvest, Hazard Tree Removal, Non-commercial Cutting, and Coppice Cuts

These activities involve the use of heavy equipment to remove green or dead trees or other vegetation from identified stands or treatment areas. Ground-based heavy equipment use requires the construction and use of skid roads, skid trails, and landings. Use of the pre-treatment checklist, design features and BMPs will reduce the potential for direct and indirect effects to soil and water resources. Treatment-specific design features will be selected by a GMUG resource specialist during pre-implementation analysis.

Pre-treatment checklist items for this type of activity include:

- Identify and delineate the WIZ in or near treatment units.
- Identify sensitive soil areas, e.g. severe EHR, slopes greater than 40 %, and landslide prone areas, in or near treatment units
- Identify wetland and fen areas in or near treatment units.
- Complete detrimental soil disturbance surveys.

Examples of appropriate design features for this type of activity include but are not limited to:

- Maintaining or restoring ground cover to reduce erosion potential (WQSP-1).
- Keeping heavy equipment in the outer half of the WIZ and outside fens and wetlands to minimize damage (WQSP-2 and WQSP-4).
- Limit detrimental soil disturbance to less than 15% of any activity area (WQSP-5A).
- Operating heavy equipment when the soil is dry or over a minimum one foot of snow to reduce soil compaction (WQSP-5B).
- Limit mechanical equipment use to slopes less than 40 % (WQSP-5B).
- Properly locate and drain skid trails (WQSP-7B).
- Reclaim disturbed areas (e.g. skid trails and landings) within five years after harvest is completed (WQSP-8A).

Direct and Indirect Effects to Soils

The mechanical equipment required for salvage harvest, resiliency treatments, and non-commercial cutting are likely to have the greatest direct and indirect effects on soils in the treatment areas. Soil properties that can be affected include physical characteristics, ground cover, erosion, moisture, productivity, nutrients, and mass failures.

Soil physical characteristics include soil depth, soil pore space and bulk density. Changes in these occur when ground-based mechanical equipment makes repeated passes over the soil, such as on skid trails and landings. Frequent stand entries with heavy equipment increases bulk density and decreases the porosity of soils, which increases the potential for detrimental compaction (Powers et al. 1998) and, if soils are wet enough, can result in rutting. These changes to the physical soil characteristics reduce the pore space volume and water holding capacity which result in reduced infiltration rates, slow soil drainage, interference to root growth, and reduced plant-available water and nutrients (Poff 1996). Physical soil disturbances also decrease gas exchange, affecting both plants and soil biota. The degree and extent of susceptibility to compaction is primarily influenced by soil texture, soil moisture, coarse fragments, depth of surface organic matter, ground pressure weight of the equipment, and whether the load is applied in a static or dynamic fashion. Finer-grained soils, such as clay and loam soils generally compact more than sandy soils (USDA Forest Service 2006b).

Soil ground cover is important for shielding the soil surface from raindrop impact, retaining moisture, and providing soil nutrients. Ground cover is especially important in the WIZ to filter sediment from treatment activities and prevent it from reaching a waterbody. Harvest equipment disturbs surface layers of the soil and understory vegetation, potentially impacting soil cover. However, slash left on site from timber harvest activities adds surface cover to the soil and provides a source of soil nutrients as it decays.

Accelerated soil erosion can occur when the surface soil is compacted or when the loose surface soil and its protective layer of organic material are changed or removed, such as by ground disturbances associated with mechanical harvest activities. This is especially likely in area with severe or very severe erosion hazard ratings (EHR). Soil compaction and rutting can affect infiltration to the point that there can be a reduction in the movement of water into the soil and water can be channeled and concentrated on the surface. As a result, water runoff (overland surface flow) is increased and carries soil particles with it. The greatest potential for accelerated erosion in a mechanical treatment unit is from the skid trails and landings where the greatest soil disturbance and compaction occur. In the remainder of the unit, slash left on the ground provides ground cover which reduces erosion potential.

Tree mortality from beetles or harvest would increase available soil moisture as evapotranspiration by the trees would be lost (Hubbard 2014). The extent of additional soil moisture depends on precipitation, amount of mortality, and remaining stand structure which can

impact snow interception and accumulation. Increased soil moisture would be available for growth of new vegetation.

Disturbance from timber harvest activities reduces soil productivity due to compaction and removal of organic material. Soil compaction and increased soil strength can slow plant growth, impeded root development, decrease water infiltration, restrict percolation, increase overland flow during high precipitation events, and can cause plant nutrients to be relatively immobile or inaccessible (Poff 1996). Recent research suggests that the effect of severe compaction on biomass productivity is highly dependent upon soil texture (Powers et al. 2005). Leaving slash on the ground from timber harvest activities adds nutrients to the soil as it decays. Studies have shown that the amounts of nitrate, total nitrogen, and ammonium increase in the soil in areas where beetle-killed trees were harvested over areas where these trees were not harvested (Rhoades 2012).

The effects of mechanical harvest activities on soils are likely to be localized, moderate, and short-term. Forest Service direction is to manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15 percent of the treatment area (USDA Forest Service 2006a). Design features, BMPs, and soil disturbance monitoring will avoid treating areas with sensitive soils (e.g. severe EHR and steep slopes), restrict activity when soil conditions are too wet, limit the aerial extent of skid trails and landings, and decompact and revegetate disturbed areas to minimize areas of detrimentally compacted, eroded or displaced soil. Other design features and BMPs will ensure adequate ground cover is maintained, especially in the WIZ, to provide sediment filtering and keep the soil on site. SBEADMR mechanical harvest treatments are unlikely to change any of the WCF "Soils" indicator attributes.

Management activities can also lead to mass failures (e.g. landslides) if conducted on unstable slopes from increased soil moisture contributing to saturated conditions and loss of root strength in localized areas. Activities can create conditions that result in channeling water and concentrating it onto a limited area on hill slopes, such as below a rutted skid trail. Mass failures triggered by human causes are classified as detrimental soil disturbance. These disturbances result in significant long-term changes in soil productivity that last centuries. The recent large rock avalanche in Mesa County shows the potential for mass failure within the GMUG. The proposed treatments are unlikely to contribute to a mass failure of this size, but could influence smaller areas. Landslide potential is included as part of the pre-implementation surveys and treatment areas will be located outside of identified slope failures.

Direct and Indirect Effects to Surface Waterbodies and Stream Health

Mechanical harvest activities can negatively affect stream health by removing canopy cover and creating physical disturbance to stream channels. The WCF indicator "Aquatic Habitat Condition" is used in this analysis as a measure of overall stream health in a watershed. This

indicator has three attributes: "Habitat fragmentation", "Large woody debris", and "Channel shape and function".

Mechanical harvest treatments that remove canopy cover in the WIZ could affect water temperature, leading to aquatic habitat fragmentation. However, machine use to extract the trees would be limited to the outer half of the WIZ (WQSP-2) reducing the number of trees removed from the WIZ. In addition, most of the trees removed would be dead and not providing as much shade as would a live tree. Effects to water temperature from mechanical harvest treatments would be minor. There should be little change in the "Habitat fragmentation" attribute from mechanical harvest treatments in any affected watershed.

The "Large woody debris" attribute is concerned with the lack of large wood in stream systems and changes due to riparian management activities that would reduce large wood recruitment. In the case of SBEADMR, large woody debris and recruitment would not be a concern in the affected watersheds due to the high mortality from the spruce beetle and aspen decline.

The "Channel shape and function" attribute is concerned with channel width-to-depth ratios and floodplain connectivity. Aside from new road/stream crossings, there would be no effect to width-to-depth ratios or floodplain connectivity from SBEADMR treatments as mechanical equipment use is restricted to the outer half of the WIZ, which provides a buffer from direct impacts to stream channels, and heavy equipment is to be kept out of streams (WQSP-2). There would be little change in the "Channel shape and function" attribute from mechanical harvest treatments in any affected watershed.

Overall, effects to stream health from mechanical timber harvest would be minor and stream health condition would be maintained in the affected watersheds.

Direct and Indirect Effects to Water Quality

Water quality parameters of concern from mechanical timber harvest include turbidity, suspended sediment, temperature, and nutrients (MacDonald and Stednick 2003). Turbidity and suspended sediment derive from accelerated erosion off the harvest unit, primarily from ground skidding, landings and site preparation, reaching a nearby waterbody. The type and magnitude of soil erosion depends on the amount of soil exposed by mechanical activities, effects to infiltration rates, slope, soil type, intensity and amount of precipitation, and mitigation applied following treatment. As discussed above for soils, design features and BMPs will avoid treating areas with sensitive soils (e.g. severe EHR and steep slopes), restrict activity when soil conditions are too wet, limit the aerial extent of skid trails and landings, and decompact and revegetate disturbed areas to minimize areas of detrimentally compacted, eroded or displaced soil. Other design features and BMPs will ensure adequate ground cover is maintained, especially in the WIZ, to provide sediment filtering and keep the soil on site and out of the waterbodies. Any sedimentation due to mechanical timber harvest would be minor and localized.

Stream temperature is regulated by streamside vegetation and riparian area canopy controlling the amount of direct solar radiation reaching the surface water. Maintaining shade by retaining streamside vegetation can minimize stream temperature increases. Effects to water temperature from mechanical harvest treatments would be minor as machine use to extract the trees would be limited to the outer half of the WIZ (WQSP-2) reducing the number of trees removed from the WIZ. Most of the streamside vegetation within the inner half of the WIZ would remain intact and provide shading to the streams.

Rates and processes of nutrient cycling in a forest and adjacent waterbodies can be altered by timber harvest. Nutrients of concern include nitrogen, phosphorus, potassium, calcium, and magnesium. Streams in undisturbed forests generally have low concentrations of nitrate because nitrogen in the soil is used by plants and other organisms and nitrification rates are slow. Nitrate concentrations in streams may temporarily increase after timber harvest, but the effect is short term and do not exceed drinking water standards. Phosphorus delivery to streams is tied to erosion rates, so if accelerated erosion is minimized, phosphorus concentrations should not significantly be affected by timber harvest. In general, mechanical timber harvest would have only a minor effect on nutrient concentrations in surface water (MacDonald and Stednick 2003).

Direct and Indirect Effects to Water Yield

Field research, hydrologic theory, and modeling studies all indicate that a change in forest cover from timber harvest will affect water yield and streamflows. This is particularly true at higher elevations in snow dominated zones where there is more precipitation and greater potential to alter interception and transpiration (MacDonald and Stednick 2003). Large-scale removal of live trees can alter water yield by reducing interception and evapotranspiration. Removal of dead trees also reduces interception but does not change evapotranspiration. Canopy removal allows snow to reach the ground, increasing snowpack depth. Less snow is lost to sublimation so more is available during spring snowmelt for runoff (Elder, 2006). This increases runoff into streams, groundwater recharge and peak flows (Troendle 1987, Baker, 1986, Bosch 1982, Cahill 1951, Troendle 2000). Troendle and King reviewed studies of the effects of timber harvest on water yield and determined that, after clearcutting, approximately one-third of the increased water yield was due to savings from canopy sublimation and two-thirds to decreased evapotranspiration. The increase in water yield is only observable in small watersheds if a minimum of 20 percent of the area is clearcut (Elliot 2010). Increases in water yields decline as new vegetation grows to replace the harvested trees. However, it takes decades, possibly 60 years or more, for water yields to return to background in the Rocky Mountains (Elliot 2010) and takes longer in spruce stands than in aspen stands (MacDonald and Stednick 2003).

Water yield response to the proposed mechanical harvest treatments is likely to be variable (Pugh 2012, Troendle 2000) and depends upon a number of factors which differ for each watershed, including watershed size, location, general aspect, localized climate, species of the trees, and

percentage of green trees vs. beetle-killed trees removed. Resiliency treatments in spruce would involve removal of single or small groups of live trees, affecting both interception and transpiration but resulting in treatment of 20 to 40 percent of a stand. Salvage treatments in spruce could result in near complete removal of all overstory trees resulting in openings of 40 acres or larger. Larger openings would have greater impacts on snow accumulation and distribution resulting in an increase in snow water equivalent (MacDonald and Stednick 2003). Salvage treatments would result in a greater increase in water yield at the stand scale than resiliency treatments. Treatment of aspen would result in less increase in water yield at the stand scale than treatments in spruce because the aspen would regrow more quickly. Removal of hazard trees would not result in an observable change in water yield at the stand scale because of the small area of trees that would be removed.

Observable increases in water yield at the stand scale would be transmitted downstream, but with increasing watershed area, the effects from changes in any given stand will become proportionately smaller. Limiting the SBEADMR treatments to 25 percent of the area of a watershed will make it unlikely that the proposed treatments will not result in a detectable change in water yield at the watershed scale.

Direct and Indirect Effects to Fens, Wetlands and Riparian Areas

Direct effects to fens, wetlands, and riparian areas would result from use of heavy equipment in these areas. Indirect effects would result from changes in shallow groundwater and overland flow from changes in water yield.

Direct effects to fens and wetlands are unlikely because heavy equipment would be kept out of these areas (WQSP-2 and WQSP-4). Equipment use would be allowed in the outer half of the WIZ, which could affect riparian vegetation. This impact would be localized and limited in extent. Increased soil moisture from timber harvest could increase shallow groundwater flow to fens, wetlands, and riparian areas located downslope from harvest units, particularly large openings created by salvage treatments. This effect would be localized and would reduce over time as vegetation regrows in the treated stands.

Road Construction and Reconstruction

A transportation/road system has been developed on paper to implement the SBEADMR project. The existing road network would be used to the maximum extent possible to access the proposed treatments and to remove forest products. For commercial treatments, existing roads would be supplemented by constructing new roads only when necessary. No road construction is proposed for noncommercial treatments. Where necessary for resource protection, existing roads would be maintained or reconstructed. Per Forest Plan direction, there would be no increase in open road density.

A total mileage estimate for road construction is provided for Alternative 2 and Alternative 3. The highest percent of potential watershed disturbance from new roads is 0.3 percent[4]. Expected actions for roads include vegetation clearing, excavation and/or embankment, blading and shaping, out-sloping, drainage dips, and water-spreading ditches, and may include importing of armoring and surfacing rock material as needed. More embankment and drainage structures would be utilized when there are adjacent resource concerns (perennial and intermittent stream crossings, high soil erosion hazard, steeper side slopes, etc.). Note that because all new roads in the action alternatives would be decommissioned within 5 years of the closure of the associated SBEADMR timber sale, all road construction analyzed in SBEADMR is temporary.

Reconstruction and maintenance generally includes work to improve and restore roads, or to bring them back up to the original design standard. Improvements would provide for serviceability for project haul vehicles, as well as for proper hydrologic function and stream protection in accordance with applicable Best Management Practices. Actions can include surface improvement; construction of drainage dips, culverts, riprap fills or other drainage or stabilization features with potential disturbance outside the established roadway (toe of fill to top of cut); realignment; and widening of curves as needed for log trucks and chip van passage.

All new roads, and existing non-system roads used for SBEADMR, would be decommissioned within five years of harvest being completed. Road decommissioning involves removing bridges and culverts, eliminating ditches, out-sloping the roadbed, may include contouring to re-establish the natural undisturbed slope, scarifying of the road surface to reduce compaction, promoting native vegetation, removing ruts and berms, effectively blocking the road to normal vehicular traffic where feasible under existing terrain conditions, and building cross ditches and water bars. When bridges and culverts are removed, associated fills would be removed to the extent necessary to permit normal maximum flow of water and reconstruction of the floodplain and stream channel as needed.

Use of the pre-treatment checklist, design features and BMPs will reduce the potential for direct and indirect effects to soil and water resources. Treatment-specific design features will be selected by a GMUG resource specialist during pre-implementation analysis.

Pre-treatment checklist items for this type of activity include:

- Identify and delineate the WIZ in or near road locations.

[4] Acres of new road construction (assuming 40 foot width of disturbance) divided by the area of the NFS lands in the watershed.

- Identify sensitive soil areas, e.g. severe EHR, slopes greater than 40 %, and landslide prone areas, in or near proposed road locations
- Evaluate proposed road locations for number and locations of stream crossings, length within WIZs, and the potential for impacts to the hydrology of groundwater dependent ecosystems

Examples of appropriate design features for this type of activity include but are not limited to:

- Stream crossings would be minimized and constructed according to Forest Service standards to minimize negative impacts to stream channels and aquatic habitat (WQSP- 3A).
- Proposed roads would be located outside of fens and wetlands, and to the extent feasible, WIZs (WQSP-4).
- Avoid soil-disturbing actions during wet soil conditions (WQSP-5B).
- Use appropriate erosion control measures during construction activities (WQSP-6).
- Provide appropriate road drainage measures and use filter strips to prevent sediment from reaching waterbodies (WQSP-7A).
- All new roads would be decommissioned within five years of harvest being completed (WQSP-3A, WQSP-8B).

Direct and Indirect Effects to Soils

Road construction activities require that the soil and rock be exposed, dug, cut through, and reshaped by heavy equipment. The probability of erosion increases when vegetation is removed and base soil is exposed. In addition, soil in the road prism is compacted, further increasing erosion potential. Erosion rates are typically highest during road construction and decrease over time as disturbed sites develop an armored surface. However, road maintenance activities and traffic can cause erosion rates to increase (MacDonald and Stednick 2003).

The effect that road construction and reconstruction have on the soil resource depends on a the type of equipment used, the experience and care of the operator, weather, soil moisture conditions, resilience of the soil, and the amount of coarse fragments left on-site. Research studies, substantiated by local field observations on the GMUG, point out that negative effects can be prevented or kept to a minimum by the careful operation of equipment, the appropriate timing of activities, and the application of mitigation measures to a site as soon as possible (USDA Forest Service 1991a).

Small slumps and slides may occur as a result of the digging, cutting, and over-all disturbance of road construction can change weight distribution relationships on a slope and can change the surface and subsurface flow patterns of water across the land. If care is not taken or unstable areas are not avoided, these actions can result in slumping, slipping, and soi1 erosion (USDA Forest Service 1991a, MacDonald and Stednick 2003).

The effects of roads on soils are likely to be localized, minor, and moderate to long-term. New roads would be designed and constructed with design features and BMPs implemented to reduce potential impacts (WQSP-5b, WQSP-6, and WQSP-7A). Pre-implementation surveys would identify WIZs, fens, wetlands, and geologically unstable areas in the proposed road locations. These areas would be avoided to the extent practicable (WQSP-4). All new roads would be decommissioned within five years of harvest being completed (WQSP-3B). Road decommissioning activities like out-sloping the roadbed, contouring to re-establish the natural undisturbed slope, scarifying of the road surface to reduce compaction, promoting native vegetation, removing ruts and berms, blocking the road to normal vehicular traffic, and building cross ditches and water bars (WQSP-8B) would restore hillslope drainage patterns to near pre-disturbance conditions and encourage re-establishment of ground cover on the road prism to reduce erosion potential to near pre-disturbance conditions.

Direct and Indirect Effects to Surface Waterbodies and Stream Health

Road construction activities can negatively affect stream health by blocking aquatic organism passage and creating physical disturbance to stream channels. The WCF indicator "Aquatic Habitat Condition" is used in this analysis as a measure of overall stream health in a watershed. Construction of road/stream crossings could affect the "Habitat fragmentation" and "Channel shape and function" attributes of this indicator. Overall, stream health would be maintained in the affected watersheds.

New road/stream crossings could block aquatic organism passage if incorrectly designed and installed and result in aquatic habitat fragmentation. Table 63 lists the number of new road/stream crossings that would be constructed in each geographic area and the number of watersheds that would have new crossings constructed by alternative. The greatest number of new crossings in any watershed would be 13 in two watersheds: Little Henderson Creek-East Muddy Creek (140200040204) and Headwaters Hubbard Creek (140200040404) in the North Fork Valley Geographic Area.

Table 63. Number of New Road/Stream Crossings Constructed in Each Geographic Area.

Geographic Area	Alternative 2		Alternative 3	
	New Road/Stream Crossings (#)	Watersheds Affected (#)	New Road/Stream Crossings (#)	Watersheds Affected (#)
Grand Mesa	26	8	13	4
Gunnison Basin North	35	11	21	6
Gunnison Basin South	33	9	6	4
North Fork Valley	44	8	36	7
San Juans	29	3	4	1

Geographic Area	Alternative 2		Alternative 3	
	New Road/Stream Crossings (#)	Watersheds Affected (#)	New Road/Stream Crossings (#)	Watersheds Affected (#)
Uncompahgre Plateau	38	10	21	5
Total	205	49	101	27

Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. There should be little change in the "Habitat fragmentation" attribute from construction of new road/stream crossings in any affected watershed.

The "Channel shape and function" attribute is concerned with channel width-to-depth ratios and floodplain connectivity. Installation of round culverts at road/stream crossings would alter channel shape at the crossing location. Use of bridges, bottom-less arch culverts, or low water crossings where appropriate would create less change to channel shape. Stream crossings are to be designed to sustain bankfull stream dimensions, which would minimize channel morphology changes (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Decommissioning activities include removing bridges and culverts and associated fills to the extent necessary to permit normal maximum flow of water and reconstruction of the floodplain and stream channel as needed (WQSP-8B). Aside from at new road/stream crossings, there would be no effect to width-to-depth ratios or floodplain connectivity from road construction as heavy equipment is to be kept out of streams (WQSP-2). There would be localized changes to channel morphology at new crossings sites that would persist until the crossing structures are removed and the stream banks restabilize.

Due to the relatively small number of new crossings in any one watershed, stream health in the affected watersheds would be maintained.

Direct and Indirect Effects to Water Quality

Use of existing roads where possible will decrease the potential for direct and indirect adverse effects of roads on water quality by reducing the need for new road construction. In addition, existing roads that are used would be maintained or reconstructed to ensure suitability for project vehicles and to mitigate existing resource concerns. Improvements to road surfacing and road drainage would be a benefit to water quality as connected disturbed areas and other sediment sources would be removed or mitigated.

Sediment is the water quality parameter of most concern resulting from road construction and reconstruction. As noted above for soils, erosion rates during and immediately after road construction are high due to soil disturbance. Sources of sediment include the cutslope, road prism, and the fillslope. The crucial issue is how much of the sediment generated by road

construction is delivered to nearby waterbodies. Sediment is delivered by overland flow off bare and compacted areas, but also when runoff is concentrated in roadside ditches and cross drains.

Sediment delivery during and following road construction can be reduced by the use of barriers such as straw bales or silt fences, re-establishment of cover on disturbed or bare soil areas with mulch, geotextiles, or seed, installation of energy dissipaters at the outlets of cross drains, increasing the distance between the road and nearby waterbodies, and ensuring sufficient ground cover in the space between the road and nearby waterbodies to filter out sediment. These actions would minimize the amount of connected disturbed areas. Design features WQSP-6 and WQSP-7A that require the use of appropriate erosion control measures during construction and appropriate road drainage measures and filter strips would reduce the delivery of sediment to waterbodies during road construction. In addition, new roads would be located outside of the WIZ to ensure a filter strip between the road location and a waterbody (WQSP-4). However, there would be some sites where locating a new road outside of the WIZ is not feasible due to the need to cross the stream. These sites would be where the greatest potential for sediment delivery from new road construction would occur. Table 64 lists the miles of new road that would be constructed in the WIZ (within 100 feet from a waterbody) in each geographic area and the number of watersheds that would have new roads constructed in the WIZ by alternative. The greatest number of new road miles in the WIZ in any watershed would be 1.1 miles (Alternative 2) in Coal Creek watershed (140200010204) in the Gunnison Basin North Geographic Area.

Table 64. Miles of New Road Constructed in the WIZ in each Geographic Area.

Geographic Area	Alternative 2		Alternative 3	
	New Roads in WIZ (miles)	Watersheds Affected (#)	New Roads in WIZ (miles)	Watersheds Affected (#)
Grand Mesa	1.7	9	1.0	5
Gunnison Basin North	3.1	14	2.3	9
Gunnison Basin South	2.0	9	0.4	4
North Fork Valley	2.7	8	2.3	7
San Juans	1.6	5	0.3	1
Uncompahgre Plateau	2.6	11	1.2	6
Total	13.7	56	7.5	32

During construction of new road/stream crossings, there would unavoidably be direct input of sediment into the waterbody from bank disturbance. This sediment would likely cause temporary increases in turbidity and result in some sediment deposition downstream of the crossing site. Table 64 above lists the number of new road/stream crossings that would be constructed in each geographic area and the number of watersheds that would have new

crossings constructed by alternative. Use of appropriate erosion control measures at road/stream crossing locations (WQSP-6) would minimize the introduction of sediment to the waterbody during crossing construction.

All new roads would be decommissioned within five years of harvest being completed (WQSP-3B). Road decommissioning activities like out-sloping the roadbed, contouring to re-establish the natural undisturbed slope, scarifying of the road surface to reduce compaction, promoting native vegetation, removing ruts and berms, blocking the road to normal vehicular traffic, and building cross ditches and water bars (WQSP-8B) would restore hillslope drainage patterns to near pre-disturbance conditions and encourage re-establishment of ground cover on the road prism to reduce erosion potential to near pre-disturbance conditions. As with crossing construction, there would unavoidably be direct input of sediment into the waterbody from bank disturbance resulting in increased turbidity and sediment deposition. Use of appropriate erosion control measures at road/stream crossing locations (WQSP-6) would minimize the introduction of sediment to the waterbody during crossing decommissioning.

The effects of roads on water quality are likely to be localized, minor, and of moderate-term.

Direct and Indirect Effects to Water Yield

New roads in a watershed may increase the amount of runoff and the peak runoff rate. Road prisms are compacted and have little infiltration capacity. Precipitation and snowmelt intercepted by a road is quickly transmitted to the channel by surface runoff. Construction of a cutslope will intercept shallow groundwater flows, bringing this water to the surface and increase surface runoff. Hydrologic impacts of roads can be reduced by contouring the roadway to encourage dispersed runoff or installing sufficient surface drainage structures to disperse runoff to hillsides rather than directly to stream channels (Elliot 2000).

The effects of roads on water yield are likely to be localized, minor, and of moderate-term. Design feature WQSP-7A that requires the use of appropriate erosion control measures during construction and appropriate road drainage measures and filter strips would reduce the hydrologic impact during road construction. Road decommissioning activities like out-sloping the roadbed, contouring to re-establish the natural undisturbed slope, scarifying of the road surface to reduce compaction, promoting native vegetation, removing ruts and berms, blocking the road to normal vehicular traffic, and building cross ditches and water bars (WQSP-8B) would restore hillslope drainage patterns to near pre-disturbance conditions.

Direct and Indirect Effects to Fens, Wetlands and Riparian Areas

Direct effects to fens, wetlands, and riparian areas would result from use of heavy equipment in these areas. Indirect effects would result from changes in shallow groundwater and overland flow from changes in hillslope hydrology.

Direct effects to fens and wetlands is unlikely because roads would be located away from these areas (WQSP-4). As discussed above, there would be some road construction in the WIZ (Table

64), which could affect riparian vegetation. This impact would be localized and limited in extent. Increased runoff from new roads disrupting hillslope hydrology could increase shallow groundwater flow to fens, wetlands, and riparian areas located downslope from road locations. This effect would be localized and would reduce over time as roads are decommissioned and hillslope hydrology is restored.

Some existing roads located within the WIZ or other sensitive areas may be moved and erosion control measures improved during road reconstruction to reduce impacts to riparian areas and provide a beneficial effect to watersheds.

Mechanical and Hand Fuels Treatments

Mechanical fuels treatment consists of mastication. Masticators are heavy pieces of equipment that shred understory vegetation and small trees. Masticated material is typically burned within a few years. Hand treatments include thinning or pruning with chain saws, and hand piling and burning slash. Use of the pre-treatment checklist, design features and BMPs will reduce the potential for direct and indirect effects to soil and water resources. Treatment-specific design features will be selected by a GMUG resource specialist during pre-implementation analysis.

Pre-treatment checklist items for this type of activity include:

- Identify and delineate the WIZ in or near treatment units.
- Identify sensitive soil areas, e.g. severe EHR, slopes greater than 40 %, and landslide prone areas, in or near treatment units
- Identify wetland and fen areas in or near treatment units.

Examples of design features appropriate for this type of activity include, but are not limited to:

- Maintain at least 80 percent ground cover in WIZs (WQSP-2).
- Avoiding operating equipment in fens and wetlands (WQSP-4).
- Operating heavy equipment on dry soils to minimize soil compaction (WQSP-9A).

Direct and Indirect Effects to Soils

Mechanical fuels treatments, i.e. mastication, cause less compaction and disturbance than mechanical harvest and roads. Masticators are typically driven over the masticated material which reduces ground disturbance and soil compaction (Stednick 2010). Hatchett and others (2006) found that the use of heavy mastication equipment did not result in significant soil compaction at most soil depths in a study of mastication effects at Lake Tahoe, CA. Mastication equipment would be used when the soil is dry to help reduce soil compaction (WQSP-9A). The shredded vegetation remains on the soil surface, which minimizes or eliminates erosion, and provides soil nutrients as it decays. Rhoades and others (2012) found an increase in soil nitrogen

availability within 3 to 5 years of site treatment. Mechanical fuels treatments are likely to have localized, minor, and short-term effects on soils.

Hand fuels treatments occur over the smallest areas and leave some vegetative material on the ground. Hand treatments cause minimal compaction and disturbance to surface soils. Hand fuels treatments are likely to have insignificant effects on soils.

Direct and Indirect Effects to Surface Waterbodies and Stream Health

Mechanical fuels treatments can negatively affect stream health by removing canopy cover and creating physical disturbance to stream channels. The WCF indicator "Aquatic Habitat Condition" is used in this analysis as a measure of overall stream health in a watershed. This indicator has three attributes: "Habitat fragmentation," "Large woody debris," and "Channel shape and function." None of these attributes would be affected by mechanical fuels treatments. However, machine use would be limited to the outer half of the WIZ (WQSP-2) reducing the amount of treatment in the WIZ. This would minimize effects to water temperature that could affect habitat fragmentation, and would prevent physical damage to stream channels (Stednick 2010). Large woody debris and recruitment would not be affected by mechanical fuels treatment due to the high mortality from the spruce beetle and aspen decline. Overall, effects to stream health from mechanical timber harvest would be minor and stream health condition would be maintained in the affected watersheds.

Direct and Indirect Effects to Water Quality

Similar to mechanical timber harvest, the water quality parameters of concern from mechanical fuels treatments include sediment, temperature, and nutrients. Unlike mechanical timber harvest, mechanical fuels treatments result in much less ground disturbance and increased soil cover, so erosion and sediment production is much lower (Stednick 2010). Hatchett and others (2006) applied rainfall simulation to plots with varying ground cover following mastication. The greatest sediment yields resulted from plots with bare ground and the least resulted from plots with mulch from mastication. Design features and BMPs will ensure adequate vegetation and ground cover is maintained in the WIZ, to provide shade, nutrient capture, and sediment filtering so that effects to water quality from mechanical fuels treatments would be minor, localized, and short-term, even when operations extend over large areas (Robichaud et al. 2010, Stednick 2010).

Direct and Indirect Effects to Water Yield

Similar to mechanical timber harvest, a change in forest cover from mechanical fuel treatments could affect water yield and streamflows. However, in most cases, basal area reduction would not exceed the 20 to 25 percent needed to generate measureable increases in water yield. In addition, overland flow is not likely to occur because of the small amount of surface ground disturbance, lack of soil compaction, and the presence of mulch ground cover. Mechanical fuel

treatments will create little detectable impact on water yields on-site or downstream (Troendle et al. 2010).

Direct and Indirect Effects to Fens, Wetlands and Riparian Areas

Direct effects to fens, wetlands, and riparian areas would result from use of heavy equipment in these areas. Indirect effects would result from changes in shallow groundwater and overland flow from changes in water yield.

Direct effects to fens and wetlands are unlikely because heavy equipment would be kept out of these areas (WQSP-2 and WQSP-4). Equipment use would be allowed in the outer half of the WIZ, which could affect riparian vegetation. This impact would be localized and limited in extent. There may be on-site increases in soil moisture in mechanical fuel treatment units, but the extra water is unlikely to move off site into nearby wetlands and fens. There would likely be very minor effects, if any, to fens or wetlands.

Broadcast and Pile Burning

Prescribed fire, including broadcast burning and pile burning, will be conducted for slash disposal and site preparation to create suitable conditions for aspen regeneration spruce planting. Broadcast burning occurs over the entire site, typically resulting in a mosaic of low to moderate burn severity areas. Pile burns occur on small areas where slash is piled with by hand or machine, resulting in localized areas of moderate to high severity. Prescribed fires would be guided by a Burn Plan that will specify the conditions under which the burn can occur in order to minimize resource damage while meeting management objectives. Use of the pre-treatment checklist, design features and BMPs will reduce the potential for direct and indirect effects to soil and water resources. Treatment-specific design features will be selected by a GMUG resource specialist during pre-implementation analysis.

Pre-treatment checklist items for this type of activity include:

- Identify and delineate the WIZ in or near treatment units.
- Identify wetland and fen areas in or near treatment units.

Examples of design features appropriate for this type of activity include, but are not limited to:

- Maintain at sufficient organic ground cover in the activity area and WIZ (WQSP-1, WQSP-2).
- Restrict amount of prescribed fire in the WIZ (WQSP-2).
- Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area (WQSP-5A).

- Use filter strips to disconnect disturbed soil from streams, lakes, and wetlands (WQSP-6)
- Conduct prescribed fires when soil and duff are moist (WQSP-9A).
- Avoid building firelines in or around riparian areas, wetlands, fens or other sensitive water-dependent sites. Restore fire lines after use. (WQSP-9B, WQSP-9C, WQSP-9D, WQSP-9E).
- Limit the size, composition, and aerial extent of slash piles to minimize effects to soils from pile burns (SP-4).
- Minimize soil damage from machine pile burning through post-burn monitoring and burn scar restoration (Appendix B and Chapter 2, Decision-Making Triggers for Adaptive Implementation).

Direct and Indirect Effects to Soils

Direct and indirect effects to soils from prescribed fire depend on the severity of the burn and the aerial extent of the high severity burn areas. Low severity burn removes some of the litter layer but leaves the duff mostly intact. High severity burn totally consumes the duff and organic matter in the surface soil leaving the mineral soil exposed, can create areas of water repellent soils, and damage the soil biotic community. High severity burn intensity occurs where the fire burns hotter or for longer time periods, such as where fuels are larger or denser.

Broadcast burning is a prescribed fire technique that creates patchy, low to moderate severity impacts to surface soils. Burning is conducted when soils and fuels have higher moisture levels which reduce fire impacts to soils. Patchy burn patterns leave relatively bare areas surrounded by unburned or slightly burned areas with sufficient cover to reduce runoff and erosion potential. This type of broadcast burning has effects which are generally localized, minor and short-term (McIver 2013, Erickson 2008). Vegetation recovery after a broadcast burn is generally rapid, reducing erosion rates to pre-fire levels within 1 to 2 years (Robichaud et al. 2010).

Pile burns can damage soil structure, productivity, and soil biota, but can be effectively rehabilitated through scarification and mulching (Korb et al. 2004, Jiménez Esquilín 2007, Fornwalt 2011). To keep impacts to soils to a minimum, pile size would be limited with larger piles allowed only on landings and smaller piles in the interior areas of treatment units. The total area covered by piles/acre would be kept under ~5% (<2,500 square feet/acre covered by piles) (SP-4). This restriction on size and area of piles would ensure the extent of soil affected would be less than 15% of an activity area. In addition, piles built by machine would be constructed in such a manner encourage efficient burning and combustion. Following completion of burning, a sample of pile burn scars would be monitored within three years for extent of impacts and would be rehabilitated as needed. Pile burns effects will be localized, moderate, and short-term.

Direct and Indirect Effects to Surface Waterbodies and Stream Health

Prescribed fire treatments can negatively affect stream health by removing canopy cover and large woody debris. The WCF indicator "Aquatic Habitat Condition" is used in this analysis as a measure of overall stream health in a watershed. This indicator has three attributes: "Habitat fragmentation," "Large woody debris," and "Channel shape and function." None of these attributes would be affected by prescribed fire treatments. Broadcast burns may be allowed to back into WIZs (WQSP-2). WIZs can contain high fuel loads and can benefit from fuels reduction treatments. Design features will be selected to maintain sufficient canopy and ground cover but still permit some treatments within the WIZ. These design features would ensure that stream temperature and large woody debris are maintained in waterbodies adjacent to broadcast burn units. Overall, effects to stream health from prescribed fire would be minor and stream health condition would be maintained in the affected watersheds.

Direct and Indirect Effects to Water Quality

Water quality parameters of concern from prescribed fire treatments include sediment, temperature, and nutrients. The major factor that determines the effect of burning on erosion is the amount of disturbance to the surface organic matter that protects mineral soil. As noted for soils, different burn severities remove differing amounts of surface organic matter and expose greater or lesser amounts of mineral soil. Greater amounts of erosion result from high burn severity areas. Broadcast burns typically result in a patchy mosaic of low and moderate burn severity areas. Areas of unburned or lower burn severity can filter sediment and infiltrate runoff from more severely burned areas (e.g., pile burn scars) such that the amount of erosion and runoff that leaves the site is reduced. Streamside buffers are effective at capturing overland flows, removing sediments, and regulating stream temperatures. If vegetation is quickly re-established in broadcast burn areas, nutrient export is generally short-lived and usually does not become a threat to water quality or site productivity. Effects to water quality from prescribed fire treatments would be minor, localized, and short-term (Robichaud et al. 2010, Stednick 2010, Troendle et al. 2010).

Direct and Indirect Effects to Water Yield

As with impacts to soil and water quality, the effects of prescribed fire on water yield is dependent upon the severity of the fire and the area burned. Runoff will increase in high burn severity areas but there would be much less hydrologic effects in low severity burn areas. Little overland flow will occur if the extent of bare mineral soil is less than 35 to 40 percent of the area. Low severity broadcast burns generally result in 5 to 30 percent exposed mineral soil. Pile burns can leave scars from high severity burns but these are limited in area and surrounded by unburned areas that will infiltrate runoff generated from the burn scar. There would be little effect to water yield and streamflows from the prescribed fire treatments because there would not be a high degree of tree mortality from the fire and ground cover would be maintained (Troendle et al. 2010).

Direct and Indirect Effects to Fens, Wetlands and Riparian Areas

Effects to fens, wetlands, and riparian areas would result from burning or fireline construction in these areas. Direct effects to fens and wetlands are unlikely because prescribed burns would not occur in these areas (WQSP-2) and firelines would not be built in fens or wetlands (WQSP-9B). Pile burning will not occur in WIZs and broadcast burns may be allowed to back into WIZs. WIZs can contain high fuel loads and can benefit from fuels reduction treatments. Design features will be selected to maintain sufficient canopy and ground cover but still permit some treatments within the WIZ. WIZs recover quickly from burning so impacts from broadcast burning to WIZs is anticipated to be short term and minor (Bêche 2005, Bisson 2003, Dwire 2003, Kobziar 2006).

Potential for High Severity Fire

Although both action alternatives include removal of dead and dying trees, the low number of proposed annual treated acres will not result in a significant reduction in the potential severity of large wildland fires, if a wildfire was to occur. The effects of high severity fire would be the same as that described for Alternative 1.

Watershed Condition Class

An analysis of Watershed Condition Class was completed that examined the potential direct and indirect effects of the SBEADMR treatments on watershed condition class scores and ratings (See Appendix I). Each element (indicators and attributes) of the Watershed Condition Framework were evaluated and how SBEADMR treatments could affect those ratings was analyzed. This analysis concluded that SBEADMR treatments could potentially change the ratings for the “Riparian/Wetland Vegetation” and “Roads and Trails” indicators if the areal extent of the SBEADMR treatments in a watershed were great enough. The analysis also concluded that, given the percentage change required in these indicators to change the overall watershed condition score, the only watersheds where the watershed condition class could potentially be changed by SBEADMR treatments are those which currently have a watershed condition score of 1.6, that is, the “borderline” Class 1/Class 2 watersheds. The results of the analysis of SBEADMR effects on watershed condition class for borderline watersheds is discussed below in the Geographic Area effects descriptions.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects by Geographic Area

Grand Mesa

Watershed Condition Class

There are two borderline watersheds in the Grand Mesa Geographic Area (Table 65). In Leon Creek, Alternative 2 treatments total 789 acres, or about 3 percent of the watershed area, and would not result in a change in watershed condition score or class. Alternative 2 treatments in

Headwaters Buzzard Creek total 2389 acres or about 11 percent of the watershed area, so this watershed was analyzed further for impacts to the "Riparian/Wetland Vegetation" and "Roads and Trails" indicators (Appendix I).

Table 65. Borderline Watersheds in Grand Mesa Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140100051102	Headwaters Buzzard Creek	2389	11	Further analysis
140100051201	Leon Creek	789	3	No effect

GIS analysis determined that only 205 acres of riparian vegetation is intersected by or is within 500 feet of a priority treatment area or hazard tree removal area in this watershed. This small amount of riparian vegetation that could be affected would not be sufficient to change the "Riparian/Wetland Vegetation" indicator rating for this watershed. There are no new roads proposed in this watershed, so the "Roads and Trails" indicator would likewise not change. Therefore, there would be no change in watershed condition score or class for Headwaters Buzzard Creek watershed.

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There are two impaired stream segments located in three Grand Mesa watersheds (Table 23). Both of these waterbodies are listed for impairments by selenium and metals, pollutants that would not be affected by Alternative 2 treatments. There would be no direct or indirect effects to impaired waterbodies in the Grand Mesa watersheds.

Stream Connectivity

New stream crossings would be built in 8 Grand Mesa watersheds (Table 66). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows,

and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 1.7 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.6 miles in Cottonwood Creek (140100051304). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 66. Alternative 2 New Crossings and Road in the WIZ in Grand Mesa Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140100051302	Big Creek	5	0.66	0.72	1236
140100051305	Bull Creek	3	0.33	0.45	1689
140100051307	Coon Creek	-	-	-	203
140100051304	Cottonwood Creek	8	1.01	1.19	3270
140100051301	Grove Creek	1	0.23	0.28	213
140200050702	Headwaters Kannah Creek	1	0.25	0.25	267
140200050106	Kiser Creek	2	0.70	0.75	660
140100051201	Leon Creek	5	0.19	0.22	1265
140200050111	Surface Creek	1	0.33	0.34	238
	Total	26	--	--	9041

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 67 shows the acres and percent of the watershed area that would receive commercial timber harvest in Grand Mesa Watersheds for both Alternative 2 and 3. Commercial treatments in all of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 67. Acres of Commercial Treatments in Grand Mesa Watersheds.

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140100051302	Big Creek	20,351	4263	21	2474	12
140100051305	Bull Creek	14,626	1305	9	625	4
140100051307	Coon Creek	11,362	353	3	337	3
140100051304	Cottonwood Creek	14,301	2114	15	1594	11
140100051301	Grove Creek	16,563	1139	7	380	2
140200050702	Headwaters Kannah Creek	38,139	1902	5	911	2
140200050106	Kiser Creek	21,784	1996	9	1626	8
140100051201	Leon Creek	28,684	619	2	0	0
140100051308	Mesa Creek	21,663	114	< 1	114	< 1
140200050111	Surface Creek	29,311	1490	5	1041	4
140200050108	Ward Creek	14,793	161	1	161	1

Municipal Supply Watersheds

All of the identified treatment areas in the Grand Mesa Geographic Area are located within a delineated Source Water Area (Table 65). The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 68 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, most of the fens and wetlands are in or near priority treatment areas. Fens and wetlands in or near treatment areas would be identified in the Pre-treatment checklist procedure (Appendix C). Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 68. Fens and Wetlands in or near Alternative 2 Treatment Areas in Grand Mesa Watersheds

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140100051302	Big Creek	0	51.3	0.2	11.5
140100051305	Bull Creek	22.8	60.5	0	0.1
140100051307	Coon Creek	0	15.6	0	2.6
140100051304	Cottonwood Creek	0	38.6	0	0
140200050107	Dirty George Creek	1.5	0	0	0
140100051301	Grove Creek	0	0	2.3	8.5
140200050702	Headwaters Kannah Creek	2.2	32	2.1	52.4
140100051103	Hightower Creek-Buzzard Creek	0	0	0.3	0
140200050106	Kiser Creek	0	36.9	0	44.7
140100051201	Leon Creek	0	0	9	12.6
140100051308	Mesa Creek	0	5.5	0.3	2
140200050109	Oak Creek	0	0	0	3.3
140200050111	Surface Creek	16	37	0	2.5

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator "Soils Condition" as a measure of overall soil health in a watershed in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

Gunnison Basin North

Watershed Condition Class

The extent of Alternative 2 treatments in 10 of the 12 borderline watersheds in the Gunnison Basin North Geographic Area is less than 10 percent of the watershed area and would not result in a change in watershed condition score or class (Table 69). Alternative 2 treatments in the other two watersheds exceed 10 percent of the watershed area, so these watersheds were analyzed further for impacts to the "Riparian/Wetland Vegetation" and "Roads and Trails" indicators (Appendix I).

Table 69. Borderline Watersheds in Gunnison Basin North Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140200010111	Bear Creek-Spring Creek	1306	6	No effect
140200010112	Beaver Creek	7920	43	Further analysis
140200010202	Brush Creek	258	1	No effect
140200021003	Corral Creek-Gunnison River	120	< 1	No effect
140200020705	Cow Creek-Soap Creek	115	< 1	No effect
140200010108	Lottis Creek	57	0	No effect
140200010210	Lower East River	57	0	No effect
140200010113	Lower Taylor River	4373	11	Further analysis
140200010203	Middle East River	709	4	No effect
140200010106	Outlet Willow Creek	115	< 1	No effect
140200010201	Upper East River	22	0	No effect
140200040301	Ruby Anthracite Creek	529	2	No effect

GIS analysis determined the acres of riparian vegetation is intersected by or is within 500 feet of a priority treatment area or hazard tree removal area in these two watersheds (Table 70). Although the acres of riparian vegetation exceeds 200 acres in both watersheds, this amounts to 2 percent or less of the watershed area. This small amount of riparian vegetation that could be affected would not be sufficient to change the "Riparian/Wetland Vegetation" indicator rating for these watersheds. No new roads are proposed in Alternative 2 for Lower Taylor River watershed and only 0.1 miles in Beaver Creek watershed. Open road density rating would not change. None of the new road would be located within 100 feet of a waterbody, therefore the "Proximity to Water" attribute rating also would not change. Therefore, there would be no change in watershed condition score or class for either of these watersheds.

Table 70. Riparian Vegetation and New Road Construction in Borderline Watersheds in Gunnison Basin North Geographic Area.

HUC 12 Name	Riparian Veg (acres)	Open Road Density				Proximity to Water	
		Current Density (mi/mi^2)	Current Rating	Alt 2 New Road (miles)	Alt 2 Density (mi/mi^2)	Current Rating	Alt 2 New Road (miles)
Beaver Creek	423	0.8	1	0.1	0.8	3	0
Lower Taylor River	228	0.8	1	0	0.8	3	0

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There are eight impaired stream segments located in four Gunnison Basin North watersheds (Table 30). Seven of these impaired segments are listed for impairments of the aquatic life use by metals, pollutants that would not be affected by Alternative 2 treatments. The other impaired (Cement Creek) is listed for impairments of aquatic life use as indicated by the condition of the benthic macroinvertebrate community. It is unknown exactly what pollutant(s) are causing the impairment, but it could be excess sediment, metals, or temperature. GIS review of Potential Treatment Areas in these watersheds indicated that the Bear Creek Commercial PTA directly intersected with the Cement Creek impaired segment for a few hundred feet, and was within 200 feet of the stream for approximately 1.5 miles. The boundary of this PTA was moved to provide at least a 300 foot buffer between the PTA and Cement Creek. This distance would be sufficient to maintain stream shade and filter sediment such that the impaired waterbody would not be further impacted.

Stream Connectivity

New stream crossings would be built in 11 Gunnison Basin North watersheds (Table 71). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 3.1 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 1.1 miles in Coal Creek (140200010204). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 71. Alternative 2 New Crossings and Road in the WIZ in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200020201	Antelope Creek	4	0.53	0.69	1036
140200010111	Bear Creek-Spring Creek	1	0.56	0.57	242
140200020103	Carbon Creek	7	0.31	0.42	2140
140200010207	Cement Creek	-	-	-	1903
140200010204	Coal Creek	9	1.25	1.46	5745
140200020701	East Elk Creek	1	0.48	0.49	261
140200010203	Middle East River	4	0.64	0.68	1679
140200020105	Middle Ohio Creek	2	0.27	0.32	419
140200020104	Mill Creek	1	0.15	0.17	343
140200010110	Rocky Brook-Spring Creek	1	0.58	0.59	356
140200020101	Upper Ohio Creek	-	-	-	38
140200030301	Upper Quartz Creek	3	0.78	0.81	1333
140200020403	Willow Creek-Blue Mesa Reservoir	2	0.80	0.85	371
140200010206	Washington Gulch-Slate River	-	-	-	361

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 72 shows the acres and percent of the watershed area that would receive commercial timber harvest in Gunnison Basin North Watersheds for both Alternative 2 and 3. Commercial treatments in all of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 72. Acres of Commercial Treatments in Gunnison Basin North Watersheds.

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140200020201	Antelope Creek	21,030	982	5	12	< 1
140200010111	Bear Creek-Spring Creek	23,119	1242	5	480	2
140200020401	Beaver Creek	23,115	34	< 1	0	0
140200020103	Carbon Creek	16,053	1052	7	1052	7
140200010207	Cement Creek	22,850	341	2	292	1
140200010204	Coal Creek	13,147	1386	11	451	3
140200020701	East Elk Creek	14,154	1154	8	0	0
140200030302	Gold Creek	19,356	551	3	408	2
140200030101	Headwaters Tomichi Creek	17,989	208	1	0	0
140200010203	Middle East River	16,676	617	4	617	4
140200020105	Middle Ohio Creek	19,521	180	1	180	1
140200020104	Mill Creek	10,667	203	2	0	0
140200020702	Red Creek	9,094	1144	13	0	0
140200040301	Ruby Anthracite Creek	32,680	513	2	481	2
140200020101	Upper Ohio Creek	15,506	553	4	146	1
140200030301	Upper Quartz Creek	25,889	1246	5	707	3
140200010206	Washington Gulch-Slate River	22,977	438	2	438	2
140200020403	Willow Creek-Blue Mesa Reservoir	42,361	1159	3	19	< 1

Municipal Supply Watersheds

All of the identified treatment areas in the Gunnison Basin North Geographic Area are located within a delineated Source Water Area (Table 27). The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 73 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, most of the fens and wetlands are in or near hazard tree removal areas. Fens and wetlands would be identified in the Pre-treatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance

because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 73. Fens and Wetlands in or near Alternative 2 Treatment Areas in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200010112	Beaver Creek	0	0	0	19.6
140200010204	Coal Creek	0	22.6	0	0
140200020705	Cow Creek-Soap Creek	2.3	0	0	0
140200030101	Headwaters Tomichi Creek	0	0	2.4	0
140200010108	Lottis Creek	0	0	2.1	0
140200010103	Middle Taylor River	0.7	0	0	0
140200010106	Outlet Willow Creek	0	0	8.9	0
140200010110	Rocky Brook-Spring Creek	0.1	0	0	0
140200010104	Texas Creek	48.9	0	0	0
140200010102	Trail Creek-Upper Taylor River	11.5	0	9.4	0
140200010201	Upper East River	0	0	0.3	0
140200010101	Upper Taylor River	20.1	0	5.8	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator "Soils Condition" as a measure of overall soil health in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

Gunnison Basin South

Watershed Condition Class

The extent of Alternative 2 treatments in 7 of the 10 borderline watersheds in the Gunnison Basin South Geographic Area is less than 10 percent of the watershed area and would not result

in a change in watershed condition score or class (Table 74). Alternative 2 treatments in the other three watersheds exceed 10 percent of the watershed area, so these watersheds were analyzed further for impacts to the "Riparian/Wetland Vegetation" and "Roads and Trails" indicators (Appendix I).

Table 74. Borderline Watersheds in Gunnison Basin South Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140200030503	Archuleta Creek	890	2	No effect
140200030504	Headwaters Los Pinos Creek	7798	25	Further analysis
140200020602	Lake Sanc Cristobal-Lake Fork	17	0	No effect
140200020802	Little Blue Creek	1229	6	No effect
140200030104	Long Branch Creek	154	1	No effect
140200020604	Nellie Creek-Henson Creek	43	0	No effect
140200030509	Outlet Cochetopa Creek	6	0	No effect
140200030202	Outlet Razor Creek	51	0	No effect
140200030502	Pauline Creek	10,836	41	Further analysis
140200020607	Trout Creek-Lake Fork	3440	14	Further analysis

GIS analysis determined the acres of riparian vegetation is intersected by or is within 500 feet of a priority treatment area or hazard tree removal area in these three watersheds (Table 75). Although the acres of riparian vegetation exceeds 100 acres in all three watersheds, this amounts to 2 percent or less of the watershed area. This small amount of riparian vegetation that could be affected would not be sufficient to change the "Riparian/Wetland Vegetation" indicator rating for these watersheds. Proposed new roads in Alternative 2 in two of these watersheds exceed 10 miles, which raises the road density. However, both of these watersheds are already rated as a "2" for open road density and the threshold for a "3" rating is 2.4 mi/mi^2, so this rating would not change. Proposed new roads in the third watershed only totals 0.3 miles and this would not change the open road density. Very little of the new road would be constructed within 100 feet of a waterbody, therefore the "Proximity to Water" attribute rating would not change in any of these three watersheds. Therefore, there would be no change in watershed condition score or class for any of these three watersheds.

Table 75. Riparian Vegetation and New Road Construction in Borderline Watersheds in Gunnison Basin South Geographic Area.

HUC 12 Name	Riparian Veg (acres)	Open Road Density				Proximity to Water	
		Current Density (mi/mi^2)	Current Rating	Alt 2 New Road (miles)	Alt 2 Density (mi/mi^2)	Current Rating	Alt 2 New Road (miles)
Headwaters Los Pinos	411	1.4	2	12.3	1.7	3	0.4
Pauline Creek	437	2.0	2	11.7	2.3	2	0.2
Trout Creek-Lake Fork	113	0.4	1	0.3	0.4	2	0

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There are three impaired stream segments located in six Gunnison Basin South watersheds (Table 37). One of these waterbodies (North Fork Henson Creek) is listed for impairment of the water supply use by manganese, a pollutant that would not be affected by Alternative 2 treatments. The other two waterbodies (South Beaver Creek and Cochetopa Creek) are listed for impairments of aquatic life use as indicated by the condition of the benthic macroinvertebrate community. It is unknown exactly what pollutant(s) are causing the impairment, but it could be excess sediment, metals, or temperature. Alternative 2 treatments could affect sediment loads or temperature, however all identified treatment areas in these watersheds are at least 500 feet from the impaired waterbodies. This distance would be sufficient to maintain stream shade and filter sediment such that the impaired waterbody would not be further impacted.

Stream Connectivity

New stream crossings would be built in 9 Gunnison Basin South watersheds (Table 76). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 2.0 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.5

miles in Marshall Creek (140200030103). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 76. Alternative 2 New Crossings and Road in the WIZ in Gunnison Basin South Watersheds

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200030503	Archuleta Creek	2	0.99	1.01	526
140200020502	Headwaters Cebolla Creek	1	0.40	0.41	241
140200030504	Headwaters Los Pinos Creek	6	0.81	0.85	2133
140200030103	Marshall Creek	9	0.73	0.79	2616
140200030502	Pauline Creek	3	0.68	0.71	837
140200020506	Rock Creek	2	0.49	0.55	1046
140200020504	Spring Creek	3	0.22	0.25	709
140200030507	West Pass Creek	4	1.42	1.44	903
140200020610	Willow Creek	3	0.89	1.55	1381

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 77 shows the acres and percent of the watershed area that would receive commercial timber harvest in Gunnison Basin South watersheds for both Alternative 2 and 3. Commercial treatments in all of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 77. Acres of Commercial Treatments in Gunnison Basin South Watersheds.

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140200030503	Archuleta Creek	37,552	2181	6	0	0
140200020801	Headwaters Blue Creek	26,873	211	1	0	0
140200020502	Headwaters Cebolla Creek	19,310	3332	17	0	0
140200030501	Headwaters Cochetopa Creek	31,713	347	1	0	0
140200030504	Headwaters Los Pinos Creek	32,085	5440	17	0	0
140200030201	Headwaters Razor Creek	24,686	780	3	55	< 1
140200020802	Little Blue Creek	22,327	1161	5	21	< 1
140200030103	Marshall Creek	36,742	5019	14	2244	6
140200020501	Mill Creek-Brush Creek	19,123	1008	5	0	0
140200030502	Pauline Creek	26,481	6179	23	0	0
140200020506	Rock Creek	26,268	883	3	0	0
140200020504	Spring Creek	23,225	2029	9	475	2
140200020607	Trout Creek-Lake Fork	24,597	99	< 1	59	< 1
140200030507	West Pass Creek	31,859	979	3	269	1
140200020610	Willow Creek	14,784	1102	8	726	5

Municipal Supply Watersheds

All of the identified treatment areas in the Gunnison Basin South Geographic Area are located within a delineated Source Water Area (Table 34). The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 78 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, there is a mix of the fens and wetlands in or near hazard tree removal areas and priority treatment areas. Fens and wetlands would be identified in the Pre-treatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large

openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 78. Fens and Wetlands in or near Alternative 2 Treatment Areas in Gunnison Basin South Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200030503	Archuleta Creek	0	0	23.4	7.6
140200020801	Headwaters Blue Creek	3.1	0	0	0
140200020602	Lake Sanc Cristobal-Lake Fork	24.4	0	0	0
140200020802	Little Blue Creek	0	7.8	0	0
140200030104	Long Branch Creek	0	0	16.2	0
140200030103	Marshall Creek	0	0	0.5	45.4
140200030502	Pauline Creek	8.9	13	6.9	49.2
140200030507	West Pass Creek	0	0.4	5	9.9

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator "Soils Condition" as a measure of overall soil health in a watershed in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

North Fork Valley

Watershed Condition Class

The extent of Alternative 2 treatments in 4 of the 5 borderline watersheds in the North Fork Valley Geographic Area is less than 5 percent of the watershed area and would not result in a change in watershed condition score or class (Table 79). Alternative 2 treatments in Terror Creek watershed is 36 percent of the watershed area, so this watershed was analyzed further for impacts to the "Riparian/Wetland Vegetation" and "Roads and Trails" indicators (Appendix I).

Table 79. Borderline Watersheds in North Fork Valley Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140200021204	Crawford Reservoir	364	4	No effect
140200021002	Curecanti Creek	264	1	No effect
140200040407	Miller Creek	181	< 1	No effect
140200040103	Outlet West Muddy Creek	467	2	No effect
140200040406	Terror Creek	6856	36	Further analysis

GIS analysis determined that only 141 acres of riparian vegetation is intersected by or is within 500 feet of a priority treatment area or hazard tree removal area in this watershed. This small amount of riparian vegetation that could be affected would not be sufficient to change the "Riparian/Wetland Vegetation" indicator rating for this watershed. Proposed new roads in this watershed in Alternative 2 total 1.5 miles, which raises the road density from 1.3 mi/mi^2 to 1.4 mi/mi^2. However, this watershed is already rated as a "2" for open road density and the threshold for a "3" rating is 2.4 mi/mi^2, so this rating would not change. None of the new road would be constructed within 100 feet of a waterbody, therefore the "Proximity to Water" attribute rating would not change either. Therefore, there would be no change in watershed condition score or class for Terror Creek watershed.

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There is one impaired stream segment located in four North Fork Valley watersheds (Table 44). This waterbody is listed for impairment of aquatic life by iron, a pollutant that would not be affected by Alternative 2 treatments. There would be no direct or indirect effects to impaired waterbodies in the North Fork Valley watersheds.

Stream Connectivity

New stream crossings would be built in 8 North Fork Valley watersheds (Table 80). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows,

and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 2.7 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.8 miles in Little Henderson Creek-East Muddy Creek (140200040204). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 80. Alternative 2 New Crossings and Road in the WIZ in North Fork Valley Watersheds

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200040101	Cow Creek	4	0.23	0.29	2154
140200021004	Crystal Creek	1	0.25	0.26	244
140200040404	Headwaters Hubbard Creek	13	0.64	0.84	3604
140200040102	Headwaters West Muddy Creek	5	0.38	0.42	1387
140200040204	Little Henderson Creek-East Muddy Creek	13	0.27	0.33	4065
140200021205	Middle Smith Fork	1	0.16	0.17	222
140200040405	Outlet Hubbard Creek	5	0.56	0.63	1061
140200040301	Ruby Anthracite Creek	2	0.34	0.35	1284

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 81 shows the acres and percent of the watershed area that would receive commercial timber harvest in North Fork Valley watersheds for both Alternative 2 and 3. Commercial treatments in all of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 81. Acres of Commercial Treatments in North Fork Valley Watersheds

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140200040101	Cow Creek	11,434	1185	10	863	8
140200021204	Crawford Reservoir	10,303	364	4	364	4
140200021004	Crystal Creek	36,987	986	3	0	0
140200021002	Curecanti Creek	25,226	109	< 1	20	< 1
140200040404	Headwaters Hubbard Creek	13,194	1948	15	1039	8
140200040102	Headwaters West Muddy Creek	20,251	867	4	682	3
140200040204	Little Henderson Creek-East Muddy Creek	37,632	535	1	535	1
140200021005	Mesa Creek-Gunnison River	31,772	987	3	987	3
140200021205	Middle Smith Fork	21,586	101	< 1	101	< 1
140200021202	Muddy Creek	15,256	53	< 1	53	< 1
140200040405	Outlet Hubbard Creek	23,895	879	4	768	3
140200040406	Terror Creek	18,829	559	3	379	2

Municipal Supply Watersheds

All of the identified treatment areas in the North Fork Valley Geographic Area are located within a delineated Source Water Area (Table 41). The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 82 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, there are very few fens or wetlands in or near treatment areas. The only fen area is in Headwaters Leroux Creek near hazard tree removal areas. Most of the wetland areas in the other watersheds are near hazard tree removal areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 82. Fens and Wetlands in or near Alternative 2 Treatment Areas in North Fork Valley Watersheds

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200021002	Curecanti Creek	0	0	2.4	0
140200040404	Headwaters Hubbard Creek	0	0	0	1.9
140200040505	Headwaters Leroux Creek	8.9	0	1.3	0
140200040103	Outlet West Muddy Creek	0	0	0.1	0
140200040402	Raven Gulch	0	0	1.6	0
140200040301	Ruby Anthracite Creek	0	0	6.8	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator "Soils Condition" as a measure of overall soil health in a watershed in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

San Juans

Watershed Condition Class

Alternative 2 treatments in all six of the borderline watersheds in the San Juans Geographic Area consist of only hazard tree removal on one percent or less of the total watershed areas (Table 83). This small magnitude of treatment would not cause a change in watershed condition class in any of these watersheds (Appendix I).

Table 83. Borderline Watersheds in San Juans Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140300030107	Bear Creek	4	0	No effect
140200060205	Coal Creek-Uncompahgre River	3	0	No effect
140300030101	Howard Fork	2	0	No effect
140300030102	Lake Fork	15	0	No effect
140200020902	Upper Cimarron River	43	0	No effect
140200060206	West Fork Dallas Creek	2	0	No effect

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There are four impaired stream segments located in three San Juans watersheds (Table 51). All of these waterbodies are listed for impairment of aquatic life by metals, including cadmium, copper, zinc, and/or silver, pollutants that would not be affected by Alternative 2 treatments. There would be no direct or indirect effects to impaired waterbodies in the San Juans watersheds.

Stream Connectivity

New stream crossings would be built in 3 San Juans watersheds (Table 84). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 1.6 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.6 miles in Headwaters Beaver Creek (140300030302). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 84. Alternative 2 New Crossings and Road in the WIZ in San Juans Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140300030302	Headwaters Beaver Creek	12	0.51	0.60	3,212
140200020801	Headwaters Blue Creek	-	-	-	64
140200020903	Headwaters Little Cimarron River	8	0.23	0.33	2,426
140300030301	Howard Fork	-	-	-	199
140300030303	Turner Creek-Beaver Creek	9	0.50	0.91	2,329

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 85 shows the acres and percent of the watershed area that would receive commercial timber harvest in San Juans watersheds for both Alternative 2 and 3. Commercial treatments in all of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 85. Acres of Commercial Treatments in San Juans Watersheds

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140300030108	Fall Creek	26,850	767	3	751	3
140300030302	Headwaters Beaver Creek	23,546	3846	16	348	2
140200020903	Headwaters Little Cimarron River	27,413	2820	10	719	3
140300030401	Headwaters Naturita Creek	56,071	627	1	71	< 1
140300030106	Headwaters San Miguel River	33,071	2363	7	2363	7
140300030301	Saltado Creek	12,953	762	6	122	1
140300030103	South Fork San Miguel River	11,933	189	2	189	2
140300030305	Specie Creek-San Miguel River	24,682	295	1	264	1
140300030303	Turner Creek-Beaver Creek	25,586	530	2	37	< 1

Municipal Supply Watersheds

All of the identified treatment areas in 23 of the 25 watersheds in the San Juans Geographic Area are located within a delineated Source Water Area (Table 48). In Turner Creek-Beaver Creek (140300030303), 98 percent of the treatments are in a Source Water Area, but in Headwaters Naturita Creek, only 2 percent are. The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 86 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, there is a mix of the fens and wetlands in or near hazard tree removal areas and priority treatment areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 86. Fens and Wetlands in or near Alternative 2 Treatment Areas in San Juans Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200060208	Beaver Creek-Dalles Creek	1.5	0	0	0
140300030108	Fall Creek	0	1.6	0	1.4
140300030302	Headwaters Beaver Creek	21.8	10.5	4.3	12.4
140200020903	Headwaters Little Cimarron River	11.5	17.2	8.7	26.7
140300030106	Headwaters San Miguel River	0	9.6	0	10.8
140200060201	Red Mountain Creek	3.8	0	0	0
140200020901	Silver Jack Reservoir-Cimarron River	11.2	0	0	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator "Soils Condition" as a measure of overall soil health in a watershed in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

Uncompahgre Plateau

Watershed Condition Class

The extent of Alternative 2 treatments in 6 of the 7 borderline watersheds in the Uncompahgre Plateau Geographic Area is less than 10 percent of the watershed area and would not result in a change in watershed condition score or class (Table 87). Alternative 2 treatments in Headwaters Dry Creek watershed is 22 percent of the watershed area, so this watershed was analyzed further for impacts to the "Riparian/Wetland Vegetation" and "Roads and Trails" indicators (Appendix I).

Table 87. Borderline Watersheds in Uncompahgre Plateau Geographic Area.

HUC12 Code	HUC12 Name	Alt 2 Treatments		Effect on Watershed Condition Class
		Acres of Treatment	% of Watershed Area	
140300040402	Calamity Creek	178	< 1	No effect
140300030605	Campbell Creek	85	< 1	No effect
140200050304	East Fork Escalante Creek	525	3	No effect
140200060501	Headwaters Dry Creek	7428	22	Further analysis
140300030203	Lower Horsefly Creek	2127	9	No effect
140200050203	Middle Roubideau Creek	2462	9	No effect
140300030604	Spring Creek	85	< 1	No effect

GIS analysis determined that only 91 acres of riparian vegetation is intersected by or is within 500 feet of a priority treatment area or hazard tree removal area in this watershed. This small amount of riparian vegetation that could be affected would not be sufficient to change the "Riparian/Wetland Vegetation" indicator rating for this watershed. Proposed new roads in this watershed in Alternative 2 total 14.8 miles, which raises the road density from 1.0 mi/mi^2 to 1.3 mi/mi^2. However, this watershed is already rated as a "2" for open road density and the threshold for a "3" rating is 2.4 mi/mi^2, so this rating would not change. Only 0.3 miles of new road would be constructed within 100 feet of a waterbody, therefore the "Proximity to Water"

attribute rating would not change either. Therefore, there would be no change in watershed condition score or class for Headwaters Dry Creek watershed.

Surface Waterbodies and Stream Health

This analysis uses the WCF indicator "Aquatic Habitat Condition" as a measure of overall stream health in the watershed. The analysis of direct and indirect effects to stream health from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that stream health condition would be maintained in all watersheds.

Classified Uses and Impaired Streams

There are two impaired stream segments located in three Uncompahgre Plateau watersheds Table 58). Both of these waterbodies are listed for impairments of aquatic life by iron and copper, pollutants that would not be affected by Alternative 2 treatments. There would be no direct or indirect effects to impaired waterbodies in the Uncompahgre Plateau watersheds.

Stream Connectivity

New stream crossings would be built in 10 Uncompahgre Plateau watersheds (Table 88). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 2.6 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.7 miles in Upper Spring Creek (140200060601). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 88. Alternative 2 New Crossings and Road in the WIZ in Uncompahgre Plateau Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200050204	Cottonwood Creek	1	0.73	0.75	880
140200050305	Dry Fork Escalante Creek	2	0.23	0.26	1739
140200060501	Headwaters Dry Creek	7	0.62	0.80	1570
140300030203	Lower Horsefly Creek	-	-	-	227
140300030202	Middle Horsefly Creek	2	0.61	0.63	704
140200050203	Middle Roubideau Creek	4	0.15	0.18	927
140300030601	North Fork Tabeguache Creek	1	0.15	0.16	283
140200050202	Potter Creek	2	0.46	0.48	587
140300030201	Upper Horsefly Creek	1	0.86	0.88	623
140200050201	Upper Roubideau Creek	7	0.08	0.12	2767
140200060601	Upper Spring Creek	11	0.26	0.47	3446

Water Yield

As discussed above, of all of the SBEADMR treatments, the greatest potential for an increase in water yield would be from commercial timber harvest if 25 percent or more of the watershed basal area is removed. Table 89 shows the acres and percent of the watershed area that would receive commercial timber harvest in Uncompahgre Plateau watersheds for both Alternative 2 and 3. Commercial treatments in most of the watersheds in Alternative 2 would be below the 25 percent basal area removed threshold. In these watersheds, there may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Table 89. Acres of Commercial Treatments in Uncompahgre Plateau Watersheds.

HUC12 Code	HUC12 Name	Watershed Area (Acres)	Commercial Treatments			
			Alt 2		Alt 3	
			Acres	%	Acres	%
140300030701	Cottonwood Creek	32,749	368	1	147	< 1
140200050204	Cottonwood Creek	29,988	606	2	0	0
140200050305	Dry Fork Escalante Creek	30,933	899	3	0	0
140200060403	Happy Canyon Creek	38,456	105	< 1	105	< 1
140200060501	Headwaters Dry Creek	33,992	6882	20	6257	18
140300030602	Headwaters Tabeguache Creek	27,263	1909	7	59	< 1
140300030203	Lower Horsefly Creek	25,030	495	2	495	2
140300030202	Middle Horsefly Creek	17,876	2398	13	1125	6
140200050203	Middle Roubideau Creek	27,986	2369	9	0	0
140200060602	Middle Spring Creek	21,667	45	< 1	45	< 1
140300030601	North Fork Tabeguache Creek	11,624	305	3	0	0
140200050202	Potter Creek	36,584	1345	4	0	0
140300030201	Upper Horsefly Creek	29,058	918	3	802	3
140200050201	Upper Roubideau Creek	33,346	7461	22	1520	5
140200060601	Upper Spring Creek	16,999	6883	41	6314	37

In Upper Spring Creek (140200060601) in Alternative 2, the large extent of area that could be treated with commercial timber harvest would result in sufficient basal area removed to affect water yield. Most of this treatment is proposed to be combination treatments or resiliency treatments, with a large amount of stands of aspen and spruce mix. Resiliency treatments, especially in aspen, would result in less water yield increase than if it was all salvage logging creating large openings. There would be a measurable increase in water yield at the watershed scale if all of these acres were treated within a short period of time. This would likely be seen in the spring on the rising limb of the snowmelt hydrograph (MacDonald and Stednick 2003). The rating for the WCF "Channel Shape and Function" attribute is currently "2 – functioning at risk," indicating the channels in the watershed are experiencing moderate levels of instability. Additional flow in these channels could exacerbate the channel instability, causing bank erosion and localized flooding.

Municipal Supply Watersheds

Of the six Geographic Areas, the watersheds in the Uncompahgre Plateau Geographic Area have the greatest amount of identified treatment areas no located within a delineated Source Water Area (Table 55). Fifteen of the 38 watersheds have less than 10 percent of the treatment areas

located in a Source Water Area and 22 of the 38 have more than 95 percent of the treatment areas in a Source Water Area. The direct and indirect effects on water quantity and water quality resulting from the different types of treatments that could occur in the treatment areas are discussed above. There would be no measureable change on water quantity and the use of design features and BMPs to reduce the potential for erosion and sediment transport to streams. Direct and indirect effects to municipal water supplies would be negligible and short-term.

Fens and Wetlands

Table 90 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 2 treatment area. In this Geographic Area, there are very few fens or wetlands in or near priority treatment areas and these would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 90. Fens and Wetlands in or near Alternative 2 Treatment Areas in Uncompahgre Plateau Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200050204	Cottonwood Creek	0	0	1.1	0
140200050304	East Fork Escalante Creek	1.9	0	0.6	0
140300030602	Headwaters Tabeguache Creek	0	0	0	10.4
140200060602	Middle Spring Creek	0	0	0.8	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

This analysis uses the WCF indicator “Soils Condition” as a measure of overall soil health in a watershed in a watershed. The analysis of direct and indirect effects to soil from proposed mechanical timber harvest, road construction and reconstruction, mechanical fuel treatment, and prescribed fire described above and in Appendix I conclude that soil condition would be maintained in all watersheds.

Alternative 3 (WUI Focus) – Effects by Geographic Area

Grand Mesa

Watershed Condition Class

The effects on Watershed Condition Class in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Surface Waterbodies and Stream Health

The effects on stream health in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

New stream crossings would be built in 4 Grand Mesa watersheds (Table 91), resulting in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 1.0 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.6 miles in Cottonwood Creek (140100051304). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 91. Alternative 3 New Crossings and Road in the WIZ in Grand Mesa Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140100051302	Big Creek	4	0.66	0.71	930
140100051305	Bull Creek	1	0.33	0.37	1009
140100051307	Coon Creek	-	-	-	203
140100051304	Cottonwood Creek	7	1.01	1.17	3128
140200050702	Headwaters Kannah Creek	1	0.25	0.25	267

Water Yield

The effects on water yield in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds in Alternative 3 would be below the 25 percent basal area removed threshold (Table 66). There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 92 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, most of the fens and wetlands are in or near priority treatment areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 92. Fens and Wetlands in or near Alternative 3 Treatment Areas in Grand Mesa Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140100051302	Big Creek	0	44.6	0.2	10.8
140100051305	Bull Creek	22.8	53.5	0	0.1
140100051307	Coon Creek	3.2	15.6	0	2.6
140100051304	Cottonwood Creek	0	27.8	0	0
140200050107	Dirty George Creek	1.5	0	0	0
140100051301	Grove Creek	0	0	3.8	0
140200050702	Headwaters Kannah Creek	2.2	28.4	8.5	12.1
140100051103	Hightower Creek-Buzzard Creek	0	0	0.3	0
140200050106	Kiser Creek	0	36.9	0.1	42.8

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140100051201	Leon Creek	0	0	9	0
140100051308	Mesa Creek	0	5.5	0.3	1.7
140200050109	Oak Creek	0	0	0	3.3
140200050111	Surface Creek	16.1	32.5	0	2.5

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the Grand Mesa Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Gunnison Basin North

Watershed Condition Class

The effects on Watershed Condition Class in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Surface Waterbodies and Stream Health

The effects on stream health in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

New stream crossings would be built in 6 Gunnison Basin North watersheds (Table 93). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 2.3 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.9 miles in Coal Creek (140200010204). During road planning, the location of the WIZ would

be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 93. Alternative 3 New Crossings and Road in the WIZ in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200010111	Bear Creek-Spring Creek	1	0.56	0.57	242
140200020103	Carbon Creek	7	0.31	0.42	2140
140200010207	Cement Creek	-	-	-	1903
140200010204	Coal Creek	5	1.25	1.37	4732
140200010203	Middle East River	4	0.64	0.68	1679
140200020105	Middle Ohio Creek	2	0.27	0.32	419
140200020101	Upper Ohio Creek	-	-	-	38
140200030301	Upper Quartz Creek	2	0.78	0.80	553
140200010206	Washington Gulch-Slate River	-	-	-	361

Water Yield

The effects on water yield in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds in Alternative 3 would be below the 25 percent basal area removed threshold (Table 70). There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 94 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, nearly of the fens and wetlands are in or near hazard tree removal areas. Only one watershed (Beaver Creek 140200010112) has any fen or wetland in or near a priority treatment area. Fens and wetlands would be identified in the

Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 94. Fens and Wetlands in or near Alternative 3 Treatment Areas in Gunnison Basin North Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200010112	Beaver Creek	0	0	5.9	1.5
140200010204	Coal Creek	0	0	0	0
140200020705	Cow Creek-Soap Creek	2.3	0	0	0
140200030101	Headwaters Tomichi Creek	0	0	2.4	0
140200010108	Lottis Creek	0	0	2.1	0
140200010103	Middle Taylor River	0.7	0	0	0
140200010106	Outlet Willow Creek	0	0	8.9	0
140200010110	Rocky Brook-Spring Creek	0.1	0	0	0
140200010104	Texas Creek	48.9	0	0	0
140200010102	Trail Creek-Upper Taylor River	11.5	0	9.4	0
140200010201	Upper East River	0	0	0.3	0
140200010101	Upper Taylor River	20.1	0	5.8	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the Gunnison Basin North Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Gunnison Basin South

Watershed Condition Class

The extent of Alternative 3 treatments in Gunnison Basin South borderline watersheds would be less than 10 percent of their respective watershed areas and would not result in a change in watershed condition score or class.

Surface Waterbodies and Stream Health

The effects on stream health in the Gunnison Basin South Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the Gunnison Basin South Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

New stream crossings would be built in 4 Gunnison Basin South watersheds Table 95). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Three new crossings would be built in Willow Creek (140200020610), nearly doubling the stream crossing density. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 0.4 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.25 miles in Willow Creek. During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 95. Alternative 3 New Crossings and Road in the WIZ in Gunnison Basin South Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200030103	Marshall Creek	1	0.73	0.74	234
140200020504	Spring Creek	1	0.22	0.23	240
140200030507	West Pass Creek	1	1.42	1.42	237
140200020610	Willow Creek	3	0.89	1.55	1215

Water Yield

The effects on water yield in the Gunnison Basin South Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds in Alternative 3 would be below the 25 percent basal area removed threshold (Table 75). There

may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the Gunnison Basin South Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 96 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, most of the fens and wetlands are in or near hazard tree removal areas. Only one watershed (Marshall Creek 140200030103) has wetland areas in or near priority treatment areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 96. Fens and Wetlands in or near Alternative 3 Treatment Areas in Gunnison Basin South Watersheds.

		Fens		Wetlands	
HUC 12 Code	**HUC 12 Name**	**Hazard Tree (acres)**	**Priority Treatment Area[1] (acres)**	**Hazard Tree (acres)**	**Priority Treatment Area[1] (acres)**
140200030503	Archuleta Creek	0	0	23.6	0
140200020801	Headwaters Blue Creek	3.1	0	0	0
140200020602	Lake Sanc Cristobal-Lake Fork	24.4	0	0	0
140200020802	Little Blue Creek	4.7	0	0	0
140200030104	Long Branch Creek	0	0	16.2	0
140200030103	Marshall Creek	0	0	2.6	33.2
140200030502	Pauline Creek	8.9	0	20.1	0
140200030507	West Pass Creek	0.4	0	7	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the Gunnison Basin South Geographic Area in Alternative 3 would be the same as described for Alternative 2.

North Fork Valley

Watershed Condition Class

The effects on Watershed Condition Class in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Surface Waterbodies and Stream Health

The effects on stream health in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

New stream crossings would be built in 7 North Fork Valley watersheds (Table 97). In most watersheds, this would result in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 2.3 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.8 miles in Little Henderson Creek-East Muddy Creek (140200040204). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 97. Alternative 3 New Crossings and Road in the WIZ in North Fork Valley Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200040101	Cow Creek	3	0.23	0.27	1910
140200040404	Headwaters Hubbard Creek	7	0.64	0.75	2169
140200040102	Headwaters West Muddy Creek	5	0.38	0.42	1387
140200040204	Little Henderson Creek-East Muddy Creek	13	0.27	0.33	4065
140200021205	Middle Smith Fork	1	0.16	0.17	222
140200040405	Outlet Hubbard Creek	5	0.56	0.63	1061
140200040301	Ruby Anthracite Creek	2	0.34	0.35	1284

Water Yield

The effects on water yield in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds in Alternative 3 would be below the 25 percent basal area removed threshold (Table 80). There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 98 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, there are very few fens or wetlands in or near treatment areas. The only fen area is in Headwaters Leroux Creek near hazard tree removal areas. Most of the wetland areas in the other watersheds are near priority treatment areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 98. Fens and Wetlands in or near Alternative 3 Treatment Areas in North Fork Valley Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200021002	Curecanti Creek	0	0	0.3	2.1
140200040404	Headwaters Hubbard Creek	0	0	0	1.9
140200040505	Headwaters Leroux Creek	8.9	0	0	1.3
140200040103	Outlet West Muddy Creek	0	0	0	0.1
140200040402	Raven Gulch	0	0	0	1.6
140200040301	Ruby Anthracite Creek	0	0	0	6.8

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the North Fork Valley Geographic Area in Alternative 3 would be the same as described for Alternative 2.

San Juans

Watershed Condition Class

The effects on Watershed Condition Class in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Surface Waterbodies and Stream Health

The effects on stream health in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

Four new stream crossings would be built in Headwaters Little Cimarron River (Table 99), resulting in a slight increase in the number of crossings per miles of stream. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned

within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 0.3 miles of new road would be constructed within 100 feet of a waterbody in this watershed. During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 99. Alternative 3 New Crossings and Road in the WIZ in San Juans Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200020903	Headwaters Little Cimarron River	4	0.23	0.28	1506

Water Yield

The effects on water yield in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds in Alternative 3 would be below the 25 percent basal area removed threshold (Table 84). There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 100 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, there are more fens than wetlands and most are in or near hazard tree removal areas. Fens and wetlands would be identified in the Pretreatment checklist procedure. These areas would be protected from direct physical disturbance because they would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 100. Fens and Wetlands in or near Alternative 3 Treatment Areas in San Juans Watersheds.

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200060208	Beaver Creek-Dalles Creek	1.5	0	0	0
140300030108	Fall Creek	0	1.6	0	1.4
140300030302	Headwaters Beaver Creek	27.9	0	6	0
140200020903	Headwaters Little Cimarron River	11.5	0	8.7	0
140300030106	Headwaters San Miguel River	0	9.6	0	10.8
140200060201	Red Mountain Creek	3.8	0	0	0
140200020901	Silver Jack Reservoir-Cimarron River	11.2	0	0	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the San Juans Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Uncompahgre Plateau

Watershed Condition Class

The effects on Watershed Condition Class in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Surface Waterbodies and Stream Health

The effects on stream health in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Classified Uses and Impaired Streams

The effects on impaired streams in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Stream Connectivity

New stream crossings would be built in 5 Uncompahgre Plateau watersheds (Table 101). Three of these watersheds would only have one new crossing, which would result in a slight increase in the number of crossings per miles of stream. Seven new crossings would be constructed in

Headwaters Dry Creek and eleven in Upper Spring Creek, increasing the density by 30 and 80 percent respectively. Stream crossings are to be designed to sustain bankfull stream dimensions, pass normal flows, and allow for aquatic organism passage (WQSP-3A). In addition, all new stream crossings would be decommissioned within 5 years after harvest. Effects to aquatic organism passage should be minor and temporary. Approximately 1.2 miles of new road would be constructed within 100 feet of a waterbody. The most in any one watershed would be approximately 0.6 miles in Upper Spring Creek (140200060601). During road planning, the location of the WIZ would be identified and road location changed to avoid new construction within the WIZ to the extent practicable.

Table 101. Alternative 3 New Crossings and Road in the WIZ in Uncompahgre Plateau Watersheds.

HUC 12 Code	HUC 12 Watershed Name	New Road Crossings	Stream Crossings / Mile of Stream		New Roads within 100 ft (feet)
			Existing Roads	With New Roads	
140200060501	Headwaters Dry Creek	7	0.62	0.80	1570
140300030203	Lower Horsefly Creek	-	-	-	227
140300030202	Middle Horsefly Creek	1	0.61	0.62	492
140300030201	Upper Horsefly Creek	1	0.86	0.88	623
140200050201	Upper Roubideau Creek	1	0.08	0.08	222
140200060601	Upper Spring Creek	11	0.26	0.47	3446

Water Yield

The effects on water yield in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2. Commercial treatments in all of the watersheds except Upper Spring Creek (140200060601) in Alternative 3 would be below the 25 percent basal area removed threshold (Table 88). There may be some increase in water yield observable at the stand scale but it would not be measurable at the watershed scale. There would be less acres of commercial treatments in Upper Spring Creek in Alternative 3, but more than 25 percent of the watershed basal area would still be affected. Effects to water yield in this watershed would be the same as described for Alternative 2.

Municipal Supply Watersheds

The effects on municipal supply watersheds in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Fens and Wetlands

Table 102 lists the acres of fens and wetlands that intersect or are within 500 feet of an identified Alternative 3 treatment area. In this Geographic Area, there are very few fens or wetlands in or near priority treatment areas and these would be identified in the Pretreatment checklist procedure. Fens and wetlands would be protected from direct physical disturbance because these areas would be avoided during mechanical treatment operations and prescribed fire. There may be some minor increases in shallow groundwater and overland flow from vegetation changes upslope of the fens or wetlands, particularly near large openings created by salvage logging. There would likely be minor effects, if any, to fens or wetlands.

Table 102. Fens and Wetlands in or near Alternative 3 Treatment Areas in Uncompahgre Plateau Watersheds

HUC 12 Code	HUC 12 Name	Fens		Wetlands	
		Hazard Tree (acres)	Priority Treatment Area[1] (acres)	Hazard Tree (acres)	Priority Treatment Area[1] (acres)
140200050204	Cottonwood Creek	0	0	1.1	0
140200050304	East Fork Escalante Creek	1.9	0	0.6	0
140300030602	Headwaters Tabeguache Creek	0	0	0	9.1
140200060602	Middle Spring Creek	0	0	1.3	0

[1] Priority Treatment Area includes both Commercial and Noncommercial

Soils

The effects on soils in the Uncompahgre Plateau Geographic Area in Alternative 3 would be the same as described for Alternative 2.

Cumulative Effects Common to All Action Alternatives

Cumulative watershed effects occur when the impacts of the proposed project combine with impacts from past or existing disturbance and other future actions to change hydrologic and sediment discharges regimes in the watershed to the extent that adverse impacts to water quality and waterbodies occur.

To evaluate the potential for cumulative watershed effects from proposed SBEADMR activities, GIS data was used in a modified “Equivalent Roaded Acres” procedure to determine the amount of past and existing disturbance, SBEADMR treatments, and reasonably foreseeable future

actions in each watershed with significant SBEADMR treatments proposed.[5] The computed amount of disturbance was compared to the 25 percent threshold of disturbance specified in design feature WQSP-10 (Appendix B and Chapter 2, Decision-Making Triggers for Adaptive Implementation). In watersheds where the projected cumulative disturbance reaches the threshold, SBEADMR treatments would be adjusted to ensure that the threshold disturbance is not reached. Limiting the amount of overall disturbance in a watershed reduces the potential for measureable effects (USDA Forest Service 2006a, Eaglin 1993).

"Equivalent Roaded Acres"

The "Equivalent Roaded Acres" (ERA) procedure is a method for accounting disturbance in a watershed. If the amount of disturbance in a watershed exceeds an established threshold, the potential for cumulative effects to a watershed's structure, function, and processes from changes in hydrology and sediment regimes increases. The ERA model is used as a screening tool for identifying areas of particularly intense activity rather than to predict effects (Reid 1993).

The ERA model assumes that a road or similar ground disturbance that results in an impervious or compacted surface has the greatest impact on a watershed's function in terms of runoff and sediment generation. These areas are weighted with a factor of 1, that is, 1 acre of road disturbance counts as 1 ERA. Other types of disturbance in a watershed, such as timber harvest or fire, are given weights that reflect their relative impact on runoff and sediment compared to a road. Ground-based timber harvest activity is typically given a weighting or coefficient that ranges from 20 to 30 %, that is, the effects of 3 to 5 acres of a ground-based timber harvest would be the same as 1 acre of road. Ground-based skidding results in some amount of compacted and bare ground within the harvest unit, but the entire area is not affected and there is sufficient ground cover and undisturbed area within the unit to mitigate the more severely disturbed areas. Aerial-based timber harvest activity is typically given a weighting of 5 to 15 % because there is less ground-disturbance than in ground-based harvest systems.

Areas of past activity or disturbance in a watershed is compiled, appropriate weighting or coefficients are applied to calculate the ERA for those activities. ERA's for proposed actions and reasonably foreseeable future actions are similarly calculated. These values are added together to determine the ERA of the watershed. If the calculated watershed ERA approaches or exceeds the pre-determined threshold values, proposed activities are reviewed to determine if they should be modified or delayed so that the threshold is not exceeded (Reid 1993).

[5] Thirty-seven watersheds were not included in the cumulative watershed effects analysis because the only SBEADMR treatments proposed are a small amount of hazard tree removal. This level of activity would not result in cumulative effects in these watersheds. The excluded watersheds are listed in Appendix I.

SBEADMR ERA Analysis

The SBEADMR ERA analysis was conducted in two steps. The first screen used conservative weighting for vegetation disturbance, that is, treating all types of vegetation disturbance, be it 25 year-old mechanical timber harvest or recent prescribed fire treatments, the same. In addition, maximum SBEADMR disturbance was assumed to be all acres in the identified Priority Treatment Areas, hazard tree removal areas, and roads as proposed in Alternative 2. These two assumptions would overestimate total disturbance because not all types of vegetative disturbance create equal watershed effects and not all acres identified in Alternative 2 would be treated. In step two, watersheds in which the ERA calculated in step one was equal to or greater than 20 percent of the NFS watershed area were further analyzed using refined weighting coefficients.

To calculate the ERA for the GMUG watersheds, GIS data was used to compile past activity or disturbance in each watershed. "Infrastructure Disturbance" includes roads and other similar infrastructure. Each acre of this type of disturbance was weighted as 100 %, that is, each 1 acre of Infrastructure Disturbance equals 1 ERA. Past vegetative disturbance, including mechanical timber harvest, fuels treatments, prescribed fire, and wildfire, were weighted as 25 %, that is, 4 acres of vegetation disturbance equals 1 ERA[6]. Existing "Infrastructure Disturbance" and past vegetation disturbance together are the "Baseline Total" reflecting the effects of past activities.

For SBEADMR activities, proposed treatments in Alternative 2 were similarly weighted to calculate the ERA for these activities. New roads were weighted at 100%. Commercial and Noncommercial Priority Treatment Areas and Hazard Tree Removal areas were weighted at 25%. Care was taken to avoid "double-counting" disturbance. If a new SBEADMR road is proposed in an area that was included in past vegetation disturbance, the area of the road was weighted at 100% and removed from past vegetation disturbance. The sum of the calculated ERA for all SBEADMR treatments in each watershed is the "Additional Impact Total."

Reasonably foreseeable future activities on NFS lands in each watershed were identified and similarly weighted to calculate the ERA for these activities. This is the "Future Impact." The calculated ERA for the watershed is the sum of the "Baseline Total," "Additional Impact Total," and "Future Impact" values. This sum was then divided by the area of NFS lands in the watershed to determine the "% of NFS Lands Impacted." The results of these calculations are summarized in tables in Appendix I. Additional data used as the basis for these calculations are in the project file.

Watersheds in which the "% of NFS Lands Impacted" equaled or exceeded 20% were identified. These watersheds were then reanalyzed using refined weighting coefficients. In this second step, proposed SBEADMR noncommercial priority treatment areas were separated from the

[6] The weight of 25 percent for vegetation disturbance and for the percentage of NFS lands impacted threshold was chosen because measureable increases in water yield can result when 25 percent of a small watershed's basal area is removed (Watershed Conservation Practices Handbook).

commercial priority treatment areas and hazard tree removal areas. The noncommercial priority treatment areas were weighted at 10 %, that is 10 acres of noncommercial treatment equals 1 ERA. This refined weighting better reflects the actual effects of noncommercial treatments compared to commercial treatments. Noncommercial treatments (mechanical fuels treatments and prescribed fire) result in less ground disturbance, soil compaction, and exposed mineral soil areas than mechanical timber harvest activities. The commercial priority treatment areas, hazard tree areas, and roads were weighted as before. Reasonably foreseeable future fuels treatments were also weighted at 10%. The "Refined % of NFS Lands Impacted" was calculated as the sum of "Baseline Total", "Revisited Additional Impact Total", and "Future Impact" divided by the area of NFS lands in the watershed. The results of this second step calculations is summarized in a table in Appendix I.

Note: These calculations were only performed for Alternative 2 treatment areas as this represents the maximum possible disturbance for SBEADMR activities. Alternative 3 treatment areas are a subset of Alternative 2. Calculated ERA for Alternative 3 treatments would be less than that calculated for Alternative 2. If the calculated ERA for Alternative 2 is less than the 25 percent threshold, the Alternative 3 ERA will also be less than the threshold.

Results of the SBEADMR ERA Analysis

The results of the first screening step identified 9 watersheds in which the calculated "% of NFS lands impacted" equaled or exceeded 20%. These are listed below in Table 103. These watersheds were reanalyzed in step two using the refined weighting for noncommercial vegetative disturbance. The results of the refined analysis indicates that the "% of NFS lands impacted" would equal or exceed 20 % in only 1 watershed, Headwaters Dry Creek (140200060501) in the Uncompahgre Plateau Geographic area. Activities in this watershed will be closely tracked to ensure that the watershed disturbance threshold of 25 percent is not exceeded.

Table 103. Results of SBEADMR ERA Analysis

HUC 12 Code	HUC 12 Name	Step 1		Step 2	
		% of NFS lands impacted	>/=20%	Revisited: % of NFS lands impacted	>/=20%
Grand Mesa					
140100051308	Mesa Creek	**20%**	Yes	**10%**	No
Gunnison Basin North					
140200010112	Beaver Creek	**21%**	Yes	**14%**	No
140200030602	Cabin Creek	**22%**	Yes	**16%**	No
140200020107	Sheep Gulch-Gunnison River	**22%**	Yes	**15%**	No
140200030405	Wood Gulch-Tomichi Creek	**25%**	Yes	**11%**	No
Uncompahgre Plateau					
140200060501	Headwaters Dry Creek	**20%**	Yes	**20%**	Yes
140200060602	Middle Spring Creek	**22%**	Yes	**18%**	No
140300030201	Upper Horsefly Creek	**25%**	Yes	**13%**	No
140200060601	Upper Spring Creek	**20%**	Yes	**18%**	No

Alternative 2 and Alternative 3 Cumulative Watershed Effects Analysis Summary

An ERA model procedure was used as a screening tool to analyze cumulative watershed effects from SBEADMR activities. Thirty-seven watersheds were not included in the quantitative analysis because only a small area of hazard tree removal would occur in the SBEADMR project. This small amount of activity would not cause cumulative watershed effects in these watersheds.

In the remaining watersheds, ERA for past disturbance, maximum SBEADMR Alternative 2 disturbance, and reasonably foreseeable future disturbance was calculated and the "% of NFS lands impacted" was determined. This number was compared to the threshold of 25 percent watershed area threshold in design feature WQSP-10 to determine the potential for cumulative watershed effects. Only one watershed, Headwaters Dry Creek (140200060501) in the Uncompahgre Plateau Geographic area, was found to have a "% of NFS lands impacted" that equaled or exceeded 20 percent. This watershed would have the greatest potential for cumulative watershed effects; however, use of design features and other BMPs would reduce the potential for effects. SBEADMR activities in this watershed will be tracked to ensure the 25 percent threshold is not exceeded.

Cumulative watershed effects from Alternative 2 in the remaining watersheds are not likely to occur. The calculated "% of NFS lands impacted", which is an overestimate because not all of

the Alternative 2 proposed acres would be treated, is less than 20 percent. Cumulative watershed effects from Alternative 3 are also not likely to occur because Alternative 3 treatment areas are a subset of Alternative 2, so the calculated ERA and "% of NFS lands impacted" for each watershed would be less than that calculated for Alternative 2 and would also be under 20 percent.

Transportation

The Forest transportation system is essential for implementation of the proposed vegetation treatments. Road treatments are also proposed to implement the action alternatives.

Compliance with Direction

Action alternatives meet applicable law, regulation, and policy by maintaining the existing forest transportation system, using treatment design features to minimize effects and ensure compliance with direction during implementation, taking action to provide for user and worker safety, and adding minimum but necessary new access routes while not increasing public access. The treatment would follow all applicable federal and state laws, regulations and policies to the fullest extent that they are known, understood and interpreted by resource managers.

Federal laws guiding this project include the National Forest Roads and Trails Act of 1964, as amended (16 U.S.C. 532-538), the Highway Safety Act of 1966 (23 U.S.C. 402), National Trails System Act of October 2, 1968 (16 U.S.C. 1241-1249), Surface Transportation Assistance Act of 1978, as amended (23 U.S.C. 101a, 201-205), Annual Department of the Interior, Environment, and Related Agencies Appropriations Act, and the Organic Administration Act of 1897 (16 U.S.C. 551).

Federal regulations include:

- Travel Management (36 CFR Part 212, Subparts A, B, and C) – Establishes requirements for the administration of the forest transportation system, and identification of the minimum road system needed.[7]
- Prohibitions (36 CFR Part 261, Subpart A) – Establishes prohibitions on use of NFS lands, including prohibitions on possession and operation of motor vehicles on NFS roads, on NFS trails, and in areas on NFS lands.
- Sale and Disposal of National Forest System Timber (36 CFR Part 223) – regulates road construction related to Forest Service timber sale appraisals and contracts.

[7] Travel plans exist for each of the national forests within the GMUG. No permanent changes to allowed motor vehicle use are proposed under the SBEADMR Project.

Forestry Best Management Practices are provided by the Colorado State Forest Service.

Forest Service direction on travel management is found in Forest Service Manual (FSM) 7700, which addresses planning, construction, reconstruction, operation, and maintenance of forest transportation facilities and management of motor vehicle use on NFS lands. In addition, the following Forest Service Handbooks provide further guidance: FSH 7709.55, Travel Planning Handbook; FSH 7709.56, Road Preconstruction Handbook; FSH 7709.56b, Transportation Structures Handbook; FSH 7709.57, Road Construction Handbook; and, FSH 7709.59, Road System Operations and Maintenance Handbook. National and Regional Best Management Practices are applicable to this Project. Regional BMPs are included in the FS directives under FSH 2509.25.

Forest Plan direction associated with roads and pertinent to the SBEADMR project is identified below. This summary does not include directives applicable to unique Forest Plan management areas. Review and accordance with these individual management areas is required; see the Transportation System and Haul Routes Design Features (Table 104) below.

Pertinent 1983 and 1991 Amended Land and Resource Management Plan direction includes:

- Provide a safe, efficient and environmentally sound transportation system.
- Update existing facilities and structures to meet State and Federal standards.
- Closed or restricted roads may be used for and to accomplish administrative purposes when:
    a. Prescribed in management area direction statements;
    b. Authorized by the Forest Supervisor; and
    c. In case of emergency.
- Construct and reconstruct local roads to provide access for specific resource activities such as campground, trailheads, timber sales, range allotments, mineral leases, etc., with the minimum amount of earthwork.
- Construct temporary roads for specific resource activities such as timber sales, emergencies, (e g. fire suppression), or mineral exploration. Roads needed beyond the timber sale or minerals exploration activity shall be specified roads (i.e., not temporary).
- Temporary roads shall not be designated as Forest development transportation facilities and shall not be recorded in the transportation inventory system.
- All temporary roads shall be obliterated as defined by the Forest Plan Glossary. Ninety percent of the obliterated temporary road mileage will not have sustained use three years after obliteration.
    - Rehabilitation Standards for temporary roads · Return to resource production within one year from cessation of activities.
- Maintain all roads to the following minimum requirements:
    - All paved roads - Level 5·

  - All arterial and open collectors- Level 3,
  - All open local roads - Level 2, and
  - All closed roads - Level 1
    - Level 1 maintenance includes upkeep of drainage structures and vegetation cover necessary to prevent erosion.
- Maintain structures, bridges, cattleguards, etc., to be structurally sound and safe for use.

Table 104. Road Construction and Reconstruction Standards.

Standard	Travel Speeds	Lanes	Surface	Width	Drainage
Arterial	Avg. 35-55 mph	Generally 2	All weather, generally asphalt or gravel	Typically 20 to 24 feet, but some single lane with intervisible 10-foot turnouts	Permanent, not to impede traffic
Collector	Avg. 10-30 mph	Generally 1	Generally gravel or native surface, sometimes asphalt	Permanent not to impede traffic	Permanent, but may impede traffic
Local	Average less than 20 mph	Usually single lane except for developed recreation sites	Varies from asphalt to native surface, majority native surface	Typically 10 thru 14 Feet; Turnouts optional depending upon traffic management; usually not intervisible	Dips and culverts
Temporary	Less Than 10 mph	Single	Usually native	Typically 10 thru 14 feet; the minimum width is desired to minimize surface disturbance	Drain dips, low water crossings, culverts

Pertinent direction from the Southern Rockies Lynx Amendment (2008) is addressed in the wildlife section.

Analysis Methodology

Assumptions Specific to Transportation

- The Forest transportation system, as documented and inventoried by the Forest transportation atlas, is the primary data used to summarize this effects analysis. The transportation atlas includes both public and administrative routes. All distance figures are approximate values based on the Forest transportation atlas (including spatial GIS data and tabular INFRA data) and are limited to the accuracy of those sources which includes measurements from GIS, GPS, field instruments and aerial photography. Mileages may change slightly with additional field verification and treatment implementation.
- All road work and infrastructure improvements would be conducted in accordance with the Treatment Design Features.
- The spatial boundary and subject for analysis includes all National Forest System lands administered by the GMUG, as well as National Forest System roads and other public roads open to vehicle use.
- Effects are assessed based on a 15-year time frame, assuming all treatment actions associated with the transportation network would be completed by that time. In this report, “short-term” is considered less than this, while “long-term” is considered beyond this period. A 5-year window was added to the end of the 10-year vegetation implementation time frame to allow for post-vegetation treatment road work to be finalized.
- Transportation actions by alternative were developed using the following assumptions:
    - Over the life of this project, the Forest is capable of implementing 60,000 acres of commercial mechanical harvests, including roadside danger tree mitigation and public safety treatments. This acreage was assumed for all action alternatives.
    - Road construction and haul route mileage is based on a site-specific, office based GIS exercise. Once the priority treatment areas were defined and finalized, logging and transportation specialists determined existing and new road alignments to provide feasible access to mechanically treat these areas. Aerial photos assisted this planning effort, along with other GIS data including existing roads, contours, streams, and land ownership. While access roads were identified as best as possible in the office, it is expected that minor adjustments would be necessary during implementation.
    - Existing roads were used whenever possible.
    - It was also assumed that 1/3 of identified existing haul routes managed as NFS roads would require reconstruction, while the other 2/3 would only require maintenance.

- Effects to the identified haul routes, including the potential minor adjustments in the field, are addressed in this analysis.

Data Sources

The Forest transportation atlas includes roads and motorized trail information as contained in geographic information system (GIS) spatial data and Forest Service Infrastructure (INFRA) tabular data.

Transportation Indicators

Indicators used in the analysis of transportation effects include summaries of road work and associated impacts to the Forest transportation system. Key indicators include:

- Forest transportation system conditions
- Traffic
- Health and safety
- Qualitative effects summary based on a scale from beneficial to adverse

Affected Environment

The GMUG has a large and diverse road network. This system was developed over time in part to provide for access and utilization of NFS lands. Long established needs for access roads include mining, timber, range, and recreation.

Currently the GMUG manages over 3,600 miles of NFS roads. The majority of these, nearly 2,500 miles, are low-standard, single-purpose roads available for high clearance vehicles (operational maintenance level 2). A breakdown of NFS roads on the GMUG is presented below.

Table 105. GMUG-managed NFS Roads.

Operational Maintenance Level	Description	Count	Miles
1 – Basic Custodial Care (Closed)	Intermittent use road while placed in storage; closed to all mechanized travel but not decommissioned	322	309.6
2 – High Clearance Vehicles	High clearance vehicle use	1,895	2,471.4
3 – Suitable for Passenger Cars	Maintained for travel by prudent driver in standard passenger car	308	586.8
4 – Moderate Degree of User Comfort	Moderate degree of user comfort and convenience at moderate travel speeds	64	254.9
5 – High Degree of User Comfort	High degree of user comfort and convenience	44	13.7
**Operational maintenance levels 2-5 summarized here also include administrative use roads not open to public use*			

A number of other routes are included in the project area. Many of these are public roads managed and under jurisdictions other than the Forest Service. There are also additional roads under Forest Service jurisdiction that exist on the landscape, and not managed as part of the Forest transportation system. These include roads associated with some sort of authorized use (agreement, permit, right-of-way), as well as unauthorized routes. These unauthorized roads can be user-created or a remnant of past management activity.

Last of all, there are public roads managed by public road authorities that access potential treatments. This includes major US highways, Colorado DOT managed highways, county roads, and municipal roads. There are also roads managed by other federal agencies, including the Bureau of Land Management and the Bureau of Reclamation.

Roads of various jurisdictions within the project area have had increasing roadside danger trees (see Figure 11) over time, due to spruce beetle and aspen decline.

Figure 11. Dead and dying spruce along the Los Pinos to Cebolla NFS Road in the GMUG.

A widespread road network would be necessary to access and manage NFS lands to achieve the goals of the SBEADMR project. Specifically applicable to roads, mitigating high priority roadside danger trees is needed in order to provide a safe, efficient and environmentally sound transportation system. Management of existing and new roads in accordance with current direction is desired. This would support achievement of the SBEADMR project goals while also providing for efficient and sustainable road management.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

Alternative 1, the No Action Alternative, is used as a basis for comparing the effects of the Proposed Action and other alternatives. It assumes no implementation of any elements of the Proposed Action or the Action Alternatives. There would be no direct effects from Alternative 1 to the transportation system.

Under Alternative 1, indirect effects include dead and dying trees falling across roads, blocking access and reducing road user safety. This may reduce access and may limit the long-term ability to manage and maintain portions of the Forest transportation system within the project area. It could also result in a more dangerous, inaccessible, underutilized, and undermanaged network leading to adverse resource impacts including improperly functioning road drainage systems due to lack of maintenance.

Selecting alternative 1 would represent the loss of a tremendous opportunity for forest road management. Without the opportunity to utilize revenue from sales of salvaged timber, the Forest transportation system mileage would not receive maintenance and improvement treatments associated with implementation of the SBEADMR Project.

Alternative 1 – Cumulative Effects

Implementation of other approved projects would continue to occur and include uses associated with the Forest transportation system such as forest management activities including range management, minerals extraction, timber sales, vegetation treatments, permitted users and recreation and other uses by the public.

Annual road maintenance would continue to occur, with a priority placed on passenger car roads (maintenance level 3-5). However, a road maintenance backlog exists across the GMUG. The majority of maintenance level 2 roads would not be maintained, except in areas where ongoing and future authorized activities occur. Although vegetation management activities would proceed via other authorized decisions, the scope of these activities would be smaller, such that fewer roads would be maintained in the No Action compared to the action alternatives. Road deterioration would continue to occur through use. Due to increasing population and recreationists in the project vicinity, there is associated increased demand for public lands recreation; increased use of the Forest by the public would require continual evaluation of maintenance level of roads within the system and may prioritize maintenance needs for annual maintenance activities. The indirect effects of dead and dying trees falling across roads could result in the short-term blockage of access/egress and increased risks to immediate driver safety relative to the action alternatives.

Existing travel management decisions would continue to be implemented.

Activities Common to All Action Alternatives

Primarily the existing road network would be used to access the proposed treatments and also remove forest products, supplemented with designed and temporary road construction.

The management of treatment roads will be addressed through the use of design features, discussed below. All roads constructed under any action alternative would be decommissioned upon completion of the project.

Road Work Descriptions

Maintenance

Roads being used for treatments that are in functional condition would be maintained during treatment implementation. Maintenance preserves the function of the road but generally does not include improvements. Maintenance activities generally include: blading; roadside brushing; removal of individual roadside hazard trees outside treatment units; repair and/or replacement of road surfaces; cleaning, repair, or installation of drainage structures such as culverts, ditches, and dips; dust abatement; snow plowing; removal and installation of closure barriers, and installation or repair of signs. Maintenance activities generally do not disturb ground outside the existing roadway (toe of fill to top of cut) other than removal of material around culvert inlets and cleaning of outlet ditches.

It is assumed that a majority of higher standard system roads (operational maintenance levels 3-5) used for treatment access and forest product removal would receive maintenance. A majority of these high standard roads are under maintenance agreements with counties; coordination will be needed with these agencies.

Frequent haul will wear out surface rock, eventually requiring surface replacement work to occur. A common rule of thumb is that gravel wears at the rate of 1 inch for every 10 million board feet (approximately 22,000 CCF) hauled. For road maintenance activities, user safety, drainage, and structural integrity of the road are the priority objectives.

Reconstruction

Reconstruction generally includes work to improve and restore roads, or to bring them back up to the original design standard. Improvements would provide for serviceability for treatment haul vehicles, as well as for proper hydrologic function and stream protection in accordance with applicable Best Management Practices. Actions can include surface improvement; construction of drainage dips, culverts, riprap fills or other drainage or stabilization features with potential ground disturbance outside the established roadway (toe of fill to top of cut); realignment; and widening of curves as needed for passage of log trucks, chip vans, and other critical vehicles. Reconstruction also includes the actions included in the Maintenance category. Reconstruction also includes the replacement of unsustainable existing roads with new, designed roads.

It is estimated that a majority of lower standard system roads (operational maintenance levels 1-2) used for treatment access and forest product removal would receive reconstruction. Arterial and collector roads accessing vegetation treatments would be prioritized for reconstruction.

Road Construction & Decommissioning

New road construction alignments to access priority treatment areas have been developed. For the Final EIS, the GMUG developed a proposed road system using the following criteria:

- Skid distances from PTAs were greater than ¼ mile to an existing road

Expected actions for road construction include vegetation clearing, excavation and/or embankment, blading and shaping, out-sloping, drainage dips, and water-spreading ditches, and may include importing of armoring and surfacing rock material as needed. More embankment and drainage structures would be utilized when there are adjacent resource concerns (perennial and intermittent stream crossings, high soil erosion hazard, steeper side slopes, etc.). Note that because all new roads in the action alternatives would be decommissioned within 5 years of the closure of the associated SBEADMR timber sale, all road construction analyzed in SBEADMR is temporary.

When an existing system road is having an unacceptable resource impact (e.g. located within an active floodplain), the road may be re-located to a less impactful location. In such cases, the new designed road would be retained as it is part of the Forest transportation system.

All roads constructed for SBEAMDR would be decommissioned within 5 years of the associated timber sale.

Decommissioning involves a combination of the following: removing bridges and culverts, eliminating ditches, out-sloping the roadbed, contouring to re-establish the natural undisturbed slope, scarifying of the road surface to reduce compaction, removing ruts and berms, effectively blocking the road to normal vehicular traffic where feasible under existing terrain conditions, and building cross ditches and water bars. When bridges and culverts are removed, associated fills shall also be removed to the extent necessary to permit normal maximum flow of water and reconstruction of the floodplain and stream channel as needed. Seeding is also a Forest standard for rehabilitation of disturbed areas.

Stored Roads

There are existing operational maintenance level 1 roads (currently closed and stored) that are listed for reconstruction or maintenance treatments in SBEADMR. By definition, these roads are expected to be used intermittently when needed for treatment activity access, but kept closed for periods of years between uses. When assigned under the action alternatives, these routes would be opened and receive the appropriate maintenance or reconstruction treatment as described above. In addition, these roads would remain in the Forest transportation system but would be physically closed to all motor vehicle travel following the treatment activity.

Closure would be implemented by using physical, native material barriers. Beyond the closure, the integrity of ML1 roads would be preserved to the extent practicable, implementing measures

as necessary to reduce sediment delivery from the road surface and fills and reduce the risk of crossing failure and stream diversion – making it hydrologically neutral. An example of this would be removal of culverts.

While closed to all motor vehicle traffic, system roads are categorized as being in Maintenance Level 1. Roads closed to only *public* motor vehicle use, but which receive Forest Service administrative traffic, are constant service roads and are thus not level 1.

Right-of-way Acquisition

Some roads under private jurisdiction may provide more efficient access to the project and/or minimize need for new ground-disturbing roadwork. These roads would require a Forest Service right-of-way or access agreement to allow for access and haul of forest products. Where appropriate, public easements would be pursued, at a minimum administrative access would be needed for project use. If the Forest Service were to pursue such rights-of-way or access agreements, such would be accomplished via separate NEPA processes.

Use and Encroachment of Other Public Roads

Public roads not managed by the Forest Service, including county and State managed roads, will be needed in order to access vegetation treatments. In addition, treatments would occur along and adjacent to public roads managed by other jurisdictions. Use of existing National Forest System access roads and intersections that connect to these public routes is preferred. Where SBEADMR implementation efforts could potentially interfere with traffic or operations of these public roads, coordination with the applicable agency is necessary. This includes construction of new intersections and access aprons that would tie into existing public roads. Coordination should address signing and traffic control, permitting, alignment, and construction standards necessary for new aprons and intersections, at a minimum.

Other Infrastructure

Available water and rock material sources within and adjacent to the project area would be utilized to support project road work. Roads providing access to and from these sites would also be maintained, and reconstructed when applicable. Water will generally come from sources off-Forest as supplied by the contractor. Existing and future[8] sources on NFS lands, including Los Pinos, Sage Park, Burro Park; and Mill Creek rock pits, would likely be utilized. Existing Forest Service pits would be used where economically feasible, otherwise rock would come from commercial sources off-forest.

[8] Any new quarries would be planned, managed and implemented under a separate NEPA process.

Design Features

The following Transportation System and Haul Routes (TSHR) treatment design features apply to roads under all action alternatives (Table 106). Use of the design features for all action alternatives is assumed in this effects analysis.

Sufficient design features are applied such that the action alternatives are consistent and compliant with applicable transportation direction.

There are several other design features that apply to roads to help mitigate effects to other resources; those features are documented and discussed in the associated resource sections and in Appendix B.

Table 106. Transportation System Design Features.

Design Feature	Trigger for use	Description	Effect
TSHR-1	All mechanical treatments	Existing roads will be used for equipment access to the extent road location and condition permit reasonable access. Existing roads will be restored to the appropriate condition prior to use. Priority must be given to maintenance and reconstruction of the existing transportation system to ensure and continue its integrity.	Minimize impacts to NFS lands by using existing roads.
TSHR-2	New road construction	New Access Roads: Where terrain, road length, and other resource risks exist, a "Designed Road" shall be utilized for Project access. Designed Roads would be surveyed, designed, and administered by the Forest Service engineering department. Designed Roads may become National Forest System roads if needed for long-term access and utilization, or may be subsequently decommissioned if only needed for temporary project access. The District Ranger shall be responsible for determining whether a designed road is to be added to the Forest transportation system. Temporary roads may be used where a designed road is not needed, as determined by the Forest Service. The location and clearing widths of all Temporary Roads or facilities shall be agreed to in writing (between the Forest Service and the contractor) before construction is started. Following use for harvest and project implementation, temporary roads will be decommissioned, which involves recontouring where significant sideslope exists, elimination of ditches and other structures, outsloping the roadbed, removal of ruts and berms, effectively blocking the road to normal vehicular traffic where feasible, and construction of drainage features such as cross ditches and water bars. Invasive species monitoring will occur after road decommissioning and will be followed by weed treatments where needed.	Improved access to vegetation treatments in appropriate locations.

Design Feature	Trigger for use	Description	Effect
TSHR-3	All commercial treatments	Require commercial haulers to perform maintenance commensurate with their use; depositing sufficient funds with the Forest Service may be used in lieu of performance. Surface rock replacement deposits will be collected to maintain currently surfaced roads that are used for timber hauling. Deposits will be collected commensurate with the use. Quarry materials will be collected from a site that has been found to be free of invasive plants and would meet quality and gradation requirements.	Protection of existing infrastructure.
TSHR-4	Wet conditions	Timber hauling operations will be restricted during wet or thawed conditions, when needed to protect the road surface. Professional judgment is required to assess whether a full highway legal load (85,000 lbs.) can reasonably manage the conditions without causing damage.	Avoiding unacceptable rutting of the surface and deformation of the subgrade.
TSHR-5	All operations	Safety signing will be used to alert the public that logging operations are in progress and shall meet the requirements of the Manual of Uniform Traffic Control Devices (MUTCD). If use or locations justify, active traffic control would be utilized.	Compliance with requirements on public roads; safer work sites for workers, administration, and public traffic.
TSHR-7	All operations	Use suitable road surface stabilization practices and dust abatement supplements on roads with high or heavy traffic use (See FSH 7709.56 and FSH 7709.59).	Protection of existing infrastructure. Better visibility and safer use of project roads.
TSHR-8	Snowy conditions	Move snow in a manner that will avoid or minimize disturbance of or damage to road surfaces and drainage structures. Use existing standard contract language (C5.316# or similar) for snow removal during winter logging operations to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources. Where heavy winter recreational use occurs and conditions allow, utilize bypass routes to separate recreational and project-related traffic.	Protection of road surfaces and mitigation of adverse effects to natural resources. Safer use for public and worker and administrative traffic.

Design Feature	Trigger for use	Description	Effect
TSHR-9	Water conservation	Use the following measures to conserve water when managing roads for SBEADMR: • Locate new roads with consideration of key topographic factors important to road maintenance, including steepness of slope, position on slope, aspect and drainage pattern. • When possible, schedule road maintenance activities to coincide with higher moisture content for ease of grading and better compaction. • Minimize new road widths to provide for safe use while limiting impermeable surfaces. • Keep ditches open, but do not remove vegetation that does not impede drainage. Vegetation holds the soil in place and reduces sediment loading which is the greater problem. • When installing drainage features, return intercepted runoff to its natural path at the first opportunity. • To avoid clogging, keep the grade of drainage features as steep or steeper than the roadway. • In general, avoid stream crossings. Where necessary, align the roadway to fit the stream. Avoid road capture of the channel, which can result in the stream diverting down the road – causing severe erosion. Do not constrict and accelerate flows, which can erode the channel.	Reduced erosion and sedimentation; prolonging road investments; water conservation.

Effects Common to All Action Alternatives

The following effects are anticipated to occur. Use of SBEADMR design features will minimize adverse effects related to the transportation system.

Temporary Road Closures for Worker and Public Safety

During road work activities as well as implementation of the proposed project vegetation treatments, temporary road closures would be utilized to provide for public and worker safety, as well as more efficient traffic flow. Use of transportation System and Haul Route (TSHR) design feature TSHR-5 would minimize adverse effects to safety from traffic.

Dust

It is anticipated that road work and use of roads to implement the proposed vegetation treatments would temporarily increase dust and airborne particulate matter emissions. Use of transportation System and Haul Route (TSHR) design feature TSHR-7 would minimize adverse effects due to dust.

Vegetation Clearing

Work on existing roads would remove and reduce vegetation interfering with the operation of the existing roadways. In addition, temporary and designed road construction would result in vegetation clearing to accommodate a single-lane road template. These activities are generally beneficial with regards to managing the roadway for vehicle passage and sight distance. Skid trails which will connect to transportation system will also result in vegetation removal.

Soil Compaction

Work on existing roads would minimally increase soil compaction, intentionally to ensure the roadway is prepared to safely and efficiently accommodate users including log trucks. Temporary and designed roads would intentionally have soils compacted to provide a functional roadway for project implementation. Temporary roads and designed roads would be decommissioned, reducing the compaction. Maintenance activities not specified as part of treatment such as hazard tree removal adjacent to roadways may also increase soil compaction. Skid trails which will connect to transportation system would also result in soil compaction.

Traffic

During treatment implementation, traffic would increase due to movement of equipment, forest products, and personnel in and out of the project area. Main collector and arterial forest roads would receive the majority of traffic. All haul routes would have surface deterioration proportionate to the traffic volume. Surface rock replacement funds would be collected and applied accordingly. Design features would be employed to avoid unacceptable rutting of the surface and deformation of the subgrade.

Access

Following implementation, the combination of road maintenance to existing roads, improvements to the existing roads, and removal of roadside hazards would provide for improved short-term public and administrative access throughout the treated area; such improvements may persist after the duration of the SBEADMR implementation timeframe. In addition, the roadwork applied during implementation would leave the system in a more stable and functional condition, minimizing adverse resource impacts including erosion and sedimentation.

No long-term changes to allowed public motor vehicle use are proposed under any alternative; previously designated routes documented on the motor vehicle use maps (MVUM) would remain open following project implementation.

Winter logging would likely occur, and snow plowing in accordance with design features would allow for safe project access, product haul, and resource protection.

In summary, the action alternatives may have positive effects on the Forest transportation system. Benefits include: rerouting unsustainable existing roads, bringing the maintenance level closer to the desired condition on roads used for treatments, improving roads used for project treatments through maintenance or reconstruction to minimize adverse resource impacts to other resources, and sustaining safe public and administrative access throughout the project area.

Alternative 2 (Agency Preferred Alternative) – Direct and Indirect Effects

Approximately 4,000-6,000 acres of commercial harvest treatments would be implemented annually or a total 40,000-60,000 acres over the 8-12 year implementation timeframe of the project. In order to access proposed treatments and remove forest products, Alternative 2 includes the following maximum roadwork. This is based on accessing the entire priority treatment area identified for commercial opportunity (almost 113,000 acres). This is therefore considered a maximum mileage that could be managed under SBEADMR. This roadwork is in accordance with the detailed descriptions for each activity as provided above.

Table 107. Maximum Alternative 2 Road Treatments.

Roadwork Activity	Miles
Road Construction	178
Road Reconstruction	538
Reconstruct existing system roads	*356*
Reconstruct existing non-system roads	*182*
Road Decommissioning[1]	360
Road Maintenance	714
[1] In addition to all newly constructed roads, unauthorized (non-system) roads used for hauling would also be decommissioned after vegetation treatments are complete.	

Alternative 3 (WUI Focus) – Direct Effects

Alternative 3 shifts the geographic extent of treatments such that treatments would be limited to the targeted vegetation types within the WUI and to road corridors and additional identified infrastructure extending beyond the WUI. In order to access proposed commercial treatments and remove forest products, Alternative 3 includes the following roadwork. This is based on an

Alternative 3 commercial priority treatment area of nearly 46,000 acres. Note that because *all* commercial PTA acres identified in Alternative 3 would be implemented, the road miles identified for Alternative 3 represent the total anticipated miles. This roadwork is in accordance with the detailed descriptions for each activity as provided above.

Table 108. Alternative 3 Road Treatments.

Roadwork Activity	Miles
Road Construction	80
Road Reconstruction	336
Reconstruct existing system roads	*248*
Reconstruct existing non-system roads	*88*
Road Decommissioning[1]	168
Road Maintenance	497
[1] In addition to all newly constructed roads, unauthorized roads used for haul would also be decommissioned after vegetation treatments are complete.	

Comparison of Alternatives

Table 109 compares miles of maximum potential road work (construction, decommissioning and maintenance) among the action alternatives. Alternative 2 involves more priority treatment area for commercial treatments, so the associated maximum road management mileages are higher. Alternative 3 priority treatment areas are a subset of those identified in Alternative 2, so the roads mileages are also lower. Note that because *all* commercial PTA acres identified in Alternative 3 would be implemented, the road miles identified for Alternative 3 represent the total anticipated miles.

Table 109. Comparison of Alternatives

Road Work Category	Alt 1	Alt 2	Alt 3
Road Construction	**0**	178	80
Road Reconstruction	**0**	538	336
Road Decommissioning	**0**	360	168
Road Maintenance	**0**	714	497

Cumulative Effects Common to All Action Alternatives

Relative to the No Action Alternative, more roads would be managed, maintained, and improved under the action alternatives. A short-term reduction in public access would occur in order to minimize user conflicts during individual treatment implementation. Following implementation of the action alternatives and other projects involving road maintenance, a better-maintained road system would exist. The road management would provide improved long-term public and administrative access throughout the GMUG, due to the improved road conditions. There would also be a decrease in existing unauthorized road mileage under the action alternatives, due to the associated proposed decommissioning actions.

Air Quality

Changes Between Draft and Final EIS

Major changes in the air quality analysis from the DEIS to the FEIS mostly concern the designation of Geographic Areas, establishing Priority Treatment Areas, and finer resolution in estimating proposed treatment vegetation types, acres and distribution, (Table 110). Slash pile sizes and numbers allowed per acre are modified to improve compliance with Design Feature SP-4, in order to minimize impacts to soils and erosion.

Table 110. Changes between DEIS and FEIS.

Effects Topic	DEIS	FEIS
Geographic Areas	None	Grand Mesa Gunnison Basin North Gunnison Basin South Nork Fork Valley San Juans Uncompahgre Plateau
Estimated ccf Commercial Harvest	Alternative 2 (Proposed Action – 990,000 ccf Alternative 3 (WUI) – 1,100,000 ccf Alternative 4 (Spruce Salvage) - 1,200,000 ccf	Alternative 2 (Proposed Action) – 840,000 ccf Alternative 3 (WUI) – 810,000 ccf
Salvage/Resiliency Treatments Distribution	We assume one-half of all treatments would occur in the Gunnison Basin and one-half would occur outside the Gunnison Basin on the Grand Mesa and Uncompahgre Plateau, and that ninety percent of commercial recovery and resiliency treatments would occur in spruce and ten percent in aspen.	In the Gunnison basin treatments for salvage/resiliency will be closer to 50/50 and outside the Gunnison basin treatments are estimated to be 70% resiliency and 30% salvage.
Slash Pile Sizes	Medium Size Machine Pile – 10-20 feet high, 400-900 square feet foot print Small Hand Pile – 6-10 feet high, 100-400 square feet foot print	Machine Pile – half ellipsoid 11’ wide, 10’ high, 30’ wide, 1,037 square feet foot print Hand Pile – paraboloid 10’ wide, 6’ high, 79 square feet foot print
Number of Slash Piles Per Acre	Alternative 2: Commercial Spruce Recovery Medium Size Machine Pile, 5/acre, 117,000-175,000 total piles Commercial Spruce Resiliency Medium Size Machine Pile, 1.67/acre, 21,042-37,800 total piles Non-Commercial Mechanical Hand Treatments, Small Hand Piles, 7-20/acre, 70,000-200,000 total piles Alternative 3: Direct and indirect effects would be very similar to or the same as Alternative 2 except that all prescribed burning would occur in the WUI and/or in road corridors. Alternative 4:	Alternative 2: Commercial Proposed/Current Treatment Types Spruce Recovery Salvage, Machine Pile, .5-2/acre, 12,000-48,000 total piles Commercial Proposed/Current Treatment Types Spruce Resiliency Machine Pile, 1.67/acre, 18,036 total piles Commercial Adapted/Potential Future Treatment Type Spruce Recovery Machine Pile, .5-2 piles/acre, 18,000-72,000 total piles Non-Commercial Mechanical, Hand Treatments, 15-27 piles/acre, 35,000-100,0000 total piles Alternative 3: Commercial Proposed/Current Treatment Types Spruce Recovery

Effects Topic	DEIS	FEIS
	Commercial Spruce Recovery Medium Size Machine Pile, 5/acre, 180,000-270,000 total piles Non-Commercial Mechanical Hand Treatments, Small Hand Piles, 7-20/acre, 70,000-200,000 total piles	Salvage, Machine Pile, .5-2/acre, 10,500-42,000 total piles Commercial Proposed/Current Treatment Types Spruce Resiliency Machine Pile, 1.67/acre, 10,900 total piles Commercial Adapted/Potential Future Treatment Type Spruce Recovery Machine Pile, .5-2 piles/acre, 19,500-78,000 total piles Non-Commercial Mechanical, Hand Treatments, 15-27 piles/acre, 112,500-202,500 total piles
Total Number of Slash Piles	Alternatives 2 and 3: Medium Size Machine – 138,043-212,800 Small Hand – 70,000-200,000 Alternative 4: Medium Size Machine – 180,000-270,000 Small Hand – 70,000-200,000	Alternative 2: Machine Pile – 48,036-138,036 Hand – 35,000-100,000 Alternative 3: Machine Pile – 40,900-130,900 Hand – 112,500-202,500
Aspen Broadcast Burning	Alternative 2 – 20,000-50,000 acres Alternative 3 (WUI) – 20,000-50,000 acres Alternative 4 (Spruce Salvage) – 20,000-50,000 acres	Alternative 2 – 25,000 acres Alternative 3 – 25,000 acres
Combined Treatments Incidental Vegetation Types	None	Alternative 2 – 6,478 acres Alternative 3 – 4,669 acres
CO2 Equivalents Global Warming Potential (GWP)	GWP of methane (CH4) was estimated to be about 21 times greater than carbon dioxide (CO2), so its carbon dioxide equivalent (CO2e) is 21. The carbon dioxide equivalent (CO2e) of nitrous oxide (N2O) is 310 (Environmental Protection Agency 2005).	GWP of methane (CH4) is estimated to be about 28-36 times greater than carbon dioxide (CO2), so its carbon dioxide equivalent (CO2e) is 28-36. The carbon dioxide equivalent (CO2e) of nitrous oxide (N2O) is 298 (Environmental Protection Agency 2015a).
Green House Gas Global Warming Potential	GWP values were not used to multiply CH4/C03e emissions estimate in Alternative 2, 3 and 4 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources.	GWP values are used to multiply CH4/C03e emissions estimate in Alternative 2 and 3 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources.
Cumulative Effects	Generalized actions at the GMUG forest level.	Shows present and planned projects at the Geographic Area level.

Compliance with Regulatory Direction

Federal Laws and Regulations

Under the Clean Air Act (CAA) the Environmental Protection Agency (EPA) sets limits on certain air pollutants and establishes a regulatory framework for states to follow to protect air quality. Federal land management agencies must comply with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD), and Air Quality Related Values (AQRVs). AQRV's are a scenic, cultural, physical, biological, ecological, or recreational resource on federal lands which may be affected by a change in air quality as defined by the Federal Land Manager (FLM). The Forest Service and other federal agencies have established air quality monitoring programs to study the condition of AQRVs in Class I and Class II air quality areas.

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (Environmental Protection Agency 2011).

The Prevention of Significant Deterioration (PSD) Program is a Clean Air Act requirement that sets emission limitations for major new or modified sources of air pollution such as coal fired electrical power generation plants, and sets limits to an increase of pollutants in Class I and Class II areas.

EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These include carbon Monoxide (CO), lead, nitrogen dioxide (NO2), ozone (O3), particle pollution (PM, PM10, PM2.5), and sulfur dioxide (SO2).

An <u>exceedance</u> of a NAAQS is defined in 40 CFR § 50.1(I) as …one occurrence of a measured or modeled concentration that exceeds the specified concentration level of such standard for the averaging period specified by the standard. A <u>violation</u> of the NAAQS consists of one or more exceedances of a NAAQS. The precise number of exceedances necessary to cause a violation depend on the form of the standard and other factors, including quality of the data, defined in federal rules such as 40 CFR § 50 (CAQDR 2013)

Climate Change – Greenhouse Gasses and Carbon Sequestration

Currently there are no national or state legal requirements concerning the analysis of or compliance with any GHG emissions or sequestration regulations for projects such as

SBEADMR. On 16 January 2009, the Washington Office of the USDA Forest Service released guidance to Forest Service units regarding the incorporation of climate change science into project level EPA documents (Climate Change Considerations in Project Level NEPA Analysis, January 13, 2009 - USDA 2009a).

This guidance document provides that units should consider two kinds of climate change effects at the project level. First, units may, where appropriate, consider the effect of a project on climate change. Second, units may, where appropriate, consider the effect of climate change on a proposal. (See, Harper v. Tidwell, U.S. District Court for the District of Montana, October 30, 2008.) The effects of climate change to GMUG forest ecosystems are described in detail in Chapter 1. This air quality analysis discloses a range of potential NAAQS criteria pollutants and GHG emissions the SBEADMR project could produce and compares those amounts to relevant emissions inventories at state and national levels.

On December 18, 2014, CEQ released revised draft guidance for public comment that describes how Federal departments and agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews. The revised draft guidance supersedes the draft greenhouse gas and climate change guidance released by CEQ in February 2010. This guidance explains that agencies should consider both the potential effects of a proposed action on climate change, as indicated by its estimated greenhouse gas emissions, and the implications of climate change for the environmental effects of a proposed action. The guidance also emphasizes that agency analyses should be commensurate with projected greenhouse gas emissions and climate impacts, and should employ appropriate quantitative or qualitative analytical methods to ensure useful information is available to inform the public and the decision-making process in distinguishing between alternatives and mitigations. It recommends that agencies consider 25,000 metric Tons of carbon dioxide equivalent emissions on an annual basis as a reference point below which a quantitative analysis of greenhouse gas is not recommended unless it is easily accomplished based on available tools and data. Unlike the 2010 draft guidance, the revised draft guidance applies to all proposed Federal agency actions, including land and resource management actions. It reflects CEQ's consideration of comments received on the 2010 draft guidance in addition to other Federal agency and affected stakeholder input. It does not create new or additional regulatory requirements. It instructs agencies on how to address the greenhouse gas emissions from and the effects of climate change on their proposed actions within the existing NEPA regulatory framework. CEQ extended the public comment period on the revised draft guidance for an additional 30 days and the comment period closed on March 25, 2015.

Colorado State Executive Order D00408, Reducing Greenhouse Gas Emissions in Colorado, was signed by Governor Bill Ritter in 2008 and declares the state's greenhouse gas reduction goals, directing the Colorado Department of Public Health and Environment (CDPHE) to develop regulations mandating the reporting of greenhouse gas emissions for major emitters, requesting

the Public Utilities Commission to require utilities to submit electric resource plans for meeting greenhouse gas reduction goals, and directing CDPHE to propose, after a full vetting process and within 24 months, regulations requiring reduced greenhouse gas emissions from passenger motor vehicles. The Executive Order does not apply to the SBEADMR project.

Colorado incorporated the EPA's Tailoring Rule revisions into Air Quality Control Commission (CDPHE) Regulation No. 3 on October 21, 2010. Effective January 2, 2011, GHG became subject to regulation for prevention of significant deterioration (PSD) from stationary sources. Beginning July 1, 2011, any stationary source with the potential to emit greater than 100,000 Tons per year (tpy) CO2e may be required to obtain a Title V operating permit and/or a PSD preconstruction permit. Prescribed burning is an area source, not stationary, and is exempt from the rule.

In order to conduct prescribed burning operations the GMUG is required by state law to obtain and follow the stipulations in Planned Ignition Fire Permits. The agency must show whether the applicant evaluated the use of non-burning fuel treatments in place of the proposed burn in order to reduce smoke emissions and in doing so would reduce GHG as well. (CADPHE, CAQCC, Regulation 9.V.D.2.)

Regional Haze Rule

Regional haze is a term used to describe the white or brown haze that obstructs vistas. It is caused by fine particles in the air including sulfates, carbon, soils and nitrates. Air pollutants contributing to regional haze can be both locally derived and carried into an area by the wind hundreds and even thousands of miles from a pollutant source. More than half the regional haze in Colorado comes from sources outside of the state (CDPHE 2012a).

The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in impaired mandatory Class I areas. Mandatory Class I areas include National Parks and Wilderness areas that were congressionally designated under the Clean Air Act for stringent protection of their pristine air quality (40 CFR PART 81), Areas not designated as Class I are Class II. In January, 2011, the Colorado Air Quality Control Commission approved the State's Regional Haze State Implementation Plan which sets a Reasonable Progress Goal for each Class I area to protect the best days and to improve visibility on the worst days during the time period between 2007-2018 (CDPHE 2011).

Three Wilderness areas within NFS lands on the GMUG (West Elk Wilderness, La Garita Wilderness, and the Maroon Bells-Snowmass Wilderness) are all managed as Class I airsheds with the highest standards for air quality. The Black Canyon of the Gunnison National Park adjacent to the GMUG near Montrose, Colorado, is also managed as a Class I airshed. The remaining airsheds of the GMUG are managed as Class II areas.

In the Maroon Bells-Snowmass, La Garita, and West Elk Wilderness areas, regional haze has reduced visibility by 3.07 deciviews from natural conditions (i.e. without human caused air pollution) during the analysis period from 2000 to 2004 (CDPHE 2007).

While federal land managers are tasked under the Clean Air Act with the affirmative responsibility to protect the AQRVs, including visibility of these Class I areas, the permitting authority lies with the State of Colorado and EPA.

State Laws and Regulations

The Colorado Department of Public Health and Environment, Air Pollution Control Division (CDPHE), oversees the development and adoption of the State's air quality regulation program. The commission can set its own Ambient Air Quality Standards that are equally or more stringent than the Federal air quality standards. The CDPHE implements the air management programs adopted by the commission and enforces compliance with the NAAQS, PSD increments, and regulates smoke emissions from prescribed burning in accordance with Colorado State Regulation 9 (Open Burning, Prescribed Fire, and Permitting – CDPHE 2015c).

In order to protect human health and safety prescribed burning operations are required by state law to obtain and follow the stipulations in Planned Ignition Fire Permits. Fire managers are required to burn only when authorized by the CDPHE and must meet numerous smoke permit requirements including estimates of smoke production, mitigation measures, notification of the public and CDPHE, ignition timing, ventilation objectives (mixing heights and transport winds), smoke contingency planning and implementation of best management practices. Burning may not occur when an ozone alert is in effect for the area of the burn (Colorado Air Pollution Control Division, Prescribed Fire Smoke Permits, Use of Ozone Alert Information Memorandum, 8/5/10).

Forest Service Direction

Forest Service direction guiding this project includes Forest Service Manual 2500, (Watershed and Air Management, Chapter 2580 - Air Resource Management), The Forest and Rangeland Renewable Resource Planning Act of 1974, and The GMUG Land and Resource Management Plan (Forest Plan). The Forest and Rangeland Renewable Resource Planning Act, as amended by the National Forest Management Act (16 U.S.C. 1602), directs the Secretary of Agriculture to protect and, where appropriate, improve the quality of soil, water, and air resources. In addition, the Clean Air Act, as amended (42 U.S.C. 7401 et seq.), significantly broadened the authority and responsibility of the Forest Service. The objectives of air resource management are:

1. Protect air quality related values within class I areas, as described in 42 U.S.C. 7475(d)(2)(B) and (C) and section 2580.5.

2. Control and minimize air pollutant impacts from land management activities.
3. Cooperate with air regulatory authorities to prevent significant adverse effects of air pollutants and atmospheric deposition on forest and rangelands.

The 2007 GMUG Land and Resource Management Plan Forest Plan Amendment (LRMP 2007) establishes policy regarding fire and fuels management, the use of natural fires to meet resource management objectives, air quality and the prevention of significant deterioration. Management goals focus on the protection of pristine air quality in congressionally designated Class I Wilderness areas. The Plan's Standards and Guidelines also address Class I air quality protection as well as compliance with state and federal air quality standards (LRMP 2007).

Smoke production and air quality issues centers around four different aspects (LRMP 2007):

- First is the degradation of visibility on the Grand Mesa, Uncompahgre and Gunnison National Forest with additional areas most likely to be affected by smoke as the I-70 Interstate corridor; the North Fork, Uncompahgre and the Gunnison River Valleys; and the towns of Grand Junction, Delta, Cedaredge, Paonia, Hotchkiss, Olathe, Montrose, Ridgeway, Ouray, Telluride, Norwood, Nucla, Naturita, Paradox, Gunnison and Crested Butte.
- Second, portions of the public become irritated with smelling smoke, seeing smoke, breathing smoke over long periods of time, and having smoke in their homes.
- Third, there is a segment of the public that has respiratory problems that are aggravated by irritants in wood smoke.
- Fourth, public safety along travel corridors.

Analysis Methodology

For this analysis, the air quality issues of concern entail compliance with the Clean Air Act, the State of Colorado air quality standards and regulations, and the Wilderness Act. Air quality standards primarily address human health. Under the Clean Air Act, federal land managers have a responsibility to protect Class I air quality related values (AQRVs) from degradation. The Wilderness Act requires that congressionally designated wilderness areas be managed for their protection and preservation from human caused degradation. A review of pertinent sections of the Clean Air Act, State of Colorado air quality management regulations, and CEQ guidance concerning effects of greenhouse gas emissions and climate change in NEPA review, is presented above, in order to frame the extent of the analysis and point out essential compliance requirements.

Indicators used in this analysis include the following:

- Compliance with NAAQS and the Prevention of Significant Deterioration Program
- Potential impacts to AQRVs which includes visibility impacts to Class I Wilderness areas, sensitive Class II wilderness areas, and important Scenic Vistas

- Potential impact of prescribed burning to particulates and nitrous oxide.
- Potential impact of prescribed burning to Greenhouse Gases

Assumptions

To approximate a range of emissions the proposed SBEADMR project would produce, the following assumptions were made:

- Based on the proposed action and for the purposes of this analysis, we assume treatments would occur over fifteen years.

- In the Gunnison basin about 50% of treatment will be for salvage and 50% for resiliency Outside the Gunnison basin treatments are estimated to be 70% resiliency and 30% salvage. Based on these assumptions the total volume predictions for Alternative 2 will be 840,000 ccf and 1,100,000 ccf for Alternative 3.

These assumptions are broad and are the best estimate available at the time of this analysis. However they allow emissions estimates that cover the duration of all SBEADMR treatments. The emissions estimate ranges presented here are maximum amounts.

There are currently several other vegetation management projects in the implementation stage on the Forest that also produce smoke emissions. There are five other vegetation and fuels management projects and three coal, oil and gas lease revision or modification projects in the planning stage. These other current and planned projects do not have smoke emissions estimates available for use in this analysis. Also, the amounts of potential smoke emissions from managed wildfire over the lifetime of the SBEADMR implementation period is unknown.

Modeling

The U.S. EPA's Motor Vehicle Emissions Simulator (MOVES2014) is used for generating equipment emissions factors (EPA 2014b). Equipment use estimates are used to calculate logging equipment emissions. The MOVES model estimates vehicle emissions decreasing over time as newer and more efficient vehicles are produced. For this analysis, emissions factors for 2015 vehicles are used.

To estimate emissions from prescribed burning, two models are used. Both the Piled Fuels Biomass and Emissions Calculator (PFBME), and First Order Fire Effects Model (FOFEM) estimate NAAQS criteria pollutants and GHG emissions. The online Piled Fuels Biomass and Emissions Calculator are used to estimate prescribed burning emissions from slash piles (USDA Forest Service 2014b). The computer-based program FOFEM version 6 is used to estimate prescribed burning emissions in aspen.

Smoke dispersion modeling is not required by the State of Colorado for prescribed burning permitting; however, emissions estimates are required (CDPHE 9, V. Planned Ignition Fire Permits, D. 7.).

Affected Environment

Colorado Emissions Inventory

Annual estimated emissions inventories are useful for comparing emissions from various sources. The National Emissions Inventory (NEI) is a comprehensive and detailed estimate of air emissions of both Criteria and Hazardous air pollutants from all air emissions sources and last updated in 2011. The NEI is prepared every three years by the EPA based primarily upon emission estimates and emission model inputs provided by State, Local, and Tribal air agencies for sources in their jurisdictions, and supplemented by data developed by the EPA. In Colorado, the CDPHE last updated the state wide inventory in 2013, (Table 111). The inventory includes all emission sources except for PM10 agricultural, range and forest management prescribed burning and wildfire data which was not available at the county level at the time of this analysis. The inventory estimates that during 2013, 324,330 Tons of PM10 were produced statewide from all sources except prescribed burning and wildfires and 318,339 tons NO2. (Personal communication with Dale Wells, CDPHE, 11/30/2015).

Table 111. Colorado State 2013 NAAQS Criteria Pollutant Emissions Inventory (tons per year).

The inventory includes all emission sources except for PM10 agricultural, range and forest management prescribed burning and wildfire data which was not available at the county level at the time of this analysis.

Category 2013	CO	PM10	NO2	SO2	VOC	Benzene
Ag Burning	33,958	0	1,428	615	2,338	213
Ag Tilling	0	109,694	0	0	0	0
Aircraft	13,069	227	3,632	0	909	0
Biogenic	138,567	0	40,081	0	880,531	0
Commercial Cooking	777	58,837	0	0	270	29
Construction	0	56,791	0	0	0	0
Fuel Combustion	7,086	142	7,162	333	534	0
Highway Vehicles	538,275	2,482	79,380	312	77,916	1,328
Non-Road (Off Road)	255,605	2,730	24,557	84	26,905	757
Oil and Gas area	55,588	2,190	68,784	558	312,798	0
Oil and Gas points	16,896	512	22,021	498	19,181	483
Oil and Gas Condensate Tanks	0	0	0	2,131	209,133	393
non-Oil and Gas Point Sources	24,160	15,254	54,315	39,878	21,557	169
Pesticide Application	0	0	0	0	7,351	0

Category 2013	CO	PM10	NO2	SO2	VOC	Benzene
Portable Fuel Containers	0	0	0	0	3,104	9
Railroads	2,131	438	14,601	136	653	2
Rail Yards	133	40	1,456	12	98	0
Road Dust	0	66,869	0	0	0	0
Solvent Utilization	0	0	0	0	18,809	0
Surface Coating	0	0	0	0	4,982	0
Tank Trucks In Transit	0	0	0	0	68	1
Wood Burning	55,823	8,123	923	144	10,047	426
Total	**1,142,067**	**324,330**	**318,339**	**44,701**	**1,597,185**	**3,809**

Table 112 shows the 2013 emissions inventories for nine counties that include the SBEADMR project within their boundaries. The inventories includes all emission sources except for PM10 agricultural, range and forest management prescribed burning data which was not available at the county level at the time of this analysis. The counties were estimated to produce 20,426 tons of PM10 and 32,798 tons of NO2. (Personal communication with Dale Wells, CDPHE, 11/30/2015).

The table below shows all emissions except for PM10 from agricultural, range and forest management prescribed burning and wildfire data which was not available.

Table 112. 2013 Annual County Level Emissions Inventory.

County	CO	PM10	NO2	SO2	VOC	Benzene
Delta	10,168	1,342	2,603	94	20,510	23
Garfield	27,751	5,778	17,963	191	76,333	242
Gunnison	8,719	1,490	1,165	16	21,805	27
Hinsdale	3,537	616	107	2	10,141	14
Mesa	33,216	5,336	6,455	76	38,249	115
Montrose	10,162	2,567	2,401	1,178	21,191	27
Ouray	2,978	792	437	3	9,137	8
Saguache	5,057	1,616	861	10	18,033	10
San Miguel	4,197	889	806	3	12,508	11
Total	105,785	20,426	32,798	1,573	227,907	477

A statewide prescribed fire annual emissions inventory is based on fuels data that is provided to the CDPHE by permittees. This may not include all the burns that the NEI data base captures because the NEI uses satellites to identify rangeland and agricultural burning also. Since the NEI uses satellite imagery and fuels maps to assign a fuel type and loading, there may be discrepancies in emissions data compared to what is reported to the CDPHE. The two inventories may use different emission factors and the CDPHE have tried to maintain the same emission

factors over the years so that year to year trends are apparent. According to the CDPHE, over twenty-three years, from 1992-2014, statewide prescribed fire emissions produced an average of 1,541 Tons of PM10 emissions per year (Personal communication with Coleen Campbell, CDPHE, 12/8/2015). Table 113 shows the inventory and the annual emissions range from 211 to 3,093 Tons.

Table 113. Colorado Statewide Prescribed Fire PM10 Annual Emissions 1992-2014 (Tons).

Year	Colorado Statewide Prescribed Fire PM10 Emissions (Tons)	Year	Colorado Statewide Prescribed Fire PM10 Emissions (Tons)	Year	Colorado Statewide Prescribed Fire PM10 Emissions (Tons)
1992	627	2000	390	2008	1,934
1993	1,646	2001	1,747	2009	2,195
1994	895	2002	666	2010	2,533
1995	2,267	2003	910	2011	1,734
1996	1,298	2004	3,093	2012	211
1997	709	2005	1,726	2013	2,034
1998	1,684	2006	1,447	2014	2,065
1999	1,633	2007	1,988		

Air Quality Monitoring

Colorado has been divided into eight multi-county planning areas that are generally based on topography and have similar airshed characteristics. The planning area considered in this analysis falls within three of Colorado's air quality planning regions: 1) The Central Mountains Region includes Gunnison and Hinsdale Counties; 2) the San Luis Valley Region includes Saguache County; 3) the Western Slope Region includes Garfield, Mesa, Delta, Montrose, Ouray and San Miguel Counties (CAQDR 2013).

The Central Mountains Region consists of 15 counties in the central area of the state. The Continental Divide passes through much of this region. Mountains and mountain valleys are the dominant landscape. Leadville, Steamboat Springs, Cañon City, Salida, Buena Vista, Aspen, Gunnison and Crested Butte represent the larger communities. The population of this region is about 256,800, according to U.S. Census Bureau estimates. Skiing, tourism, ranching, mining, and correctional facilities are the primary industries. Black Canyon of the Gunnison National Park is located in this region. All of the area meets with National Ambient Air Quality Standards (CAQDR 2013).

Colorado's San Luis Valley Region is in the south central portion of Colorado and includes a broad alpine valley situated between the Sangre de Cristo Mountains on the northeast and the

San Juan Mountains of the Continental Divide to the west. The valley is some 71 miles wide and 122 miles long, extending south into New Mexico. The average elevation is 7,500 feet. Principal towns include Alamosa, Monte Vista, and Del Norte. The population is about 45,100 according to U.S. Census Bureau estimates. Agriculture and tourism are the primary industries. The valley is semiarid and croplands of potatoes, head lettuce, and barley are typically irrigated. The valley is home to Great Sand Dunes National Park (CAQDR 2013).

The Western Slope Region includes nine counties on the far western border of Colorado. A mix of mountains on the east, and mesas, plateaus, valleys and canyons to the west form the landscape of this region. Grand Junction is the largest urban area, and other cities include Telluride, Montrose, Delta, Rifle, Glenwood Springs, Meeker, Rangely, Craig, Paonia, Cederedge, Ridgeway and Ouray. The population of this region is about 309,700, according to U.S. Census Bureau estimates. Primary industries include ranching, agriculture, mining, energy development and tourism. Dinosaur and Colorado National Monuments are located in this region (CAQDR 2013).

The Western Slope, along with the central mountains, is projected to be the fastest growing area of Colorado through 2020 with greater than two percent annual population increases, according to the Colorado Department of Local Affairs.

All of these areas comply with National Ambient Air Quality Standards (CAQDR 2013).

Currently there are no violations of the NAAQS and no non-attainment areas in the vicinity of the project area. Air quality is affected by activities both on the GMUG and emissions from other activities and areas in both the Rocky Mountain and Colorado Plateau region. Air quality is affected by: smoke from both wildfire and prescribed burns; wind events; dust from road construction, maintenance and use; emissions from vehicle and equipment use; agricultural activities; and methane venting from coal mining on the GMUG. None of these emissions have reached levels that have demonstrated non-attainment conditions on the GMUG. Air pollutant monitoring results for selected counties in western Colorado are shown in Table 114. The table shows monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

Methane is a recognized GHG but is not a pollutant under the EPA air quality standards. There has been an increased need to vent methane from coal mines in the North Fork Valley. Since 2001, there have been numerous venting wells drilled in the area and one coal mine near Somerset, Colorado vents an estimated 4.9 to 6.9 billion cubic feet of methane gas per year, which represents about 0.03 percent of the total United States GHG (2002). There is no indication that venting of methane for mine safety reasons will be reduced in the near future through capture or energy production (LRMP 2007).

Acid Deposition Monitoring

Elevated emissions of sulfur dioxides and nitrogen oxides can react with water molecules in the atmosphere, resulting in acidic precipitation. This precipitation is harmful to native plant communities, aquatic life, soil productivity, and cultural sites such as historic and prehistoric rock art. Monitoring of nitrogen dioxide deposition in alpine areas is occurring in the San Juan Mountains (Waterfall Canyon, near Telluride) and some lake water chemistry monitoring has occurred within the West Elks and Raggeds Wilderness Areas to determine if there is pollutant deposition. Evaluation of monitoring data for these high elevation areas has not indicated any recognizable trends associated with air quality (USDA Forest Service 2006d). The GMUG conducts long-term lake monitoring as part of the air quality program at two locations on the forest, Deep Creek Lake Monitoring Site, and South Golden Lake Monitoring Site. On the White River National Forest adjacent to the GMUG on the north, acid deposition is monitored through the following programs:

- Wilderness lake monitoring program
- U.S. Geological Survey's (USGS) snow chemistry monitoring program
- National Acid Deposition Program (NADP)

The USGS monitoring effort shows increasing trends in the concentrations and deposition of ammonium (NH_4) and nitrate (NO_3) and decreasing trends in sulfate (SO_4). The increases in NH_4 and NO_3 are likely due to increased emission sources from the region's growth in both population and energy development (Ingersol et al 2007; USDA Forest Service 2014c).

Climate Change – Greenhouse Gases and Carbon Sequestration

Greenhouse Gases

Three of the most important greenhouse gases (GHG) resulting from human activity are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). They are produced by both natural processes and human activity. While they make up less than one percent of the Earth's atmosphere, they exert a powerful influence over global temperatures.

Greenhouse gases play a role in the natural environment by absorbing the sun's heat. As the sun's energy radiates back from the Earth's surface toward space, these gases trap the heat in the atmosphere, keeping the planet's surface warmer than it would otherwise be. Increases of atmospheric greenhouse gases result in additional warming of the Earth's atmosphere. Carbon dioxide equivalents (CO2e) is a metric used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). For instance, over a 100 year period the GWP of methane (CH4) is estimated to be about 28-36 times greater than carbon dioxide (CO2), so its carbon dioxide equivalent (CO2e) is 28-36. The carbon dioxide equivalent (CO2e) of nitrous oxide (N2O) is 298 (Environmental Protection Agency 2015a).

The estimated amount of GHG emissions that will be produced in Colorado in 2020 is 147.5 million metric Tons (Center for Climate Strategies 2007). The estimated amount of GHG emissions produced in the United States in 2013 was 6,673 million metric Tons (EPA 2015b).

In 2005, Colorado's greenhouse emissions were 35 percent higher than they were in 1990. They are projected to grow 81 percent above the 1990 levels by 2020 (CDPHE 2010b). Climate change related impacts observed in Colorado in recent decades include shorter and warmer winters with reduced snowpack and earlier spring runoff, more precipitation falling as rain rather than snow, and longer periods of drought (CDPHE 2010b).

Nationally, according to the latest available inventory of GHG emissions and carbon sequestration issued in 2015, the EPA reported land use, land-use change, and forestry activities in 2013 resulted in a net C sequestration of 8,8173 Tg CO2 Eq. (240.5 Tg C). This represents an offset of approximately 13.2 percent of total U.S. CO2 emissions. Total land use, land-use change, and forestry net C sequestration increased by approximately 13.6 percent between 1990 and 2013. This increase was primarily due to an increase in the rate of net C accumulation in forest C stocks, particularly in aboveground and belowground tree biomass, and harvested wood pools. Sequestration by forest land (i.e., annual carbon stock accumulation in the five carbon pools) has increased by approximately 21 percent. This is primarily due to increased forest management and the effects of previous reforestation. The increase in intensive forest management resulted in higher growth rates and higher biomass density. The tree planting and conservation efforts of the 1970s and 1980s continue to have a significant impact on sequestration rates. Finally, the forested area in the United States increased over the past twenty-four years, although only at an average rate of 0.1 percent per year. (Environmental Protection Agency 2015b).

Globally the average annual temperature has risen since 1900 by about 1.5 °F and is expected to rise another 2 to 10 °F by 2100. The average annual temperature in the United States has risen by a comparable amount over the same time period but is expected to rise more than the global average over this century (Karl et al. 2009).

Carbon Sequestration

Forested lands across the United States currently serve as a carbon 'sink', offsetting approximately 13 percent of U.S. emissions from burning fossil fuels in 2013, and from 10 to 20 percent of U.S. emissions each year. Climate change may affect the ability of forests to continue to store and sequester carbon. Climate change increases the uncertainty of U.S. forests' ability to serve as a "sink" for carbon storage, but management options exist that could buffer the impacts of climate change on forests, and even lead to increased forest carbon storage potential. Trees take up carbon dioxide (CO2) and release oxygen (O2) through photosynthesis, transferring the carbon (C) to their trunks, limbs, roots, and leaves as they grow. When leaves or branches fall and decompose, or trees die, the stored C will be released by respiration and/or combustion back

to the atmosphere or transferred to the soil. Because of these processes, forests and forested landscapes can store considerable carbon and their growth can provide a carbon sink; landscapes that have been recently converted or reconverted to forests (from another land cover) can provide a carbon sink that is considerably larger than other land cover types (Ryan, et. al. 2012). Figure 12 displays the major forest carbon pools in the conterminous U.S. from 2000 to 2009.

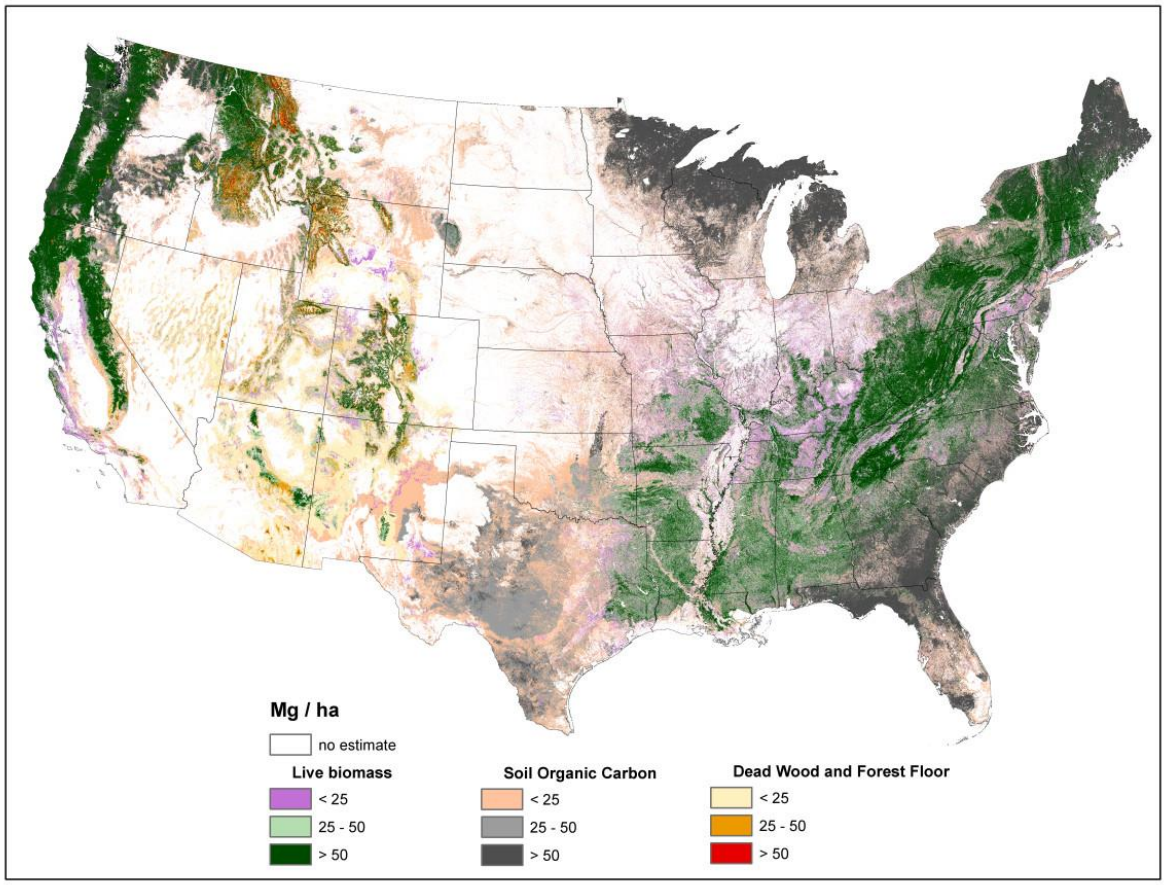

Figure 12. Major forest carbon pools.
(Major forest carbon pools with the plurality of total forest carbon stock for each pixel imputed from forest inventory plots, conterminous U.S., 2000-2009. Major pools are: 1) living biomass (aboveground, belowground, and understory), 2) dead wood and forest floor (including standing dead, down dead, and forest floor), and 3) soil organic carbon (Wilson et. al. 2013). Mg / ha represents megagrams per hectare.)

Approximately 33 percent (749 million acres) of the United States' land base is forested. This represents roughly 7.5 percent of the world's total forestland. In 2010, forested lands and long-lived wood products accounted for a net sink of 251 million metric Tons of carbon (922 million metric Tons CO2). Forest growth and afforestation currently offset approximately 13 percent of U.S. emissions from burning fossil fuels. This is an enormous ecosystem service; offsetting

another ten percent of emissions would require the conversion of one-third of our current U.S. cropland to forest plantations. While individual trees or tracts release some or all of their carbon if harvested, burned, or otherwise disturbed, subsequent forest regrowth will sequester carbon from the atmosphere. National forest lands covered in this decision are generally not subject to land-use change, and will remain as forests subject to federal protection. Forested landscapes tend to include a mix of disturbed and regrowing forest stands, and have a carbon balance of near zero over the medium and longer term. Management actions should be examined for large areas and over long time periods (Figure 13). This figure models how carbon stores change as a larger area and more stands are included in an analysis. As the number of stands increases, the gains in one stand tend to be offset by losses in another, and hence the flatter the carbon stores curve becomes (Ryan, et. al. 2012).

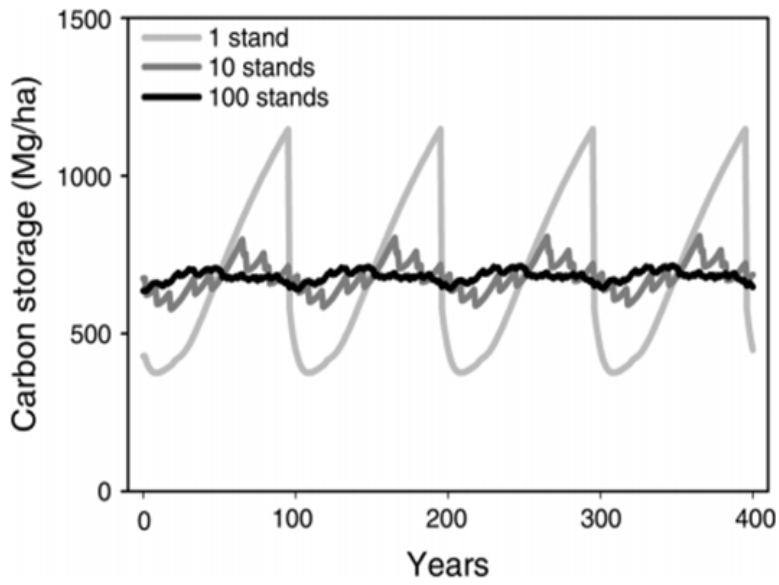

Figure 13. Model of carbon storage - Increase in Stands and Time.
This figure models how carbon stores change as a larger area and more stands are included in an analysis. As the number of stands increases, the flatter the carbon stores curve becomes. Mg/ha represents megagram per hectare.

The large flux of carbon from forests to the atmosphere (from logging and deforestation) peaked in 1915 at 760 million metric Tons of carbon per year. Currently forests take up about 250 million metric Tons of carbon per year. Our large carbon sink today is a legacy of harvesting and forest conversion that took place in the past. These disturbances released much carbon dioxide (CO2) into the atmosphere decades ago, and the regrowing forest is recovering some of that released CO2 on land that has not been permanently converted to non-forest cover (Figure 14).

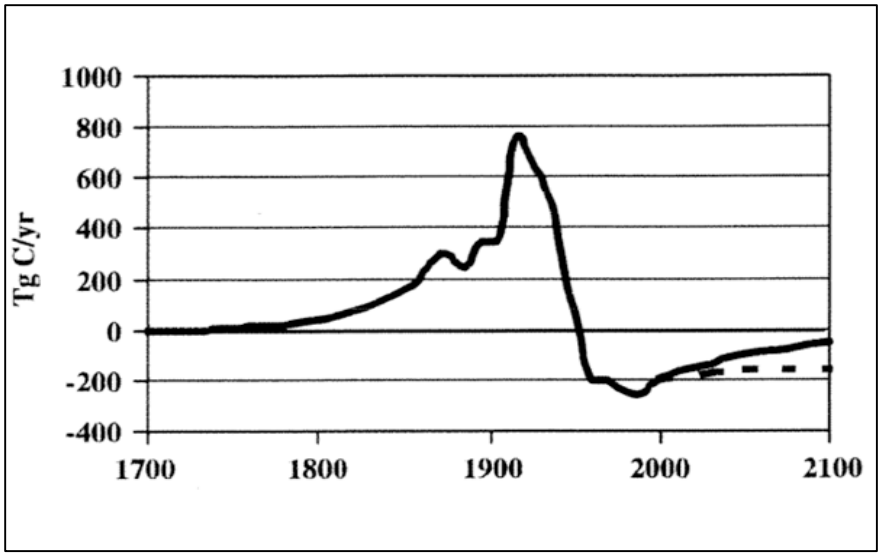

Figure 14. Carbon balance of a U.S. forest sector in millions of metric Tons of carbon per year.

Carbon balance of a U.S. forest sector in millions of metric Tons of carbon per year. The large flux of carbon from forests to the atmosphere (from logging and deforestation) peaked in 1915 at 760 million metric Tons of carbon per year. Currently forests sequester about 250 million metric Tons of carbon per year. Tg = 1 million metric Tons. Tg C or TgC Eq represents teragrams of carbon dioxide equivalent.

The persistence of the current U.S. forest carbon sink is uncertain because the effects of historic land use should taper off, while projected increases in the rates of natural disturbances such as fire may liberate current carbon stocks. Atmospheric factors may change forest growth rates, since increased nitrogen deposition and atmospheric CO2 concentrations from fossil fuel emissions can enhance tree growth. These factors may also augment current rates of carbon sequestration by forests. However, other global change factors, such as increased transpiration rates and atmospheric pollutants and the likelihood of increased drought, may offset potential increased sequestration rates.

Expected Changes

Over the next fifty years carbon stocks are likely to be more vulnerable to disturbances that are exacerbated by climate change, such as insect outbreaks, fire, drought, and storms. This may in turn lower the productivity and storage capacity of some forests while threatening the ability of some forests to remain forests. Because of more frequent/repeat burning, some forests may convert to shrubland. The effects of climate change are likely to affect forested landscapes in the eastern and western U.S. differently. The following are examples of what may occur, but does not represent a comprehensive list:

- In the eastern U.S., elevated temperature and atmospheric CO2 concentrations will likely continue to enhance sequestration by forests, but this sequestration may be offset by forest fragmentation and disturbances by invasive insects.
- In the Southeast, warmer temperatures may increase the rate of decomposition of soil organic matter, thereby increasing CO2 emissions and reducing the potential for sequestration in soils.
- In the western U.S., elevated temperatures and decreased precipitation is expected to lead to drought conditions that will exacerbate stress complexes that include fire and insect disturbance. Insect infestations are expected to affect more land than wildfire on an annual basis. Higher tree mortality, slower regeneration, and changes in the mix of tree species may result from these disturbances. While short-term effects will depend upon the amount of area affected, the cumulative impact of disturbances may turn western forests from a carbon sink into a source of atmospheric carbon (Ryan, et. al. 2012).
- Due to expected increases in dry weather, especially drought, more cases of SAD are expected. Suitability for aspen in the Southern Rockies is expected to deteriorate rapidly through the rest of the century, though some new areas may emerge as suitable habitat. Aspen forests, like other forest types, store considerable carbon in above and belowground biomass (and especially for aspen, in the soil). As stands mature and regenerate, there is a cycle of carbon release and sequestration with a high net storage of carbon. If aspen forests are replaced by shrub or meadow communities with lower carbon storage capacities, the difference will contribute to atmospheric CO2. Aspen mortality episodes in the aspen parkland of Alberta and Saskatchewan and in southwestern Colorado are expected to result in significant carbon release and positive feedbacks to climate change (Huang and Anderegg 2012, Michaelian et al. 2011).

In the decade since 2002, forest fires annually burned 0.9 percent of forested land in the United States, with the largest fire year (2006), burning 1.3 percent of forested land. This corresponds to an overall average return interval of 100 years for U.S. forest fires. Models run with downscaled climate data for the Greater Yellowstone Ecosystem predict substantial increases in fire in this region by mid-century, with fire rotation reduced to less than 30 years from the current 100-300 year return interval. If fires become more severe, especially where ecosystems are not adapted to severe fire, the likelihood that fire will change forest to shrublands or grasslands may increase. Annual carbon emissions related to fire vary considerably depending upon the year. Circumstances that directly affect fire activity include atmospheric circulation, temperature, and moisture patterns. Estimates of fire-related emissions range from 22.6 million metric Tons/year (2010) to 84.4 million metric Tons (2006), compared to net forest sequestration of 251 million metric Tons/year (Ryan, et. al. 2012).

Options for Management

Options for managing forests for carbon storage are:

- Keep forests as forests (avoid deforestation), including active regeneration of frequent fire forests subjected to crown fires where natural regeneration may take centuries.
- Manage forests sustainably for a variety of ecosystem services (maximizing carbon stores on a landscape in the near-term may ultimately lead to more uncertain carbon outcomes, due to an increased risk of fire or disturbance in the mid- to long-term).
- Reforest areas where forests historically occurred.
- Substitute forest biomass for fossil fuel use, especially forest biomass generated in normal operations, fuels treatment and forest restoration activities.
- Promote long-lived forest products such as wood-framed buildings. Long-lived forest products continue to act as carbon stores whereas substitute materials, such as concrete, result in significant carbon emissions.

Harvest and regeneration of young to middle-aged forests for long-lived forest products can help with carbon storage. In forests with an ecological history of surface and mixed-severity fires, managing for maximum carbon storage will lead to an increase in stand density and the probability of more severe fires. In contrast, managing to reduce fuels and the risk of crown fire will reduce the carbon stored in the forest and will likely be a source of atmospheric carbon unless the thinnings are used for wood products. Fuels treatments and forest restoration activities in frequent-fire forests will promote a more adaptable, sustainable forest that tends to experience low intensity fires instead of crown fires. However, such treatments may move carbon from the forest to the atmosphere. Intensive biomass use could also move carbon from the forest to the atmosphere, at least in the short term. Carbon should be only one of the many factors considered when making forest management decisions (Ryan, et. al. 2012).

Carbon Sequestration on the GMUG

In 2013, the USDA Forest Service completed an assessment of carbon storage for all National Forests, based on Forest Inventory and Analysis (FIA) data. The assessment is intended to be used in Forest planning and results are summarized in the following charts. The assessment shows that overall carbon stocks have been increasing. On the GMUG, from 1990 to 2013, carbon stocks have fluctuated around approximately 130 Tg (teragrams), (Figure 15).

In the Rocky Mountain Region, National Forest System Lands have increased since 1990, and forest ecosystem carbon storage in the area has also increased. From 1990 to 2013, overall carbon densities (Tonnes/acre) have increased for the national forests and grasslands in the Rocky Mountain region with the GMUG having the third greatest levels of density compared to eleven other national forests and grasslands.

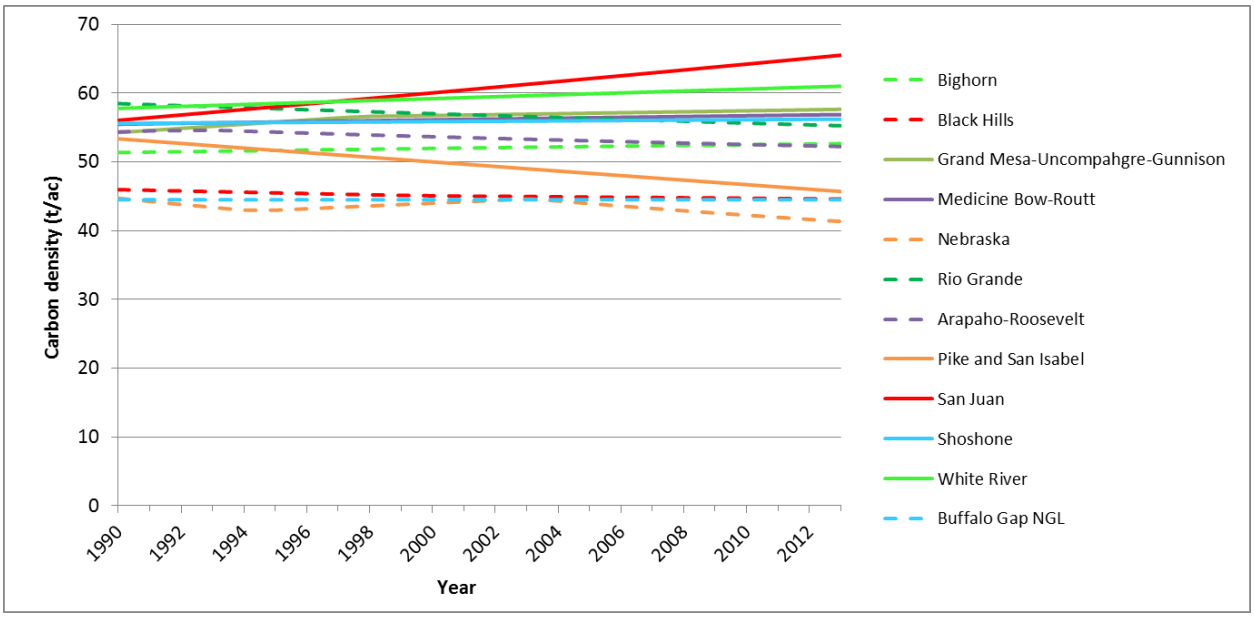

Figure 15. Carbon density (Tonnes/acre) for the national forests and grassland in the Rocky Mountain Region (1990 -2013).

The Intergovernmental Panel on Climate Change (IPCC) production accounting approach was used to estimate harvested wood products (HWP) carbon storage from 1906 to 2012 for the Rocky Mountain Region. For the Rocky Mountain Region as a whole, carbon stocks in the HWP pool were increasing at approximately 180,000 megagrams of carbon (MgC) per year in the early 1950s through 1995 when carbon stocks plateaued until 2005 followed by the peak cumulative storage to date of 12 million MgC occurring in 2013. Net positive flux into the HWP pool over this period is primarily attributable to high harvest levels in the early1950s through the 1990s. In the years between the mid-1960s and 1990 timber harvests were at high, volatile levels, with high harvests of over 800,000 ccf (600,000 MgC) occurring six times during this period. Harvest levels from National Forests of the Rocky Mountain Region have since declined to less than 470,000 ccf (350,000 MgC) per year, resulting in less carbon entering the HWP pool. With the exceptions of 1998, 2003 and 2004, when emissions from HWP at solid waste disposal sites (SWDS) exceeded additions from harvesting, the Rocky Mountain Region HWP pool has remained in a period of positive net annual stock change because additions of carbon to the HWP pool through harvest exceeds the decay of products harvested between 1906 and 2012 (Figure 16 and Figure 16) (Stockmann et. al. 2014). From 1990 to 2013 carbon stocks on the GMUG have approximated 130 Tg (Figure 18).

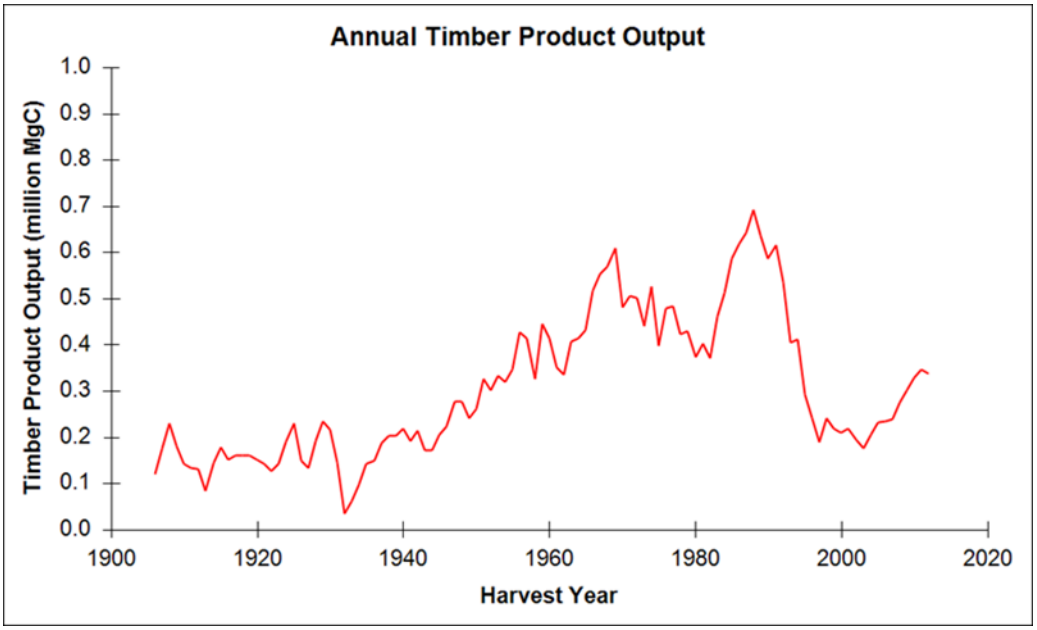

Figure 16. Annual timber product output in the Rocky Mountain Region (1906 to 2012).

Harvest estimates are based on data collected from USDA Forest Service Archives and Cut/Sold reports.

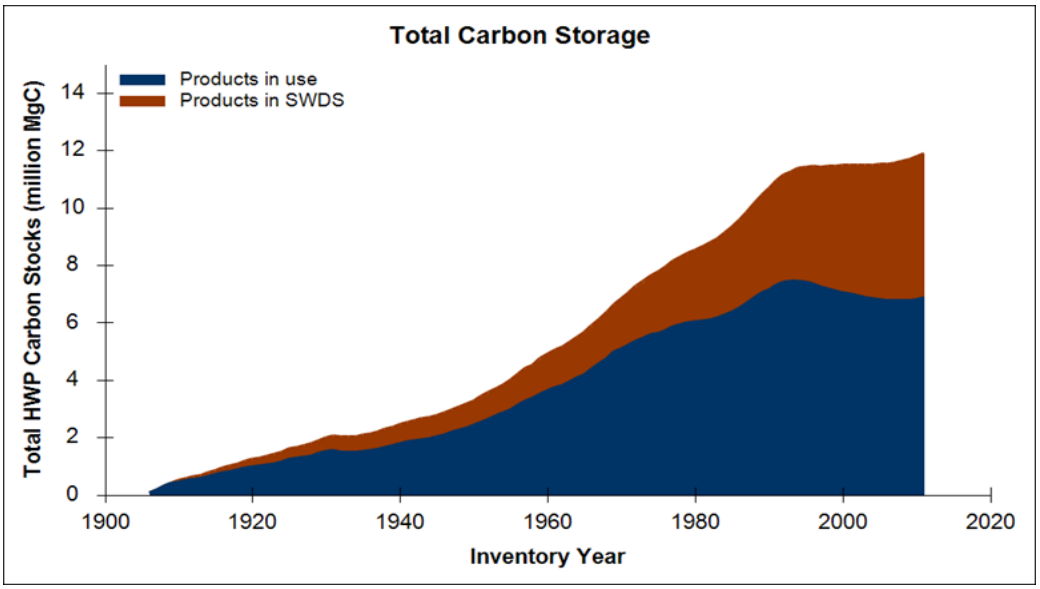

Figure 17. Cumulative total carbon stored in harvested wood products (HWP) manufactured from Northern Region timber using the IPCC/EPA approach.

Carbon in HWP includes both products that are still in use and carbon stored at SWDS, including landfills and dumps (millions of megagrams of carbon).

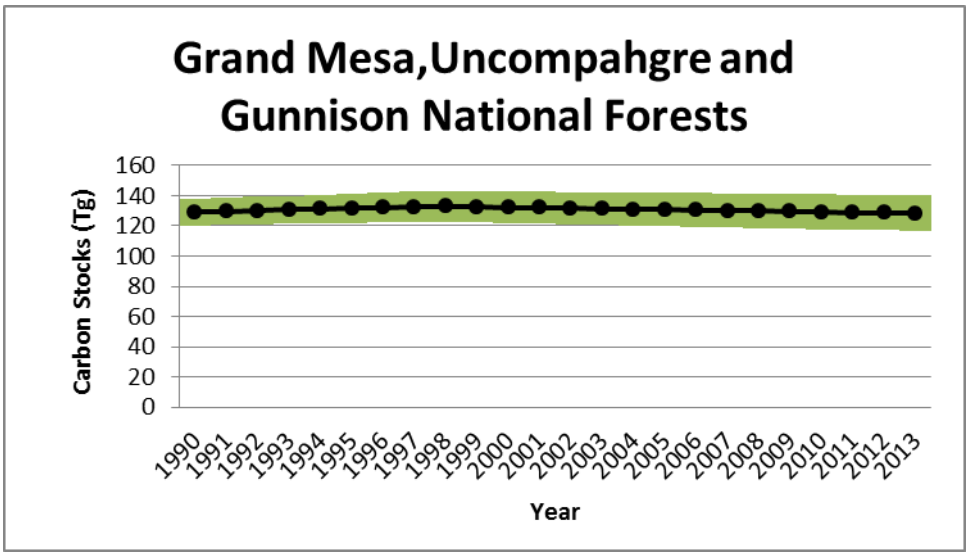

Figure 18. Carbon stocks on the GMUG from 1990 to 2013. The green band shows the range of analysis uncertainties.

Visibility

Visibility is specifically identified in the Clean Air Act as an AQRV that Federal land managers must consider. The 1990 CAA amendments include a goal of improving visibility in Class I areas with visibility impairment. Regional haze is visibility impairment resulting from the transport of particles over long distances. Visibility impairment is caused by pollutant plumes, layered haze, or uniform (regional) haze. Plumes are distinct in form and caused by a local source.

To address different ambient conditions, a uniform standard of measure, called a "deciview", has been developed to describe changes in visibility. Specifically, it is a measure of light extinction. A change of 1.0 deciview is equivalent to a ten percent change in extinction and represents a "just noticeable" change in visibility. The higher the deciview, the less a person can see into the distance.

The Forest Service has conducted limited visibility monitoring using camera images in the West Elks Wilderness (1992 to 1996) and the La Garita Wilderness (1997 to 2001) to document visibility conditions in those Class I areas. The La Garita site showed a uniform haze during more than 70 percent of the sampling period (USDA Forest Service 2006d).

As part of the Colorado State Implementation Plan for Regional Haze, the CDPHE has calculated baseline and natural visual range values for the Maroon Bells-Snowmass and West ElkWilderness areas (9.6 deciviews baseline; 6.54 deciviews natural condition) and La Garita Wilderness Areas (10.3 deciviews; 6.24 deciviews natural condition), pertinent to the

SBEADMR planning area. Natural visibility represents visibility conditions experienced in the absence of human-caused impairment.

The Regional Haze Regulations (under 40 CFR §51.308) establish that the Class I area progress goals must provide for an improvement in visibility for the most impaired (i.e., 20 percent worst) days over the period of the implementation plan, and ensure no degradation in visibility for the least impaired (i.e., 20 percent best) days over the same period.

National Ambient Air Quality Standards (NAAQS)

We reviewed the latest available Colorado Air Quality Data Report, dated 2013, to be certain that air quality conditions have not significantly changed in and around the SBEADMR project area since the project air quality analysis was first completed in September, 2014. For Central Mountains, San Luis Valley and Western Slope Regions, the areas in and around the SBEADMR project, all currently comply with NAAQS (CAQDR 2013). We reviewed the EPA's air quality monitoring data from 2010 – 2015 (Table 114) and found that while there have been exceedances of NAAQS in the SBEADMR area these exceedances have not triggered moving state planning regions from attainment into nonattainment.

Carbon Monoxide

Carbon Monoxide (CO) is a colorless and odorless gas, formed when carbon compounds in fuel are not burned completely. It is a component of motor vehicle exhaust, which contributes about 50 percent of all CO emissions nationwide, and as much as 85 percent of all CO emissions in cities. Peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are greater, and nighttime temperature inversions (conditions where air pollutants are trapped near the ground beneath a layer of warm air) are more frequent (CAQDR 2013).

In Colorado, CO concentrations have dropped dramatically from the early 1970s. This change can be seen in both the concentrations measured and the number of monitors that exceeded the level of the 8-hour standard. In 1975, 9 of the 11 (81 percent) state-operated monitors exceeded the 8-hour standard. In 1980, 13 of the 17 (77 percent) state-operated monitors exceeded the 8-hour standard. Since 1996 none of the state-operated monitors have recorded a violation of the 8-hour standard. Table 114 shows CO monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

Lead

Lead is a metal found naturally in the environment as well as in manufactured products. Due to the phase out of leaded gasoline for automobiles, piston engine aircraft and metals processing are now the major source of lead emissions to the air today. The highest levels of lead in air are

generally found near lead smelters and general aviation airports. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers (CAQDR 2013).

In Colorado the last violation of the previous 1.5 µg/m3 lead standard occurred in the first quarter of 1980 at the Denver CAMP monitor. Since then, the concentrations recorded at all monitors showed a steady decline. This decline is the direct result of the use of unleaded gasoline and replacement of older cars with newer ones that do not require leaded gasoline. The reduction in atmospheric lead shows what pollution control strategies can accomplish. In 2006, monitoring for lead by the CDPHE was reduced from six locations to one. In 2007, that lead monitor was moved from the Denver CAMP location to the Denver Municipal Animal Shelter NCore site at 678 S. Jason St. (CAQDR 2013).

Nitrogen Dioxide

In its pure state, NO2 is a reddish brown gas with a characteristic pungent odor. It is corrosive and a strong oxidizing agent. As a pollutant in ambient air, however, it is virtually colorless and odorless. NO2 can be an irritant to the eyes and throat. Oxides of nitrogen (nitric oxide and NO2) are formed when the nitrogen and oxygen in the air are combined in high temperature combustion (CAQDR 2013).

Colorado exceeded the NO2 standard in 1977 at the Denver CAMP monitor. Concentrations have shown a gradual decline for the past 20 years. However, the trend of annual averages for the past ten years has been nearly flat. Denver CAMP monitor has shown little to no change at all. The cause of this is most likely due to an increase in the number of vehicles and increased power generation associated with the increases in population in the Denver-metro area (CAQDR 2013). Table 4 shows nitrogen oxide monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

Particulate Matter

Ambient particulate matter (PM) concentrations increase substantially during a wildfire (Kochi et al. 2010b). A dose-response function is an equation that estimates the health consequences of exposure to pollution. Compared to conventional PM studies (based on urban air pollution), wildfire studies are “less likely to find a significant positive mortality effect in spite of the substantial increases in PM levels during the wildfire period” (Kochi et al. 2010a). There are several probable reasons for this finding, including: (1) urban air pollution and wildfire smoke are chemically different (wildfire smoke is generally less toxic), (2) wildfire events are more likely to promote averting behavior, such as evacuation (Kochi et al. 2010a). However, the wildfire studies did find increased hospital admissions linked to asthma and respiratory problems during wildfire events (Kochi et al. 2010a).

Smoke can travel great distances and affect communities far away from the burn unit, sometimes persisting after the burn has been completed. Particulates become part of the air mass where they

were released, gradually dispersing to a more uniform concentration within the air mass until gravity or precipitation brings them back to earth days or weeks later.

Under the existing condition, dead trees in the GMUG are providing an increase to surface fuels that over many years and could increase smoke emissions from wildland fires. Wildland fires are unpredictable as to when they occur, their size and intensity, and the amounts and duration of smoke production that can impact human health and visibility. The timing of prescribed fires is predictable, the volume of smoke produced is typically less than in a wildfire, and there is time to notify the public when burns will be implemented. As a result, adverse health consequences are less likely to result from prescribed fires. In addition, in remote areas where prescribed burning takes place, smoke would not be a human health concern for the adjacent communities. However, under the No Action Alternative, health and human safety impacts from wildfire smoke may be higher than the other alternatives.

PM10

The size of particles is directly linked to their potential for causing health problems. Small particles, less than 10 micrometers (microns) in diameter, pose the greatest problems. Since PM10 contains all particles smaller than 10 microns, PM2.5 and ultrafine particles which are <0.1 microns are included in the PM10 measurement. The smallest particles, like PM2.5, can get deep into the lungs, and some, like ultrafine particles, can penetrate all the way into the bloodstream. Exposure to such particles can affect the lungs, the heart, and the cardiovascular system. Larger particles are of less concern, although they can irritate the eyes, nose, and throat (AirNow 2003), and cause serious harm due to inflammation in the airways of people with respiratory diseases such as asthma, chronic obstructive pulmonary disease, and pneumonia (Weinmayr, et al. 2010; CAQDR 2013).

PM10 data have been collected in Colorado since 1985. The samplers were modified in 1987 to conform to the requirements of the new standard when it was established in July of 1987. Therefore, annual trends are only valid back to July 1987. Since 1988, the state has had at least one monitor exceed the level of the 24-hour PM10 standard (150 µg/m3) every year except 2004. By contrast, no monitor with at least 75 percent data recovery per calendar quarter, which is required for NAAQS comparisons, has exceeded the level of the former standard (50 µg/m3 as an annual arithmetic mean averaged over 3 years) (CAQDR 2013).

One significant exceedance of the PM10 24-hour standard occurred at a monitor in Grand Junction, in Mesa County, in 2010. A large regional wind and dust event occurred on the day of the exceedance, with exceedances recorded at other locations in western Colorado including Durango, Crested Butte, Rifle, and Clifton. The Colorado Air Pollution Control Division has therefore requested EPA to flag this day as an exceptional event (personal communication, Debra Miller, USFS, with Bradley Rink, Particulate Matter Monitoring Lead, Colorado Air Pollution Control Division, July 11, 2012). Exceptional events are defined as “unusual or naturally

occurring events that can affect air quality but are not reasonably controllable using techniques that tribal, state or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards" (Environmental Protection Agency 2013). A day that is determined by EPA to qualify as an exceptional event is not used to determine whether a violation of the ambient air quality standard has occurred.

In cases other than exceptional events, and more so than other pollutants, PM10 is a localized pollutant where concentrations vary considerably. Thus, local averages and maximum concentrations of PM10 are more meaningful than averages covering large regions or the entire state. The CDPHE has concluded that it is inappropriate to display a state-wide average graph for PM10 (CAQDR 2013). Table 114 shows PM10 monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

PM2.5

EPA generally defines PM2.5 as particulate matter with an aerodynamic diameter less than or equal to 2.5 microns in size. The health effects of PM2.5 are a function of their size and composition. These tiny particles can be breathed deeply into the alveoli of the lungs and may cause a great deal of damage to lung tissue, reducing lung function and causing or aggravating respiratory problems. They can increase the long-term risk of lung cancer or lung diseases such as emphysema or pulmonary fibrosis. The smallest range of PM2.5 particles, also called ultrafine particles (those with a diameter <0.1 μm) can be transported from the lungs into the blood stream and affect the heart and cardiovascular system (Cardiovascular Toxicology 2006). Once in the blood stream, ultrafine particles can be transported anywhere in the body. Some of these ultrafine particles are carcinogenic (CAQDR 2013).

Fine particulate matter (PM2.5) is chiefly comprised of five mass types: organic mass, elemental carbon (also known as soot or black carbon), ammonium sulfates, ammonium nitrates, and crustal materials (i.e., soil). Primary fine particulate emissions result from combustion processes (including fossil fuel combustion and biomass combustion that occurs in wild fires) and include black carbon. In general, however, black carbon and crustal materials comprise a relatively small proportion of the fine particulate mass suspended in the atmosphere. The largest constituents of fine particulate are usually organic mass, ammonium nitrates, and ammonium sulfates. Some fine particulates (PM2.5), particularly ammonium sulfate and ammonium nitrate particles, can also be formed in the atmosphere from the interaction of either SO2 or nitrogen oxides with ammonium. These types of PM2.5 particles are referred to as secondary particulates, while particles emitted directly from a source are referred to as primary particulates. Secondary particulates do not result from emissions of fugitive dust.

Monitoring for PM2.5 in Colorado began with the establishment of sites in Denver, Grand Junction, Steamboat Springs, Colorado Springs, Greeley, Fort Collins, Platteville, Boulder, Longmont, and Elbert County in 1999. By 2004, there were 20 PM2.5 monitoring sites in

Colorado. Thirteen of the 20 sites were selected based on the population of the metropolitan statistical areas. In addition, there were seven special-purpose-monitoring (SPM) sites. These sites were selected due to historically elevated concentrations of PM10 or because citizens or local governments had concerns of possible high PM2.5 concentrations in their communities. All SPM sites were removed as of December 31, 2006 due to low concentrations and a lack of funding (CAQDR 2013).

Though data has only been collected for the past 12 years, the levels of PM2.5 appear to be essentially flat. Since the standard is based on a three-year average of the top 98th percentile of samples, the 24-hour standard has not been violated at any site. Neither has the three-year average annual standard of 15 µg/m3 (CAQDR 2013). Table 114 shows PM2.5 monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

Ozone

Ozone (O_3) is a gas composed of three oxygen atoms. Ozone has the same chemical structure whether it occurs miles above the earth or at ground-level and can be beneficial or detrimental, depending on its location in the atmosphere (CAQDR 2013). Ground-level ozone is of concern to human health. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents as well as natural sources emit NO2 and VOCs that help form ozone. Ground level ozone is the primary constituent of smog.

In the stratosphere the beneficial ozone layer extends upward from about 6 to 30 miles and protects life on Earth from the sun's harmful ultraviolet (UV) rays. This natural shield had been gradually depleted by man-made chemicals like chlorofluorocarbons (CFCs), though evidence suggests that the total ozone column has not decreased since 1998 (Weatherhead 2006). A depleted ozone shield allows more UV from the sun to reach the ground, leading to more cases of skin cancer, cataracts, and other health problems (Environmental Protection Agency 2012d).

In Colorado ozone monitoring began in 1972 at the Denver CAMP station, and eight exceedances of the then-applicable 1-hour standard were recorded that year. In the Denver metropolitan area ozone averages have fluctuated around the standard and in recent years, the trend has been downward, but the averages seem to fluctuate within the amount of variance seen for the last several years (CAQDR 2013).

Unlike most other criteria pollutants, ozone is not emitted to the atmosphere directly; it is formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight. In general, ozone concentrations in the lower atmosphere are highest during warmer months and lower in the cooler months. In some parts of the western U.S., high winter-time ozone concentrations have been monitored. The project area is not in an airshed with monitored high winter-time ozone concentrations. The chemical reactions that form ozone are complicated and nonlinear, making it difficult to predict ozone concentrations that will result from increasing the amount of the ozone precursors (i.e., nitrogen oxides and volatile organic compounds) in the

atmosphere. The effect of adding nitrogen oxides or volatile organic compounds to the atmosphere on the concentration of ozone depends upon the ratio of the two precursors already present. Ozone formation is also highly dependent on meteorological conditions, including temperature, wind speed, and solar radiation. Ozone in the lower atmosphere is harmful to human health and vegetation. Some fine particulates (PM2.5), particularly ammonium sulfate and ammonium nitrate particles, can also be formed in the atmosphere from the interaction of either SO2 or nitrogen oxides with ammonium.

Smoke can increase ozone production and the CDPHE has taken measures to limit prescribed burning during ozone alerts that mostly affect the Denver metropolitan area. Smoke from fires can be major sources of ozone and their overall role in the formation is not well understood. There are some indications that smoke enhances ozone formation and also some indications it inhibits ozone formation. In the instances where smoke is suspected of decreasing ozone formation, the smoke was very heavy and perhaps blocked the strong sunlight associated with ozone formation. The CDPHE recommends that agencies should err on the side of caution about any relationship between ozone and the burning of wildland fuels (CDPHE Memorandum, Re: Prescribed Fire Smoke Permits, Use of Ozone Alert Information, 8/5/10). Table 114 shows ozone monitoring data for seven counties in the GMUG region where data is available from 2010-2015.

On October 1, 2015, EPA strengthened the National Ambient Air Quality Standards (NAAQS) for 8 hour ground-level ozone to 70 parts per billion (ppb), based on extensive scientific evidence about ozone's effects on public health and welfare.

Sulfur Dioxide

Sulfur dioxide (SO2) belongs to the family of sulfur oxide gases (SO_x). Most SO2 comes from electric utilities, particularly those that burn coal. Sulfur dioxide can react with other substances in the air to form small particles that can cause or worsen respiratory disease, aggravate existing heart disease, and form acid rain. Nationwide, SO2 concentrations have decreased over time. In Colorado, long term monitors along the Front Range indicate annual average SO2 values of 0.01 ppm or less which are well below the NAAQS (Environmental Protection Agency 2010; CAQDR 2013).

Table 114 shows monitoring data for seven counties in the GMUG region where data is available from 2010-2015. Exceedances are highlighted in yellow and ozone exceedances are based on the 8 hour ozone standard of 75. On October 1, 2015, EPA strengthened the National Ambient Air Quality Standards (NAAQS) for 8 hour ground-level ozone to 70 parts per billion (ppb), based on extensive scientific evidence about ozone's effects on public health and welfare. Exceedances of the new standard are highlighted in green. During 2014-2015 there were no exceedances of

the 75 or 70 ppb standards (0.075 or 0.070 ppm). The Annual statistics for 2015 are not final until May 1, 2016 (Environmental Protection Agency 2015c).

Table 114. Air Pollutant Monitoring Results for Selected Counties in Western Colorado.

County	CO 2nd Max 1-hr	CO 2nd Max 8-hr	NO2 98th %ile 1-hr	NO2 Mean 1-hr	O3 2nd Max 1-hr	O3 4th Max 8-hr	SO2 99th %ile 1-hr	SO2 2nd Max 24-hr	SO2 Mean 1-hr	PM2.5 98th %ile 24-hr	PM2.5 Wtd. Mean 24-hr	PM10 2nd Max 24-hr	PM10 Mean 24-hr
2010													
Delta	.	.	.	.	.	.	.	.	.	.	.	115	23
Garfield	.	.	.	.	0.09	0.077	.	.	.	.	.	55	26
Gunnison	.	.	.	.	0.07	0.06	.	.	.	.	.	123	25
La Plata	1.2	0.7	39	6	0.08	0.074	.	.	.	11	4.3	226 (2)	25
Mesa	1.7	1.1	.	.	0.08	0.069	.	.	.	37	9	131	28
Montezuma	.	.	.	.	0.08	0.066	.	.	.	13	6	.	.
San Miguel	.	.	.	.	0.06	0.059	.	.	.	.	.	133	20
2011													
Delta	.	.	.	.	.	.	.	.	.	.	.	48	21
Garfield	.	.	.	.	0.08	0.076	.	.	.	.	.	73	21
Gunnison	.	.	.	.	0.07	0.064	.	.	.	.	.	74	24
La Plata	1.3	0.7	38	7	0.08	0.077	.	.	.	11	4.4	50	18
Mesa	1.8	1.1	.	.	0.09	0.074	.	.	.	22	7.1	54	25
Montezuma	.	.	.	.	0.08	0.071	.	.	.	15	6.1	.	.
San Miguel	.	.	.	.	0.08	0.069	.	.	.	.	.	61	16
2012													
Delta	.	.	.	.	.	.	.	.	.	.	.	58	24
Garfield	.	.	30	6	0.1	0.082	.	.	.	6	2.5	46	19
Gunnison	.	.	.	.	0.08	0.07	.	.	.	.	.	91	20
La Plata	0.8	0.6	29	6	0.08	0.069	.	.	.	10	4.3	59	19
Mesa	1.6	1	.	.	0.09	0.073	.	.	.	24	7.3	143	23
Montezuma	.	.	.	.	0.08	0.07	.	.	.	12	5.6	.	.
San Miguel	.	.	.	.	0.08	0.063	.	.	.	.	.	68	17
2013													
Delta	.	.	.	.	.	.	.	.	.	.	.	44	21
Garfield	.	.	38	6	0.08	0.069	.	.	.	9	3.9	34	18
Gunnison	.	.	.	.	0.07	0.064	.	.	.	.	.	61	21
La Plata	1.7	1	35	6	0.08	0.072	.	.	.	29	4.5	38	20
Mesa	1.4	0.9	.	.	0.07	0.066	.	.	.	40	8.8	56	19
Montezuma	.	.	.	.	0.08	0.069	.	.	.	12	6.1	.	.
San Miguel	.	.	.	.	0.07	0.069	.	.	.	.	.	58	17
2014													
Delta	.	.	.	.	.	.	.	.	.	.	.	49	24
Garfield	.	.	24	5	0.08	0.066	.	.	.	10	3.8	42	18

County	CO 2nd Max 1-hr	CO 2nd Max 8-hr	NO2 98th %ile 1-hr	NO2 Mean 1-hr	O3 2nd Max 1-hr	O3 4th Max 8-hr	SO2 99th %ile 1-hr	SO2 2nd Max 24-hr	SO2 Mean 1-hr	PM2.5 98th %ile 24-hr	PM2.5 Wtd. Mean 24-hr	PM10 2nd Max 24-hr	PM10 Mean 24-hr
Gunnison	.	.	.	.	0.07	0.063	.	.	.	.	.	97	22
La Plata	1.3	1	24	5	0.08	0.067	.	.	.	10	3.8	34	15
Mesa	1.7	0.9	.	.	0.07	0.063	.	.	.	21	7.4	45	19
Montezuma	.	.	.	.	0.07	0.065	.	.	.	9	5.2	.	.
San Miguel	.	.	.	.	0.07	0.064	.	.	.	.	.	68	17
2015													
Delta	.	.	.	.	.	.	.	.	.	.	.	54	20
Garfield	.	.	30	7	0.08	0.068	.	.	.	9	4.6	40	17
Gunnison	.	.	.	.	0.08	0.068	.	.	.	.	.	76	23
La Plata	0.8	0.7	23	4	0.08	0.068	.	.	.	10	3.4	37	19
Mesa	1.3	0.9	.	.	0.08	0.065	.	.	.	21	6.2	34	16
Montezuma	.	.	.	.	0.07	0.066	.	.	.	10	4.5	.	.
San Miguel	.	.	.	.	.	.	.	.	.	.	.	89	23

(1) Exceedance of EPA Air Quality Standards:

Carbon Monoxide: 35 ppm (1-hour), 9 ppm (8-hour)
Nitrogen Dioxide: 100 ppb (1-hour), 53 ppb (annual)
Ozone: 0.12 ppm (1-hour), 0.075 ppm (8-hour)
Sulfur Dioxide: 75 ppb (1-hour), 140 ppb (24-hour), 30 ppb (annual)
PM2.5: 35 ug/m3 (24-hour), 12.0 ug/m3 (annual)
PM10: 150 ug/m3 (24-hour)
Lead: 0.15 ug/m3 (3-month avg)
(2) This exceptional event exceedance is described above in the PM10 section.

Desired Condition

The desired condition for the GMUG National Forest is as follows:

- Maintain Class I air quality conditions for those designated areas on the GMUG. Do not allow on-forest activities to elevate emissions to levels of non-attainment for the Class II areas.
- Coordinate with local, regional, and State interests to resolve regional air quality emission issues that may influence air quality and visibility on the GMUG.

Fuels management treatments that rely on burning would need to incorporate air quality management practices with regards to timing and atmospheric conditions to minimize particulate emissions.

Risks to Achieving Desired Conditions

- Wildfire, because of its unpredictable and unplanned timing, is the greatest threat to air quality on the GMUG.
- Increasing urbanization of communities surrounding the GMUG has the potential to increase fossil-fuel emissions related to increased vehicle trips and traffic.
- Development of oil and gas, and to a lesser extent, coal-fired power generation plants within the region could increase emissions that would further impact visibility or cause impacts on high elevation receptors, such as sensitive alpine vegetation, lakes, and streams in the Wilderness areas on the GMUG.

Performance measures include:

- Non-attainment conditions
- Source emissions
- Visibility ratings

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

This alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. It assumes no implementation of the Proposed Action. Under Alternative 1, there would be no additional project-related prescribed burning or equipment use. Managed Wildfire implementation would continue per existing authority and direction found in the LRMP. Current and future air quality conditions would remain the same or be similar to current conditions depending on regional urban, dust from roads, wind events, construction, transportation, fossil fuels exploration and production, burning emissions growth from sources such as electrical power generation plants, and other planned and approved vegetation management projects. However, as dead trees fall and surface fuels increase over one to two decades, the potential for wildfires and Managed Wildfire to produce more smoke would increase due to heavier surface fuel loads burning and possibly larger fire areas burning due to an increase in the resistance to control.

An increase in wildfire smoke emissions increases air quality impacts in smoke sensitive areas and Class I and II areas. Concentrations of possibly unhealthy levels of particulate matter and carbon Monoxide occurs in occupied smoke sensitive areas immediately adjacent to burning wildfires. Particulate matter can travel tens or even hundreds of miles depending on the amount of smoke produced and meteorological conditions, and cause air quality impacts to smoke sensitive areas and Class I and II airs sheds downwind. Particulates become part of the air mass where they were released, gradually dispersing to a more uniform concentration within the air mass until gravity or precipitation brings them back to earth days or weeks later. As carbon Monoxide moves further away from the burning source it degrades and reduces back into its original constituents, and generally would not pose a health problem several miles or further

away from the source. Wildfire smoke NO2 and VOC could increase or decrease ozone production depending on the amounts of smoke present during the day time and whether the smoke plume is dense enough to limit the interaction of sunlight with ozone precursor constituents (CDPHE 2010a).

Though difficult to quantify, dying and dead spruce and aspen stands would become a source of GHG over time as plant tissues cease to photosynthesize (and thus cease to sequester) and eventually decompose. However, the amount of GHG emitted from decomposition would be offset to an unknown degree by the growth of vegetation that would occupy sites opened up by forest mortality (Ryan et. al. 2012). The same type of phenomenon would occur if the forests were burned by wildfires. The wildfires would produce large amounts of GHG emissions and reduce sequestration in the short-term. Dead trees and plant tissue would decompose producing more GHG emissions, but would be offset to an unknown degree by new plant growth over the long-term.

Alternative 1 – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no changes to air quality would result from the implementation of the No Action Alternative. In other words, there are no direct effects to air quality from the No Action Alternative. However, there are indirect effects - delayed in time, different in space - of No Action, such as a potential for wildfires more proximal to the WUI and, therefore, more smoke impacts close to smoke sensitive areas.

With respect to ongoing and reasonably foreseeable actions that could result in cumulative impacts to air quality, prescribed burns authorized by other decisions in the project area would result in short-term smoke and its associated PM10 emissions. In addition, increased population growth near the GMUG results in increased emissions from transportation both on and off Forest System lands, as well as more wood-burning.

Carbon

Under the No Action Alternative, some areas would be salvaged or treated via other decisions, but to a lesser degree than under the Action Alternatives. Untreated high-mortality stands would remain a net source of carbon for the long-term, until if and when regeneration results in a rate of carbon sequestration that outpaces the carbon source of decomposing biomass.

Effects Common to All Action Alternatives

Treatments Distribution

In the Gunnison Basin treatments for salvage/resiliency will be closer to 50/50 and outside the Gunnison Basin treatments are estimated to be 70 percent resiliency and 30 percent salvage. Based on these assumptions the total volume predictions for Alternative 2 will be 840,000 centum cubic feet (ccf) and 810,000 ccf for Alternative 3. One ccf equals 100 cubic feet.

Slash Piles Design Features and Smoke Emissions

Design Feature Slash Piles 4 (SP-4) recommends keeping the treatment area covered by piles under ~5 percent (<2,178 square feet per acre). Two slash piles sizes were used for estimating smoke emissions, (Table 115). Machine piles are half ellipsoid 11’ wide, 10’ high, and 30’ long with a foot-print area of 1,037 square feet. Hand piles are paraboloid 10’ wide and 6’ high with a foot-print area of 79 square feet. In order keep treatment areas covered by piles under ~5 percent a maximum of two machine piles and twenty-seven hand piles per acre can be constructed.

Table 115. Piled Fuels Biomass and Emissions Calculator Report.

Pile Group Data:

Group No.	Group Name	No. Piles	Pile Type	Pile Shape	Pile Dimensions	Soil %	Packing Ratio	Pile Composition	Pile Quality	Consumption
1	Machine Pile	1	Machine	Half ellipsoid	W1: 11 H1: 10 L1: 30	2%	20%	Engelmann spruce (100%)	Clean	90%
2	Hand Pile	1	Hand	Paraboloid	W1: 10 H1: 6	N/A	N/A	Conifer	N/A	90%

Pile Group Results:

Pile Group No.	Pile Group Name	Foot Print Area (square feet)	Gross Volume (cubic ft)	Adjusted* Volume (cubic ft)	Pile Biomass (Tons)	Consumed Fuel (Tons)	Emissions by pollutant (Tons)						
							PM	PM10	PM2.5	CO	CO2	CH4	NMHC
1	Machine Pile	1,037	1,727.88	328.30	4.0216	3.6195	0.0409	0.0289	0.0252	0.1418	6.2119	0.0105	0.0084
2	Hand Pile	79	235.62	187.65	0.3530	0.3177	0.0035	0.0025	0.0021	0.0121	0.5285	0.0009	0.0007

*Adjusted volume for hand piles is corrected to account for the difference between the gross volume of a geometric shape and the actual volume of the pile. Machine pile adjusted volume of solid wood is determined by subtracting the amount that is soil from the gross volume and applying the appropriate packing ratio.

Incidental Vegetation Types and Estimated Percent of Consumption

The treatment of vegetation outside of spruce and aspen stands becomes necessary in areas where safe and efficient fireline locations do not match the spruce or aspen stand perimeters. Due to vegetation treatment operational constraints, fire managers would need to establish firelines outside those stands and individual treatments may treat incidental vegetation types with prescribed fire broadcast/underburning that are not dominated by spruce or aspen. Table 116 shows the estimated prescribed burning consumption rates in six incidental vegetation types used for estimating prescribed burning emissions.

Table 116. Incidental Vegetation Types Estimated Percent of Consumption.

Vegetation Type	Primary Fire Behavior/Fuels Consumption	Estimated Percent of Consumption
Sagebrush	Crown Fire Surface and Canopy Fuels Consumption	60%
Oak Dominated Mountain Shrub	Crown Fire Surface and Canopy Fuels Consumption	70%
Lodgepole Pine	Surface Fire Surface Fuels Consumption Some Tree Torching	40%
Grass/Forb	Crown Fire Surface and Canopy Fuels Consumption	90%
Ponderosa Pine	Surface Fire Surface Fuels Consumption	50%
Douglas-fir	Surface Fire Surface Fuels Consumption	50%

Class I and II Areas

Smoke from prescribed burning may temporarily reduce visibility from one day to several days at a time in Class I and II Areas in and surrounding the GMUG when burning operations take place upwind from these areas, (Table 117). SBEADMR visibility impacts would be temporary and transient compared to reduced visibility due to stationary and mobile sources that produce criteria pollutants year around.

Table 117. Class I and II Areas in and adjacent to SBEADMR Geographic Areas.

Geographic Area	Class I Areas	Class II Areas
Grand Mesa	N/A	N/A
Gunnison Basin North	Maroon Bells-Snowmass (USFS), West Elk (USFS), Black Canyon of the Gunnison National Park and Gunnison Gorge (BLM) west of GMUG forest boundary	Raggeds (USFS), Fossil Ridge (USFS), Collegiate Peak (USFS)
Gunnison Basin South	La Garita (USFS)	Powderhorn (USFS/BLM)
Nork Fork Valley	N/A	N/A
San Juans	N/A	Lizard Head USFS), Mount Sneffels (USFS), Uncompahgre (USFS/BLM)
Uncompahgre Plateau	Black Canyon of the Gunnison National Park and Gunnison Gorge Wilderness (BLM) east of GMUG forest boundary	Dominguez Canyon (BLM)

Smoke Sensitive Areas

The 2007 LRMP identifies the following as smoke sensitive areas: I-70 Interstate corridor; the North Fork, Uncompahgre and the Gunnison River Valleys; and the towns of Grand Junction, Delta, Cedaredge, Paonia, Hotchkiss, Olathe, Montrose, Ridgeway, Ouray, Telluride, Norwood, Nucla, Naturita, Paradox, Gunnison and Crested Butte (Table 118). Fire managers would be required to identify these areas in smoke permit applications and show how people living in the areas would be notified about prescribed burning well in advance of burning operations. Fire managers would also need to identify how they would monitor for possible smoke impacts and would be required to provide smoke contingency plans in case conditions are forecasted to deteriorate in smoke sensitive areas. CDPHE Regulation 9 requires fire managers to use the Pile Standard Permit Condition Worksheet as a guideline. Smoke dispersal requirements (mixing heights and transport winds) increase as the amounts of slash pile materials increase and as prescribed burning operations occur closer to homes. There would be more prescribed burning constraints under Alternative 3 (WUI), as more burning would take place closer to occupied homes.

Table 118. Smoke Sensitive Areas Affected by Geographic Areas.

Geographic Area	Counties	Smoke Sensitive Areas
Grand Mesa	Delta, Garfield, Mesa	Delta, Cedaredge, Paonia, Hotchkiss, Grand Junction, I-70 Interstate corridor, North Fork Valley, Uncompahgre Valley
Gunnison Basin North	Gunnison	Crested Butte, Gunnison, Gunnison River Valley
Gunnison Basin South	Gunnison, Hinsdale, Saguache	Gunnison, Crested Butte, Gunnison River Valley
Nork Fork Valley	Gunnison, Delta, Montrose	Olathe, Montrose, Gunnison, Nucla, Naturita, Paradox, Hotchkiss, North Fork Valley
San Juans	Gunnison, Ouray, Hinsdale, San Miguel, Montrose	Ouray, Ridgeway, Telluride, Norwood, Nucla, Naturita, Paradox, Gunnison, Crested Butte, Olathe, Uncompahgre Valley
Uncompahgre Plateau	Mesa, Montrose, San Miguel, Ouray	Montrose, Ouray, Grand Junction, Paradox, Olathe, Ridgeway, Telluride, Norwood, Nucla, Naturita, Uncompahgre Valley

Cumulative Effects – Common to Both Action Alternatives

Currently on the GMUG there are 16-18 natural gas wells in production and approximately 24 on BLM and private lands adjacent to the GMUG, and 265 proposed new wells in nine separate projects in the Grand Mesa and North Valley Geographic Areas. During the development phase one well's development produces about 0.2 tons PM10, 3.6 tons NO2 and 1,572-1,675 tons CO2e per year. During the production phase one well produces about 0.1 tons PM10, 0.4 tons NO2 and 378-405 tons CO2e per year (Environmental Assessment DOI-BLM-CO-S050-2015-0029-EA). Current wells in production (40-42 wells) produce about 3.2-3.4 tons PM10, 17.6-18.5 tons NO2 and 15,134-17,020 tons CO2e per year. If 265 proposed wells are developed they would produce about 50.35 tons PM10, 948.7 tons NO2 and 416,590-443,875 CO2e per year during development, and about 21.2 tons PM10, 116.6 tons NO2 and 100,265-107,389 tons CO2e per year in production.

The West Elk and Elk Creek coal mines currently extract 9-11 million tons of coal per year in the North Fork Valley and produce 31 million metric tons of GHGs annually; approximately 2 million of which are methane for two more years. Proposed new coal extraction are dependent on the outcome of decisions relating to the Colorado Roadless Rule and if the rule is not reinstated then current coal extraction would continue for two more years. If the Roadless Rule is reinstated

then it is proposed that new coal extraction would annually produce between 14-43 million metric tons of CO2e over 9-17 years (Table 119).

Table 119. Current and Proposed GMUG Fossil Fuels Development and Production.

Geographic Area	Current and Proposed Fossil Fuels Production Activities
Grand Mesa	**Proposed Activity:** Axia Energy, LLC, #1-16SC Well Expansion in Grand Valley District. At USA #1-16SC well pad, drilling two new wells on the well pad.
	Proposed Activity: Gunnison Energy, 18 wells. Approved, not yet constructed.
	Proposed Activity: Oxy and Axia Energy, LLC. 32 wells and compression station - near Beaver/Buzzard/Hightower Creeks. Approved, not yet constructed.
Gunnison Basin North	None
Gunnison Basin South	None
Nork Fork Valley	**Current Activity:** 9-11 million tons coal produced annually from all sources on the GMUG in the North Fork Valley.
	Current Activity: West Elk and Elk Creek coal mines: 31 million metric tons of GHGs annually; approximately 2 million of which are methane (source: Draft EIS, Colorado Roadless Rulemaking)
	Proposed Activity: West Elk & Elk Creek coal mines: - If the Roadless Rule is not reinstated then 31 million metric tons of GHGs annually; and approximately 2 million of which are methane; for 2 more years. - If the Roadless Rule is reinstated, annual CO2e 13,600,000-43,200,000 metric tons emissions over 9-17 years.
	Proposed Activity: Gunnison and SG Interests' 5-pad natural gas EA: - Up to 25 new wells within 5 years - Associated emissions for 25-well, included w/additional estimates for North Fork area (Bull Mountain) and BLM's CARMSS 2021 modeling work for the local BLM office's (Uncompahgre Field Office) planning area, from page 164 of the EA:
	Proposed Activity: 150 Well Bull Mountain MDP: The Bull Mountain Unit Master Development Plan involves the exploration and development of up to 146 natural gas wells, 4 water disposal wells and associated infrastructure on federal and private mineral leases.
	Proposed Activity: Petrox 2 Application for Permit to Drill (APDs) at Pilot Knob: Two APDs from Petrox Resources proposed for development in the Federal Somerset Unit, a 6,400- acre project area that largely overlies the Pilot Knob Roadless Area north of Somerset.
	Proposed Activity: Huntsman Unit Proposal: SG has proposed drilling in the Huntsman Unit (COC 74403X), which includes three SG leases (COC 63886,

Geographic Area	Current and Proposed Fossil Fuels Production Activities
	63888, and 63889). SG has proposed one APD there for well 10-89-31 #1 inside lease COC 63886.
	Proposed Activity: Deadman Gulch APD: SG has proposed one APD (12-89-30#1) inside the GE Deadman Gulch Unit adjacent to the Petrox Somerset Federal Unit within the Pilot Knob CRA on lease COC 64169.
	Proposed Activity: (BLM Surface) Spruce Stomp Coal Lease for 35 methane drainage wells
	Proposed Activity: Per Hotchkiss Federal BLM-DOI-UFO-2008-035 EA, up to 7 additional wells approved, not yet constructed wells of the original 16 approved.
San Juans	None
Uncompahgre Plateau	None

Table 120 summarizes the information provided above and compares current natural gas and coal production with proposed future development and production.

Table 120. Current and Proposed Natural Gas and Coal Development and Production Annual Emissions Scenarios (Tons).

NAAQS Criteria Pollutant and GHG	Current Annual Natural Gas and Coal In Production Emissions (1) 40-42 NG Wells 9-11 Million Tons Coal (Tons)	Proposed Annual Natural Gas Development Emissions 265 Wells (Tons)	Proposed Annual Natural Gas Production Emissions 265 Wells (Tons)	Proposed Annual Coal Production Emissions (1) (If the Colorado Roadless Rule and is not reinstated.) (Tons)
PM10	3.2-3.4	50.35	21.2	Not Available
NO2	17.6-18.5	948.7	116.6	Not Available
CO2e	34,115,134-34,117,020	416,590-443,875	100,265-107,389	15,400,000-47,300,000

(1) PM10 and NO2 not available for coal.

As a comparison to these emissions, potential annual SBEADMR are displayed in Table 121.

Table 121. SBEADMR Annual Emissions (Tons).

NAAQS Criteria Pollutant and GHG	SBEADMR Alternative 2 Annual Emissions (Tons)	SBEADMR Alternative 3 Annual Emissions (Tons)
PM10	423-954	371-832

NAAQS Criteria Pollutant and GHG	SBEADMR Alternative 2 Annual Emissions (Tons)	SBEADMR Alternative 3 Annual Emissions (Tons)
NO2	22-32	17-25
CO2e	8,800-15,400	6,600-13,200

Compared to Alternative 2, current natural gas and coal production produce 0.35-0.75 percent PM10, 58-80 percent NO2 and Alternative 2 would produce 0.03-0.45 percent CO2e of current production. Compared to Alternative 3, current natural gas and coal production produce 0.40-0.86 percent PM10, 74-103 percent NO2 and Alternative 2 would produce 0.02-0.04 percent CO2e of current production.

In addition to proposed SBEADMR treatments, there are about 115,292 acres in current and proposed GMUG mechanical and fuels management vegetation treatment projects on the GMUG. The projects include non-commercial tree harvest and thinning, activity fuels reduction, and prescribed broadcast and underburning in spruce, fir, aspen, pine, pinyon juniper, oak and oak brush vegetation types (Table 122). Emissions from activity fuels slash piles prescribed burning would result in smoke emissions similar to the SBEADMR project on a per acre basis. Additionally, broadcast/underburning can take place in aspen, pine, fir, pinyon juniper, oak and oakbrush vegetation types in order to meet LRMP fuel loading standards and guides. Broadcast/underburning generally produces more smoke emissions per acre compared to activity fuels slash pile burning.

Table 122. Current and Proposed Mechanical & Prescribed Burning Projects by GA.

Geographic Area	Vegetation Types	Acres
Grand Mesa	Pinyon/Juniper	54
	Spruce/Fir	317
Gunnison Basin North	Douglas-fir/Sage/Aspen	565
	Lodgepole	1,319
	Pine/Doug/Lodgepole	45,215
	Pine/Douglas-fir/Oakbrush	12,577
Gunnison Basin South	Pine/Douglas-fir	9,340
North Fork Valley	Oakbrush	492
	Pine/Douglas-fir/Oakbrush	3,753
San Juans	Spruce/Fir	1
	White Fir/Douglas-fir	293
Uncompahgre Plateau	Oak/PJ/Pine	2,032
	Pine	999
	Pine/Aspen	56
	Pine/Douglas-fir	7,679

Geographic Area	Vegetation Types	Acres
	Pine/Douglas-fir/Aspen	2,924
	Pine/Oakbrush	21,273
	Pine/PJ	5,705
	PJ/Oakbrush	698
Grand Total		**115,292**

There are about 57,028 acres in current and proposed GMUG prescribed burning vegetation treatment projects in four Geographic Areas. The projects include prescribed broadcast/underburning in aspen, pine, fir, pinyon juniper, oak brush, and sage vegetation types (Table 123). Broadcast/underburning generally produces more smoke emissions per acre compared to activity fuels slash pile burning.

Table 123. Current and Proposed Prescribed Burning only Projects by GA.

Geographic Area	Vegetation Types	Acres
Grand Mesa	Oakbrush	1,818
Gunnison Basin North	Douglas-fir/Sage/Pine	16,135
	Sagebrush/Aspen	4,719
Gunnison Basin South	Pine/Sage/Douglas-fir	4,343
	Sagebrush/Pine/Douglas-fir	1,479
Uncompahgre Plateau	Oakbrush/Pine	4,604
	Pine	1,963
	Pine/Douglas-fir	2,398
	Pine/Douglas-fir/Aspen	2,499
	Pine/Oakbrush	14,614
	PJ/Oakbrush	2,456
	Grand Total	**57,028**

Effects of past actions on air quality are reflected in the environmental baseline. Going forward, ongoing and reasonably foreseeable impacts to air quality from SBEADMR and other activities, including other prescribed burns and fossil fuel development and production on Forest System Lands and in the vicinity, would result in higher emissions than those disclosed in the direct and indirect effects. However, the capacity of the Forest Service to complete significantly more prescribed burns than those identified in SBEADMR is unlikely; cumulative emissions from these activities are likely within the range disclosed in the direct and indirect effects analysis.

Criteria Pollutants and Green House Gases

From the emissions that can be quantified pertinent to SBEADMR, implementation of Alternative 2 could produce a total of about 6,348-14,310 tons PM10 and about 329-473 tons NO2; Alternative 3 could produce a total of about 5,561-12,477 tons PM10 and about 261-371 tons NO2 over fifteen years. Alternative 2 could produce average annual greenhouse gas emissions of about 0.05-0.09 percent; and Alternative 3 could produce about 0.04-0.08 percent of those estimated to be produced in Colorado in 2020. These figures would be higher in combination with ongoing and reasonably foreseeable actions in the project area. However, as noted above, treatment-related emissions from prescribed burns and equipment would not likely be significantly higher than those disclosed in SBEADMR, as the capacity of the Forest Service to complete such additional treatments would be limited.

However, the cumulative net effects of SBEADMR and these other activities on carbon storage/greenhouse gas emissions, relative to the No Action Alternative, are difficult to quantify. As noted above, to the extent that impacted soils in treated areas may act as a source, harvested wood products and higher rates of regrowth in planted areas (and those with more open canopies) would also serve as carbon sinks.

To provide context for climate change contribution, the EPA has recently modeled global climate change impacts from a model source emitting 20 percent more GHGs than a 1500MW coal-fired steam electric generating plant (approx. 14,132,586 metric tons per year of CO2, 273.6 metric tons per year of nitrous oxide, and 136.8 metric tons per year of methane). It estimated a hypothetical maximum mean global temperature value increase resulting from such a project. The results ranged from 0.00022 and 0.00035 degrees Celsius occurring approximately 50 years after the facility begins operation. The modeled changes are extremely small, and any downsizing of these results from the global scale would produce greater uncertainty in the predictions. The EPA concluded that even assuming such an increase in temperature could be downscaled to a particular location, it “would be too small to physically measure or detect”, see Letter from Robert J. Meyers, Principal Deputy Assistant Administrator, Office of Air and Radiation re: “Endangered Species Act and GHG Emitting Activities (quoted pg. 85, EA DOI-BLM-CO-S050-2015-0029-EA). The SBEADMR project emissions are a fraction of the EPAs modeled source and are shorter in duration, and therefore reasonable to conclude that the project would have no measurable impact on the climate.

Alternative 2 (Agency Preferred Alternative) – Direct and Indirect Effects

Under Alternative 2, direct air quality effects would be the production of emissions from equipment used to implement project work, road dust and smoke emissions from prescribed burning.

For Alternative 2, 840,000 ccf are estimated to be harvested over the life of the project and, based on that total harvest estimate, equipment emissions estimates were made using daily production rates shown in Table 124. Table 125 shows the total amount of logging equipment criteria pollutants and GHG emissions that would be produced in Alternative 2. Equipment use over the approximately fifteen year implementation timeframe of the project would include only tens of gasoline or diesel fuel powered vehicles and specialized tree harvesting equipment on any given day, spread out over a large area. Therefore the amount of emissions the equipment would produce would be nearly insignificantly small compared to county and state level emissions, and emissions concentrations would depend on where, when and how many acres would be treated, the number of and types of vehicles/equipment that would be used, miles driven and their hours of operation. In most circumstances vehicle and equipment emissions disperse rapidly and the potential concentrations caused by only tens of vehicles/equipment would not cause NAAQS exceedances.

Table 124. Logging Equipment Types, Daily Production Rates, Equipment Horse Power and the Total Numbers of Operating Days Required to Complete Logging Operations Proposed in Alternative 13.

Equipment Type	Daily Production Rate	Horse Power	Alternative 2 Operating Days
Grapple Skidder	300 ccf/Day	175	2,800
Feller Buncher	367 ccf/Day	300	2,289
Stroke Delimber	200 ccf/Day	300	4,200
Loader	200 ccf/Day	175	4,200
Masticator	5 acres/Day	300	1,000
Chainsaw	100 ccf/Day	11	8,400
Pick-Up Truck (1)	100 ccf/Day	N/A	8,400
Log Hauling Truck (1)	10 ccf/Truck – Two Loads Per Day (20 ccf)	N/A	42,000

(1) CH4 and MMHC data only available for Pick-up Trucks and Log Hauling Trucks.

Table 125 shows the total amount of logging equipment criteria pollutants and GHG emissions that would be produced in Alternative 2.

Table 125. Total Amount of Logging Equipment NAAQS Criteria Pollutants and GHG Emissions Produced in Alternative 2 Over Fifteen Years (Tons).

PM10	PM2.5	CO	C02 (GHG)	CH4 (GHG)	NMHC	NO2	SO2
0.8	0.7	63.8	102.1	0.2	2.9	1.4	0.002

Dust abatement would be applied in sensitive areas (for example near subdivisions or in campgrounds) at the individual treatment phase. Transportation design features address dust abatement (Appendix B).

Prescribed burning would take place in spruce treatment units for reducing activity-related slash pile fuels and in aspen and aspen/conifer mixed stands for regenerating aspen. Based on priority treatment area analysis in the six Geographic Areas, treatment assumptions were developed in order to define treatment types, corresponding acreages, and number of piles per acre for estimating smoke emissions (Table 126). The adapted/potential future treatment type category shows 0-36,000 acres of spruce salvage and is a contingency category in case spruce stands that are currently in the Resiliency category die and move from resiliency to salvage. Aspen treatments would be accompanied by lop and scatter of activity fuels in the units to help limit ungulate and livestock access to the units in order to reduce browse pressure. Activity fuels in spruce treatments on the Uncompahgre Plateau would use lop and scatter instead of slash pile burning. Incidental Vegetation Types under Combined Treatments would be broadcast/underburned.

Table 126. Estimated Alternative 2 Treatment Types and Corresponding Acreage.

	Commercial Treatment Types Proposed and Adapted			Noncommercial Treatment Types		
	Proposed/Current Treatment Types		Adapted/ Potential Future Treatment Type			
Geographic Area	**Salvage**	**Resiliency**	**Salvage**	**Burn and Mechanical Treatment**	**Mechanical Only Treatment**	**Combined Treatments Incidental Vegetation Types**
	24,000 acres: average .5-2 machine pile/acre	14,400 acres maximum treatment 10,800 acres (70%) piled: average 1.67 machine pile/acre 4,320 acres (30%) lop and scatter (no pile burning)	0-36,000 acres: average .5-2 machine pile/acre	5,000 acres mechanical treatment and hand pile burning: average 7-20 hand piles/acre 25,000 Aspen and mixed vegetation types broadcast burning	No Rx Burning 25,000 acres Aspen thinning/ coppice cuts lop and scatter	6,478 acres mixed vegetation all broadcast/ underburning
Grand Mesa	pile burn	pile burn	pile burn	hand pile and broadcast/ underburning	mechanical only and lop and scatter	broadcast/ underburning
Gunnison Basin North	pile burn	pile burn	pile burn	hand pile and broadcast/ underburning	lop and scatter	broadcast/ underburning
Gunnison Basin South	pile burn	pile burn	pile burn	hand pile and broadcast/ underburning	lop and scatter	broadcast/ underburning
North Fork Valley	pile burn	pile burn	pile burn	hand pile and broadcast/ underburning	mechanical only and lop and scatter	broadcast/ underburning
San Juans	pile burn	pile burn	pile burn	hand pile and broadcast /underburning	lop and scatter	broadcast/ underburning
Uncompah gre Plateau	lop and scatter	lop and scatter	pile burn	hand pile and broadcast/ underburning	lop and scatter	broadcast/ underburning

Table 127 shows slash pile emissions from the Piled Fuels Biomass and Emissions Calculator outputs over fifteen years, based on the assumptions in Table 126.

Table 127. Alternative 2 Estimated Range of Total NAAQS and GHG Emissions from Prescribed Burning of Slash Pile Over Fifteen Years (Tons).

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	Commercial Treatment Types Proposed and Adapted					Noncommercial Treatment Types		Total Pile Prescribed Burning Emissions Range Over Fifteen Years (Tons)	
	Proposed/Current Treatment Types			Adapted Treatment Type					
	Spruce Recovery Salvage Machine Pile .5-2 piles/acre 24,000 acres 12,000-48,000 piles total (Tons)		Spruce Resiliency Machine Pile 1.67 piles/acre 10,800 acres 18,036 piles total (Tons)	Spruce Recovery Salvage Machine Pile .5-2 piles/acre 36,000 acres 18,000-72,000 piles total (Tons)		Non-Commercial Mechanical, Hand Treatments 15-27 piles/acre 5,000 acres 35,000-100,0000 piles total (Tons)			
	Min	Max		Min	Max	Min	Max	Min	Max
Particulate Mater	491	1,963	738	736	2,945	123	350	2,088	5,996
Particulate - PM10	347	1,387	521	520	2,081	88	250	1,476	4,239
Particulate - PM2.5	302	1,210	455	454	1,814	74	210	1,285	3,689
Carbon Monoxide - CO	1,702	6,806	2,558	2,552	10,210	424	1,210	7,236	20,784
Carbon Dioxide - CO2 – (GHG)	74,543	298,171	112,038	111,814	447,257	18,498	52,850	686,688	910,316
Methane - CH4 – (GHG)	126	504	189	189	756	32	90	526	1,539
NMHC	101	403	152	151	605	25	70	429	1,230

For treatments in aspen, the FOFEM model was used for estimating a range of potential broadcast prescribed burning emissions based on model default fuel loading values ranging from light to heavy fuel loads that are burned under very dry and wet conditions (Table 128). Under Alternative 2 it is assumed that 25,000 acres of aspen would be broadcast prescribed burned over ten years. The model outputs provide a minimum and maximum range of emissions. Aspen does not burn under wet conditions no matter the fuel loading and dry or very dry conditions are required before surface fuels will burn. Actual smoke emissions from broadcast prescribed burning in aspen would be in the upper range.

Table 128. Alternative 2 Estimated Emissions from Broadcast Prescribed Burning in Aspen Over Fifteen Years (Tons).

The total emissions range column shows the range of emissions if 25,000 acres were treated over ten years.

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	Light Fuel Load Very Dry (Tons)	Light Fuel Load Wet (Tons)	Heavy Fuel Load Very Dry (Tons)	Heavy Fuel Load Wet (Tons)	Total Aspen Prescribed Burning Emissions Range Over Fifteen Years	
					Light Fuel Load Wet (Tons)	Heavy Fuel Load Very Dry (Tons)
Particulate – PM10	1,963	875	7,363	3,838	4,713	9,325
Particulate - PM2.5	1,663	738	6,238	3,250	3,988	7,900
Methane - CH4 – (GHG)	1,000	425	3,725	1,925	2,350	4,725
Carbon Monoxide - CO	21,663	9,275	80,725	41,450	50,725	102,388
Carbon Dioxide - CO2 – (GHG)	125,263	72,438	480,663	288,450	360,888	605,925
Nitrogen Dioxide - NO2	63	63	275	225	288	338
Sulfur Dioxide - SO2	100	50	350	200	250	450

Under Alternative 2, priority treatment areas were analyzed to determine the optimal location for firelines and an estimated 6,478 acres of non-spruce/aspen could be treated (Table 129).

Table 129. Alternative 2 Incidental Vegetation Types and Acreages.

Incidental Vegetation Type	Alt 2 Acres
Grassland	1,516
Oak Dominated Mountain Shrub	1,771
Sagebrush	1,020
Douglas-fir	226
Lodgepole	839
Ponderosa pine	1,105
Total	6,478

For treatments in incidental vegetation types the FOFEM model was used for estimating a range of potential prescribed broadcast/underburning burning emissions based on estimated fuel consumption, and model default fuel loading values ranging from light to heavy fuel loads that

are burned under very dry and wet conditions. The model outputs provide a minimum and maximum range of emissions (Table 130).

Table 130. Alternative 2 Estimated Emissions from Broadcast/Underburning Incidental Vegetation Types Over Fifteen Years (Tons).

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	1	2	3	4	5	6	7	8	9	10	11	12	Total Min (Tons)	Total Max (Tons)
Particulate – PM10	3	9	19	63	76	433	4	11	40	169	16	60	158	745
Particulate - PM2.5	3	7	16	53	65	367	3	9	34	144	13	51	134	631
Methane - CH4 – (GHG)	1	4	4	16	38	219	1	3	18	80	8	30	70	352
Carbon Monoxide - CO	16	54	40	133	818	4,730	8	23	373	1,655	164	632	1,419	7,227
Carbon Dioxide - CO2 – (GHG)	1,021	3,105	10,854	36,214	6,062	29,296	2,103	6,309	6,406	22,640	1,492	5,546	27,938	103,110
Nitrogen Dioxide - NO2	2	5	19	66	5	18	4	11	9	29	1	5	40	134
Sulfur Dioxide - SO2	1	2	6	20	4	21	2	4	4	14	1	4	18	65

1. Sagebrush Light Fuel Load Emissions per Acre 60% Consumption
2. Sagebrush Heavy Fuel Load Emissions per Acre 60% Consumption
3. Oak Dominated Mountain Shrub Light Fuel Load Emissions per Acre 70% Consumption
4. Oak Dominated Mountain Shrub Heavy Fuel Load Emissions per Acre 70% Consumption
5. Lodgepole Pine Light Fuel Load Emissions per Acre 40% Consumption
6. Lodgepole Pine Heavy Fuel Load Emissions per Acre 40% Consumption
7. Grass/Forb Light Fuel Load Emissions per Acre 90% Consumption
8. Grass/Forb Heavy Fuel Load Emissions per Acre 90% Consumption
9. Ponderosa Pine Light Fuel Load Emissions per Acre 50% Consumption
10. Ponderosa Pine Heavy Fuel Load Emissions per Acre 50% Consumption
11. Douglas-fir Light Fuel Load Emissions per Acre 50% Consumption
12. Douglas-fir Heavy Fuel Load Emissions per Acre 50% Consumption

Large amounts of smoke emissions would be produced each year over the implementation timeframe of approximately fifteen years from prescribed burning of treatment activity-related fuels in slash piles, broadcast burning in aspen and aspen/conifer mixed stands, and broadcast/underburning in incidental vegetation types. Aspen does not burn under wet conditions no matter the fuel loading and dry or very dry conditions are required before surface fuels will burn. Actual smoke emissions from broadcast prescribed burning in aspen would be in the upper range. Spruce slash piles generally will have a very high consumption rate of around 90 percent. The emission calculations made for this analysis assume that all acreage considered in

Alternative 2 would be treated and all acres would be treated the same. Therefore, the estimate shows the maximum amount of emissions that theoretically could be produced. Compared to the Colorado prescribed burning emissions inventory (Table 113), implementation of Alternative 2 would produce an average of about 27-62 percent of statewide annual prescribed burning PM10 emissions, or a range of approximately 423-954 tons of PM10 per year over fifteen years. Table 131 shows all SBEADMR project equipment use and prescribed burning combined and total project emissions over ten years are displayed in the right hand columns.

Table 131. Total Alternative 2 Estimated Emissions Range for the SBEADMR Project Over Fifteen Years (Tons).

NAAQS Criteria Pollutant and Green House Gas (GHG)	Treatment Type						Logging Equipment Emissions (Tons) (3)	Total All SBEADMR Emissions Range Over Ten Years (Tons) (1, 2, 3)	
	Slash Pile Burning (Tons) (2)		Aspen Broadcast Burning (Tons) (1)		Incidental Vegetation Broadcast/ Underburning (Tons) (1)				
	Min	Max	Min	Max	Min	Max		Min	Max
PM	2,088	5,996	-	-	-	-	-	2,088	5,996
PM10	1,476	4,239	4,713	9,325	158	745	0.8	6,348	14,310
PM2.5	1,285	3,689	3,988	7,900	134	631	0.7	5,408	12,221
CO	7,236	20,784	50,725	102,388	1,419	7,227	63.8	59,444	130,463
CO2 (GHG)	686,688	910,316	360,888	605,925	27,938	103,110	102.1	1,075,616	1,619,453
CH4 (GHG)	526	1,539	2,350	4,725	70	352	0.2	2,946	6,616
NMHC	429	1,230	-	-	-	-	2.9	432	1,233
NO2 (criteria pollutant and GHG)	-	-	288	338	40	134	1.4	329	473
SO2	-	-	250	450	18	65	0.002	741	515

(1) FOFEM outputs for aspen broadcast burning do not include PM and NHMC. (2) Piled Fuels Biomass and Emissions Calculator outputs do not include NO2 and SO2. (3) CH4 and MMHC data only available for Pick-up Trucks and Log Hauling Trucks.

Greenhouse Gases and Carbon Sequestration

Implementation of Alternative 2 would produce average annual GHG emissions from prescribed burning of about 0.05-0.09 percent the amount of estimated GHG that will be produced in Colorado in 2020, and 0.001-0.002 percent of GHG emissions estimated to have been produced in the U.S. in 2013 (Table 132). Overall, as spruce and aspen stands die and decay they would produce GHG emissions that, over time, would be offset by sequestration from forest regeneration, and to a lesser amount if forest stands are replaced by grass and shrubs. The timber harvest of mostly dead or dying and, to a lesser extent, live spruce and aspen trees, would

provide a supply of harvested wood products (HWP's) that would sequester carbon when the HWP's are used in construction or in durable goods. A maximum of approximately 0.42 million metric tons of HWP carbon sequestration is possible if all the harvested wood are used in construction or durable goods.

Table 132. Alternative 2 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources.
The SBEADMR annual average represents the estimated total annual project GHG emissions from equipment use and prescribed burning.

GHG Emissions Source	Estimated GHG Emissions (millions metric Tons)
2013 United States	6,673
2020 Colorado	148
SBEADMR Average Annual	CH4 x GWP 28 (1) and CH4 x GWP 36 (1) = 0.005–0.015 CO2 = 0.07-0.11 **Total CO2e Range = 0.08-0.14**

(1) Carbon dioxide equivalents (CO2e) is a metric used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). For instance, over a 100 year period the GWP of methane (CH4) is estimated to be about 28-36 times greater than carbon dioxide (CO2), so its carbon dioxide equivalent (CO2e) is 28-36.

National Ambient Air Quality Standards (NAAQS)

Under Alternative 2, logging equipment use emissions would produce about 0.05 tons of PM10 and 0.09 tons of NO2 per year and compared to state and county annual emissions inventories would increase regional PM10 and NO2 emissions by nearly insignificant amounts (Table 111 and Table 112). Prescribed burning would produce 423-954 tons of PM10 and 22-32 tons NO2 per year on average over fifteen years. According to the 2013 county emissions inventory, below, for the eight county area covered by the GMUG, there were 20,426 tons PM10 and 32,798 tons NO2 produced by all sources excluding agriculture, range and forest management prescribed burning (data not available at the county level). Comparatively, SBEADMR would produce 2-5 percent of PM10 and 0.06-0.09 percent of NO2 annually.

Table 133. Counties within SBEADMR Geographic Areas.

Geographic Area	Counties
Grand Mesa	Delta, Garfield, Mesa
Gunnison Basin North	Gunnison
Gunnison Basin South	Gunnison, Hinsdale, Saguache
Nork Fork Valley	Gunnison, Delta, Montrose
San Juans	Gunnison, Ouray, Hinsdale, San Miguel, Montrose
Uncompahgre Plateau	Mesa, Montrose, San Miguel, Ouray

Prescribed burning would occur at higher elevations above most communities in an adjacent to the GMUG and day time smoke plumes would predominately be blown by transport winds aloft towards the east. The elevation of smoke plumes above ground level is determined by mixing heights that are highest above ground level during warm summer days, and lowest during cold winter conditions and at night. Storm or cold fronts moving through the region create windy conditions that, while good for smoke dispersal, present prescribed burning control problems that constrain burning opportunities. Therefore, the vast majority of broadcast/underburning and slash pile burning would occur during clear high pressure conditions when mixing heights and transport winds would be the predominate factors affecting smoke dispersal. Winter time burning of slash piles when there is snow on the ground can be done under windier conditions better for smoke dispersal because snow would prevent surface fire spreading and fire escaping from prescribed burn units. Most smoke impacts to smoke sensitive areas would occur during night time and early morning hours when smoke pools in drainages and low lying areas such as valleys where most people occupy homes. Night time and early morning inversions can create a cap that holds smoke close to the ground until the inversions breakdown after sun rise when the earth warms. People living in smoke sensitive areas will most likely smell smoke at night and during early morning hours.

In order to protect human health and safety, and prevent NAAQS exceedances, prescribed burning operations are required by state law to obtain and follow the stipulations in Planned Ignition Fire Permits. Fire managers are required to burn only when authorized by the CDPHE and must meet numerous smoke permit requirements including estimates of smoke production, mitigation measures, notification of the public and CDPHE, ignition timing, ventilation objectives (mixing heights and transport winds), smoke contingency planning and implementation of best management practices. Burning may not occur when an ozone alert is in effect for the area of the burn (Colorado Air Pollution Control Division, Prescribed Fire Smoke Permits, Use of Ozone Alert Information Memorandum, 8/5/10).

Alternative 3 (WUI Focus) – Direct and Indirect Effects

Direct and indirect effects from emissions would be similar to Alternative 2 except that all equipment use and prescribed burning would occur in the WUI and in road and utility corridors. Under Alternative 3, 810,000 ccf are estimated to be harvested over the life of the project and, based on that total harvest estimate, equipment emissions estimates were made using daily production rates shown in Table 134. Equipment emissions would be about 13 percent less PM10 and about the same amount of NO2 compared to Alternative 2. Table 135 shows the total amount of logging equipment criteria pollutants and GHG emissions that would be produced in Alternative 3.

Table 134. Logging Equipment Types, Daily Production Rates, Equipment Horse Power and the Total Numbers of Operating Days Required to Completed Logging Operations Proposed in Alternative 3.

Equipment Type	Daily Production Rate	Horse Power	Alternative 3 Operating Days
Grapple Skidder	300 ccf/Day	175	2,700
Feller Buncher	367 ccf/Day	300	2,207
Stroke Delimber	200 ccf/Day	300	4,050
Loader	200 ccf/Day	175	4,050
Masticator	5 acres/Day	300	1,000
Chainsaw	100 ccf/Day	11	8,100
Pick-Up Truck (1)	100 ccf/Day	N/A	8,100
Log Hauling Truck (1)	10 ccf/Truck – Two Loads Per Day (20 ccf)	N/A	40,500

(1) CH4 and MMHC data only available for Pick-up Trucks and Log Hauling Trucks.

Table 135. Total Amount of Logging Equipment NAAQS Criteria Pollutants and GHG Emissions Produced in Alternative 2 Over Fifteen Years (Tons).

PM10	PM2.5	CO	C02 (GHG)	CH4 (GHG)	NMHC	NO2	SO2
0.7	0.7	62.0	206.0	0.2	2.8	1.4	0.002

Under Alternative 3 prescribed burning would take place in the WUI and in road and utility corridors. Compared to Alternative 2, there would be 3,000 less acres of commercial salvage, 1,200 more acres of commercial resiliency, and 3,000 more acres in the adapted/potential future treatment type commercial salvage category. There would be 2,500 more acres of non-

commercial mechanical treatment hand pile burning and 5,000 less acres of aspen and mixed vegetation broadcast burning. There would be about 1,800 less acres of incidental vegetation broadcast/underburning (Table 136).

Table 136. Estimated Alternative 3 Treatment Types and Corresponding Acreage.

Geographic Area	Commercial Treatment Types Proposed and Adapted			Noncommercial Treatment Types		
	Proposed/Current Treatment Types		Adapted/ Potential Future Treatment Type			
	Salvage	Resiliency	Salvage	Burn and Mechanical Treatment	Mechanical Only Treatment	Combined Treatments Incidental Vegetation Types
	- 21,000 acres: average .5-2 machine pile/acre	15,600 acres maximum treatment - 10,900 acres (70%) piled: average 1.67 machine pile/acre - 4,680 acres (30%) lop and scatter (no pile burning)	- 0-39,000 acres: average .5-2 machine pile/acre	- 7,500 acres mechanical treatment and hand pile burning: average 15-27 hand piles/acre - 20,000 Aspen and mixed vegetation types broadcast burning	No Rx Burning - 20,000 acres Aspen thinning/ coppice cuts lop and scatter	- 4,669 acres mixed vegetation all broadcast/underburning
Grand Mesa	pile burn	pile burn	pile burn	hand pile and broadcast/underburning	mechanical only and lop and scatter	broadcast/underburning
Gunnison Basin North	pile burn	pile burn	pile burn	hand pile and broadcast/underburning	lop and scatter	broadcast/underburning
Gunnison Basin South	pile burn	pile burn	pile burn	hand pile and broadcast/underburning	lop and scatter	broadcast/underburning
North Fork Valley	pile burn	pile burn	pile burn	hand pile and broadcast/underburning	mechanical only and lop and scatter	broadcast/underburning
San Juans	pile burn	pile burn	pile burn	hand pile and broadcast/underburning	lop and scatter	broadcast/underburning
Uncompahgre Plateau	lop and scatter	lop and scatter	pile burn	hand pile and broadcast/underburning	lop and scatter	broadcast/underburning

Prescribed fire smoke emissions from commercial and non-commercial treatments would be about 6-12 percent more for PM10 compared to Alternative 2 (Table 137) (NO2 not available).

Table 137. Alternative 3 Estimated Range of Total NAAQS and GHG Emissions from Prescribed Burning of Slash Pile Over Fifteen Years (Tons).

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	Commercial Treatment Types Proposed and Adapted					Noncommercial Treatment Types		Total Pile Prescribed Burning Emissions Range Over Fifteen Years (Tons)	
	Proposed/Current Treatment Types			Adapted/Potential Future Treatment Type					
	Spruce Recovery Salvage Machine Pile 0.5-2 piles/acre 21,000 acres 10,500-42,000 piles total (Tons)		Spruce Resiliency Machine Pile 1.67 piles/acre 10,900 acres 18,203 piles total (Tons)	Spruce Recovery Salvage Machine Pile 0.5-2 piles/acre 39,000 acres 19,500-78,000 piles total (Tons)		Non-commercial mechanical, hand treatments 15-27 piles/acre 7,500 acres 112,500-202,500 piles total (Tons)			
	Min	Max		Min	Max	Min	Max	Min	Max
Particulate Mater	429	1,718	745	798	3,190	394	709	2,366	6,362
Particulate - PM10	303	1,214	526	564	2,254	281	506	1,674	4,500
Particulate - PM2.5	265	1,058	459	491	1,966	236	425	1,451	3,908
Carbon Monoxide - CO	1,489	5,956	2,581	2,765	11,060	1,361	2,450	8,196	22,047
Carbon Dioxide - CO2 – (GHG)	65,225	260,900	113,075	121,132	484,528	59,456	107,021	380,935	965,524
Methane - CH4 – (GHG)	110	441	191	205	819	101	182	607	1,633
NMHC	88	353	153	164	655	79	142	484	1,303

Prescribed fire smoke emissions from aspen broadcast burning would be about 20-32 percent less of PM10 and 20 percent less of NO2 compared to Alternative 2 (Table 138).

Table 138. Alternative 3 Estimated Emissions from Broadcast Prescribed Burning in Aspen (Tons Per Acre).
The total emissions range column shows the range of emissions if 20,000 acres were treated over fifteen years.

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	Light Fuel Load Very Dry (Tons)	Light Fuel Load Wet (Tons)	Heavy Fuel Load Very Dry (Tons)	Heavy Fuel Load Wet (Tons)	Total Aspen Prescribed Burning Emissions Range Over Fifteen Years	
					Light Fuel Load Wet (Tons)	Heavy Fuel Load Very Dry (Tons)
Particulate – PM10	1,570	700	5,890	3,070	3,770	7,460
Particulate - PM2.5	1,330	590	4,990	2,600	3,190	6,320
Methane - CH4 – (GHG)	800	340	2,980	1,540	1,880	3,780
Carbon Monoxide - CO	17,330	7,420	64,580	33,160	40,580	81,910
Carbon Dioxide - CO2 – (GHG)	100,210	57,950	384,530	230,760	288,710	484,740
Nitrogen Dioxide - NO2	50	50	220	180	230	270
Sulfur Dioxide - SO2	80	40	280	160	200	360

Under Alternative 3, priority treatment areas were analyzed to determine the optimal location for firelines and an estimated 4,669 acres of non-spruce/aspen could be treated (Table 139).

Table 139. Alternative 3 Incidental Vegetation Types and Acreages.

Incidental Vegetation Type	Alt 3 Acres
Grassland	837
Oak Dominated Mountain Shrub	1,400
Sagebrush	869
Douglas-fir	142
Lodgepole	544
Ponderosa pine	878
Total	4,669

Prescribed fire smoke emissions from broadcast/underburning incidental vegetation types would be about 27-31 percent less for PM10 and 25-27 percent less NO2 compared to Alternative 2 (Table 140).

Table 140. Alternative 3 Estimated Emissions from Broadcast/Underburning Incidental Vegetation Types Over Fifteen Years (Tons).

NAAQS Criteria Pollutant and Greenhouse Gas (GHG)	1	2	3	4	5	6	7	8	9	10	11	12	Total Min (Tons)	Total Max (Tons)
Particulate – PM10	2	7	15	50	50	281	2	6	32	134	10	38	116	516
Particulate - PM2.5	2	6	13	42	42	238	2	5	27	114	8	32	94	437
Methane - CH4 – (GHG)	1	3	4	13	25	142	0	2	14	64	5	19	49	243
Carbon Monoxide – CO	13	46	32	105	530	3,067	4	13	296	1,315	103	397	978	4,943
Carbon Dioxide - CO2 – (GHG)	869	2,645	8,580	28,628	3,930	18,995	1,161	3,483	5,090	17,989	937	3,485	20,567	75,225
Nitrogen Dioxide - NO2	1	4	15	52	3	12	2	6	7	23	1	3	29	100
Sulfur Dioxide - SO2	0	1	5	16	3	14	1	2	3	11	1	2	13	46

1. Sagebrush Light Fuel Load Emissions per Acre 60% Consumption
2. Sagebrush Heavy Fuel Load Emissions per Acre 60% Consumption
3. Oak Dominated Mountain Shrub Light Fuel Load Emissions per Acre 70% Consumption
4. Oak Dominated Mountain Shrub Heavy Fuel Load Emissions per Acre 70% Consumption
5. Lodgepole Pine Light Fuel Load Emissions per Acre 40% Consumption
6. Lodgepole Pine Heavy Fuel Load Emissions per Acre 40% Consumption
7. Grass/Forb Light Fuel Load Emissions per Acre 90% Consumption
8. Grass/Forb Heavy Fuel Load Emissions per Acre 90% Consumption
9. Ponderosa Pine Light Fuel Load Emissions per Acre 50% Consumption
10. Ponderosa Pine Heavy Fuel Load Emissions per Acre 50% Consumption
11. Douglas-fir Light Fuel Load Emissions per Acre 50% Consumption
12. Douglas-fir Heavy Fuel Load Emissions per Acre 50% Consumption

Compared to Alternative 2, there would be about 22 percent less PM10 and 21 percent less NO2 total project emissions primarily due to the reduction of aspen broadcast burning that would occur under Alternative 3 (Table 140). Logging equipment use emissions would produce about 0.07 tons of PM10 and 0.13 tons of NO2 per year and compared to state and county annual emissions inventories (Table 111 and Table 112) would increase regional PM10 and NO2 emissions by nearly insignificant amounts. Large amounts of smoke emissions would be produced each year over the implementation timeframe of approximately fifteen years from prescribed burning of treatment activity-related fuels in slash piles, broadcast burning in aspen and aspen/conifer mixed stands, and broadcast/underburning in incidental vegetation types.

Actual smoke emissions from broadcast prescribed burning in aspen would be in the upper range. Compared to the Colorado prescribed burning emissions inventory (Table 113), Alternative 3 would produce an average of about 24-54 percent of statewide annual prescribed burning PM10 emissions, or a range of approximately 371-832 tons of PM10 per year over fifteen years.

Table 141. Total Alternative 3 estimated emissions range for the SBEADMR project over fifteen years (Tons).

NAAQS Criteria Pollutant and Green House Gas (GHG)	Treatment Type						Logging Equipment Emissions (Tons) (3)	Total All SBEADMR Emissions Range Over Fifteen Years (Tons) (1, 2, 3)	
	Slash Pile Burning (Tons) (2)		Aspen Broadcast Burning (Tons) (1)		Incidental Vegetation Broadcast/ Underburning (Tons) (1)				
	Min	Max	Min	Max	Min	Max		Min	Max
PM	2,366	6,362	-	-	-	-	-	2,366	6,362
PM10	1,674	4,500	3,770	7,460	116	516	0.7	5,561	12,477
PM2.5	1,451	3,908	3,190	6,320	94	437	0.7	4,736	10,666
CO	8,196	22,047	40,580	81,910	978	4,943	62.0	49,838	108,962
CO2 (GHG)	380,935	965,524	288,710	484,740	20,567	75,225	206.0	690,491	1,525,695
CH4 (GHG)	607	1,633	1,880	3,780	49	243	0.2	2,536	5,656
NMHC	484	1,303	-	-	-	-	2.8	488	1,306
NO2 (criteria pollutant and GHG)	-	-	230	270	29	100	1.4	261	372
SO2	-	-	200	360	13	46	0.002	213	406
(1) FOFEM outputs for aspen broadcast burning do not include PM and NHMC. (2) Piled Fuels Biomass and Emissions Calculator outputs do not include NO2 and SO2. (3) CH4 and MMHC data only available for Pick-up Trucks and Log Hauling Trucks.									

Greenhouse Gases

Alternative 3 would produce average annual GHG emissions from prescribed burning of about 0.04-0.08 percent the amount of estimated GHG that will be produced in Colorado in 2020, and 0.0009-0.0018 percent of GHG emissions estimated to have been produced in the U.S. in 2013 (Table 142). Compared to Alternative 2, there would be about 14-25 percent less GHG produced. Overall, as spruce and aspen stands die and decay they would produce GHG emissions that, over time, would be offset by sequestration from forest regeneration, and to a lesser amount if forest stands are replaced by grass and shrubs. The timber harvest of mostly dead or dying and, to a lesser extent, live spruce and aspen trees, would provide a supply of harvested wood products (HWP's) that would sequester carbon when the HWP's are used in construction or in durable

goods. A maximum of approximately 0.55 million metric tons of HWP carbon sequestration is possible if all the harvested wood are used in construction or durable goods.

Table 142. Alternative 3 Comparisons of Estimated GHG Emissions to Annual Colorado and United States Sources.
The SBEADMR Average Annual represents the estimated total annual project GHG emissions from equipment use and prescribed burning and takes into account the IPCC 2014 global warming potential factors for CH4.

GHG Emissions Source	Estimated GHG Emissions (millions metric Tons)
2013 United States	6,673
2020 Colorado	148
SBEADMR Average Annual	CH4 x GWP 28 (1) and CH4 x GWP 36 (1) = 0.005–0.014 CO2 = 0.05-0.10 **Total CO2e Range = 0.06-0.12**

(1) Carbon dioxide equivalents (CO2e) is a metric used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). For instance, over a 100 year period the GWP of methane (CH4) is estimated to be about 28-36 times greater than carbon dioxide (CO2), so its carbon dioxide equivalent (CO2e) is 28-36.

National Ambient Air Quality Standards (NAAQS)

Under Alternative 3, logging equipment use emissions would produce about 0.05 tons of PM10 and 0.09 tons of NO2 per year and compared to state and county annual emissions inventories would increase regional PM10 and NO2 emissions by nearly insignificant amounts (Table 111 and Table 112). Prescribed burning would produce 371-832 tons of PM10 and 17-25 tons NO2 per year on average over fifteen years. According to the 2013 county emissions inventory (Table 113) for the eight county area covered by the GMUG, there were 20,426 tons PM10 and 32,798 tons NO2 produced by all sources excluding agriculture, range and forest management prescribed burning (data not available at the county level). Comparatively, SBEADMR would produce 2-4 percent of PM10 and 0.05-0.08 percent of NO2 annually.

Fire and Fuels

Changes between Draft and Final EIS

Several key changes were made between the DEIS and the FEIS to clarify the effects and improve the alternatives based on public input. Modifications to the alternatives are discussed in Chapter 2.

- To focus FEIS treatments into more specific, higher priority areas and to improve the effects analysis over the DEIS, a prioritization process was used to develop Potential Treatment Areas (PTAs) in which all treatments would be placed. (See Chapter 2 and Appendix F for more details). A key input to prioritizing the Potential Treatment Areas was Wildland Urban Interface Risk. By including WUI Risk, the areas that were closer to WUI, or that had more WUI and other values at risk, were emphasized, essentially moving treatments closer to WUI areas.

- Additionally, the concept of 'Geographic Areas' was added to the FEIS. The Geographic Areas are portions of the GMUG with similar ecological and land management issues and are described in Chapter 2. Any significant Geographic Area differences in treatment effects on fire and fuels management are discussed in the appropriate sections below.

- Additional literature was considered and cited.

- Additional clarifications were added to the non-commercial treatments as follows:

    - Several non-commercial areas were identified in which only mechanical treatments would be used, i.e., no prescribed fire would be used due to difficulty of burning, small size of units, or ability to meet objectives solely with mechanical treatment. A total of 2,365 acres were identified on which only mechanical treatments will be utilized.

    - Total aspen acres treated with broadcast burning would be approximately 25,000 during the entire project time period.

    - The total non-commercial pile burning acres associated with aspen hand-thinning/piling treatments, would be approximately 5,000 acres over the course of the project. Note that this does not include pile-burning of slash associated with commercial treatments.

    - Approximately 25,000 acres of non-commercial mechanical aspen treatments, which could include mastication, lop and scatter thinning, and coppice cuts, would be implemented during the entire project to target aspen health.

- Note that some areas may be treated with both mechanical treatment and broadcast burning, in which case, the total footprint of the area treated non-commercially could be less than 60,000 acres throughout the life of the project

- Based both on recent experience on the GMUG with piling of slash generated from salvage, resiliency, and non-commercial treatments and comments regarding impacts to soils the maximum size of machine piles was reduced to minimize soil impacts and the number of piles/acre was reduced. Additional design features were also developed to ensure monitoring and response to any soil damage or exotic species invasions related to machine pile burning.

- Slash on resiliency treatments in the Uncompahgre Plateau Geographic Area will generally be lopped and scattered rather than piled both to provide microsites for regeneration and to discourage wildlife and domestic livestock from browsing on regenerating spruce and aspen. Slash on resiliency treatments in other Geographic Areas will generally be piled and burned.

- Minor amounts of vegetation types other than spruce and aspen are included to allow for the development of effective, controllable prescribed fire units. Objectives and effects for each of these "incidental" vegetation types are included in the effects section in order to provide thorough effects disclosure; however, these incidental vegetation types are not central to the goals of the FEIS.

Compliance with Regulatory Direction

Forest Service direction guiding this project includes the Forest Service Manual (FSM) 5100. According to Forest Service Manual (FSM) 5100, Chapter 5150, and corresponding R2 Supplement No. 5100-93-2, methods used for controlling flammability and reducing resistance to control may include mechanical, chemical, biological, or manual means, including the use of prescribed fire. The supplement adds details pertinent to fuels management in R2, in particular, the maintenance of fuel profiles consistent with historic fire regimes characteristic of sustainable ecosystems and/or consistent with land uses. Policies pertinent to prescribed burning and state air quality regulations are included in Forest Service Manual (FSM) 5100.

The proposed project also adheres to the 1991 Forest Plan Amendment for fuel treatment activities in management areas 1A (Developed Recreation Sites), 1B (Downhill skiing and winter sports) and 1D (Utility corridors and electronic sites), to "maintain fuel conditions which permit fire suppression forces to meet fire protection objectives for the area," following the standard and guideline to "Reduce or otherwise treat all fuels so the potential fireline intensity will not exceed 100 BTU's/sec/ft (B138) on 90 percent of the days during the regular fire season" (8224GM). This threshold correlates to 4-foot flame lengths. The GMUG will comply

with this standard and guide by treating fuels to keep flame heights of potential wildfires under 4 feet in management areas 1A, 1B an 1D.[9]

Analysis Methodology

Due to a lack of quantitative data on surface and canopy fuels and inherent error in fire behavior modeling, effects analysis will largely be discussed in a qualitative manner, with some quantitative examples. Note that the quantitative fire behavior examples are only for surface fire. Crown fire was not modeled because several assumptions would have to be made, and crown fire transition models are sensitive and not always very accurate.

Some background data were used in a fire behavior model to exemplify situations bounding expected effects. The last ten years of weather data were obtained from the Lujan RAWS (Remote Automated Weather Station) and McClure Pass RAWS, which typify weather on a large portion of the Engelmann spruce and aspen vegetation types on the GMUG. Using weather data typical of the June 1 through October 31 fire season, fuel models representing various fuel conditions were run through a fire behavior modelling application, BehavePlus 5.0.5, to predict flame height for typical areas. BehavePlus is a fire behavior modelling application which calculates estimates of fire behavior characteristics such as flame height or rate of spread given inputs such as fuel model, fuel moistures, slope, temperature, relative humidity and wind. Predictions were run for 0 and 30 percent slope to bracket most mechanical treatment conditions. For fuel models with a live woody component in the surface fuels such as shrubs or young trees, 60 percent fuel moisture was used to simulate dry, late season conditions (Vaillant et al. 2009).

Potential surface fire behavior specific to this project was estimated for situations where Forest Plan Standard and Guidelines require flame heights lower than 4 feet to allow fires to be more readily suppressed – management areas 1A, 1B and 1C. Extensive modeling was not done for all fuel types due to the limitations in the methods. Potential fire behavior was also estimated for a sample vegetation type where fuel reduction may not have occurred, such as over-mature or dead spruce, for comparison. Potential fire behavior was also estimated for scenarios in which grass, forbs and shrubs grow back after trees die and fall or are removed through treatments and more sunlight is available at the forest floor.

[9] When making fire suppression tactical decisions near values at risk or in the wildland urban interface (WUI), firefighters base their decisions in part on anticipated flame length. The Hauling Chart is a tool that helps firefighters calculate the probable flame length and, with flame lengths over 4-foot, the chart also recommends using heavy equipment instead of firefighters on foot.

In order to understand the contribution of past actions to the cumulative effects of the proposed action and alternatives, this analysis relies on current environmental conditions, or the aggregate of effects of past actions (CEQ, 2005).

Affected Environment

Climate

Climate, not fuels, may be the most important factor in driving fire extent in subalpine areas of the Rocky Mountains, such as the area for this project (Sibold et al. 2006). The project area experiences cold winters and hot, dry weather generally early in the summer, followed by monsoons later in the summer. Figure 19 through Figure 22 show high summer temperatures between June and September. The Energy Release Component (ERC), which is a measure of how hot a fire could burn, is high early in the summer, and then drops slightly in July as the summer monsoon generally begins and fuel moistures are higher. During extreme weather conditions, which are becoming increasingly common (Sherriff et al. 2014), fires in spruce-fir burn with high intensity and are generally not affected by control efforts until winds slow down and cooler, moister conditions prevail. In the SBEADMR project area, both winter and summer temperatures have increased in recent years. As discussed previously in this EIS, recent weather data indicate that the past decade has been the hottest and driest in centuries (Worrall et al. 2013, Worrall and Rehfeldt 2014).

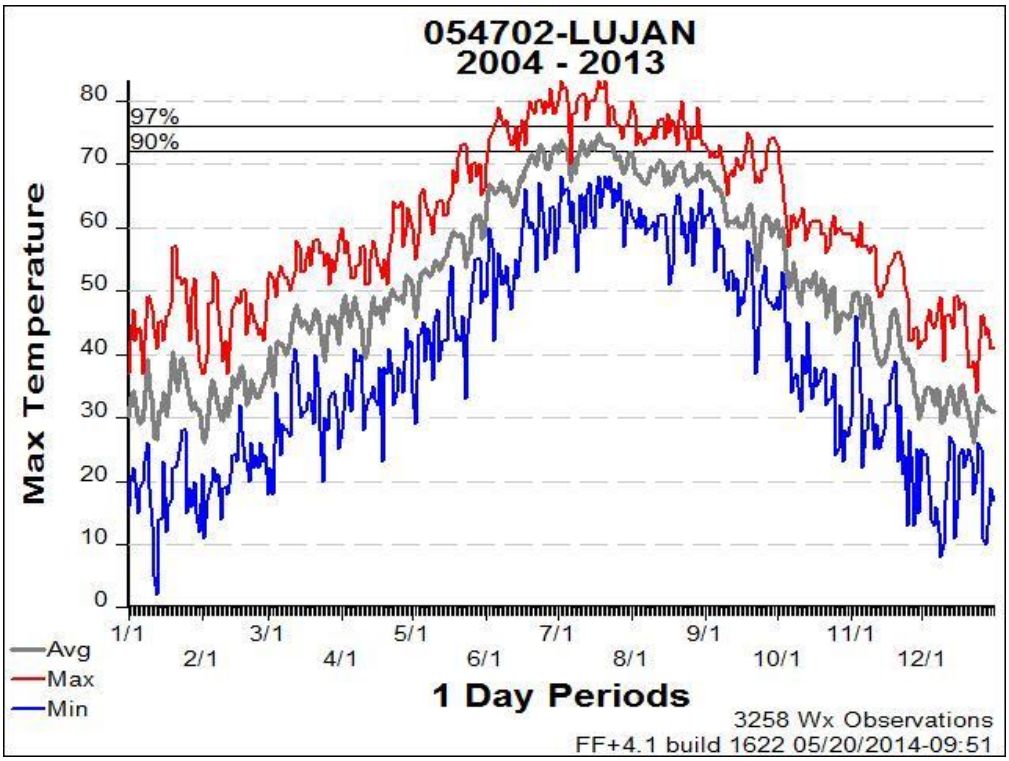

Figure 19. Maximum daily temperatures for the past ten years for Lujan RAWS.

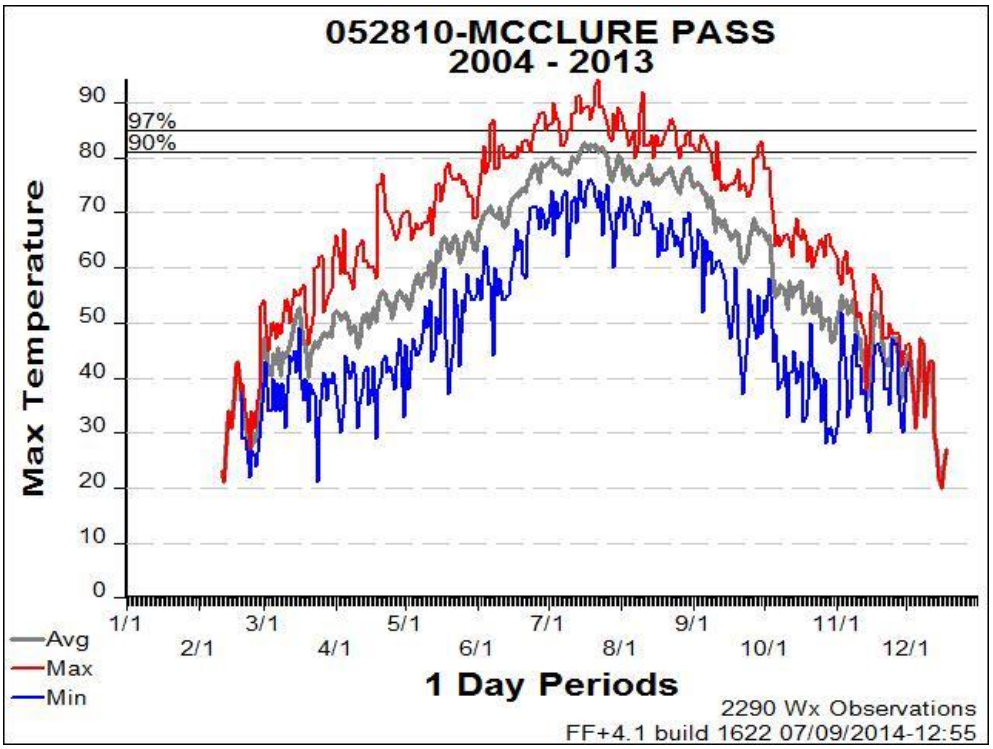

Figure 20. Maximum daily temperatures for the past ten years for McClure Pass RAWS.

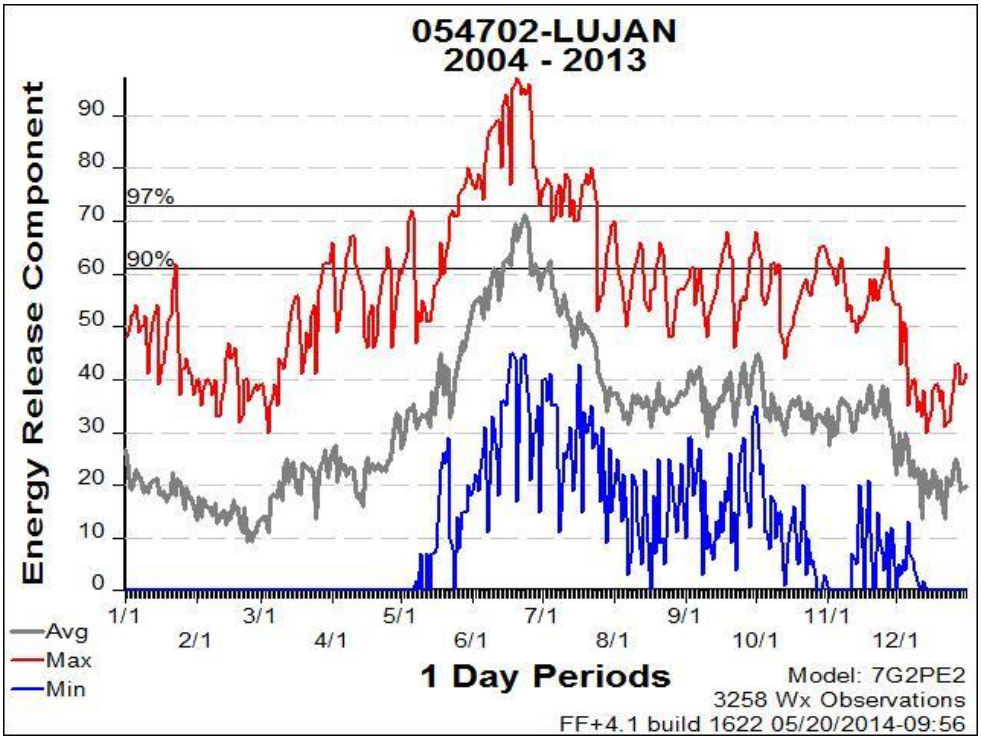

Figure 21. Energy Release Components for the past 10 years for Lujan RAWS.

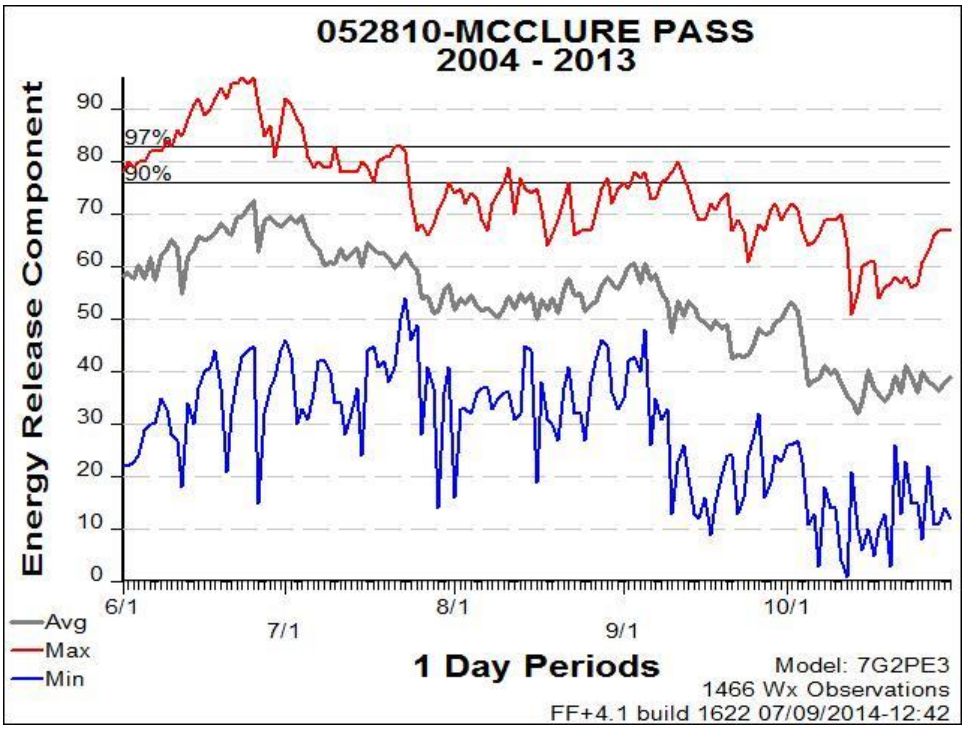

Figure 22. Energy Release Components for the past 10 years for McClure Pass RAWS.

Fire Regimes

Spruce

Fire regimes in spruce-fir are generally categorized as Fire Regime V, or infrequent fire occurrence (200+ years) that result in stand-replacing fires; fires could be up to 500 years apart in higher elevations (USDA Forest Service 2007 Fire Use Forest Plan Amendment, Appendix E). About 60 percent of spruce/fir stands on the GMUG are overmature (Forest Plan, 1991). Due to the overmature nature of many of these stands (stand density, ladder fuels in the form of regeneration, and build-up of surface fuels) it is expected that many of these stands would readily support fire under dry, windy weather conditions. Although most ignitions in spruce-fir lead to fires which are generally small, slow-moving, and exhibiting less than 2-foot flame lengths, under extreme weather conditions, fires in spruce-fir stands become stand-replacing, plume-dominated fires exhibiting high-intensity crown fire, long range spotting, significant rates of spread and high-severity fire effects.

As noted above, there is some consensus that "fire regimes in the subalpine zone of the Rocky Mountain region are driven primarily by fire weather" (Sibold et al. 2006). That being said, fuels must still be present in an amount and configuration that supports fire establishment on the landscape when weather is conducive for fires to occur. Current stand conditions in spruce across much of the GMUG are adequate to support significant fire intensity and fire size, or are approaching those stand conditions due to age and successional processes. Unlike other more mesic ecotypes which have experienced a fuels buildup since fire suppression activities began to exert influence in the 1900's, fire regimes in spruce have not been affected as much as those in lower elevation, more xeric vegetation types (Sibold et al. 2006). However, comparisons of historic photos to present conditions do suggest changes in stand condition that would lead to higher severity fires. Stands were more open, with much more diversity of sizes and ages; small openings were much more frequent. On a multi-stand or landscape scale in spruce/fir, there is more continuity of older age classes, or juxtaposition of older age classes against other older age classes, due to a decrease in fire disturbance on the landscape over the past one hundred plus years. This condition of increasing continuity of older age classes in spruce/fir is not as significant as found in more xeric forest types at lower elevations but is beginning to manifest itself in the widespread nature of the current beetle outbreak and could well manifest itself in future years as very large fires such as occurred on the Rio Grande National Forest in 2013 (see 'Historic Fires' discussion below).

Aspen

Fire in aspen is not well understood. Due to lush herbaceous and understory growth and moist conditions, fire generally does not burn through pure aspen stands. Fire may be carried through stands of aspen mixed with other conifer if enough needles are present in the surface fuels. When aspen is present in a stand of more flammable species, it can sprout prolifically after fire.

Because aspen is found mixed with many other vegetation types, it is difficult to place in any particular fire regime. When aspen is found with vegetation types which burn in low-severity, frequent fires, aspen may regenerate post-burns enough to remain a part of the vegetation type. As fire regimes increase in severity or size, seral aspen, or aspen which is eventually replaced by other tree species, may tend to increase. In high-severity fire regimes where fires are infrequent, such as the fire regime in spruce, aspen may regenerate initially after fire, but may eventually be replaced by other tree species (Shinneman et al. 2013).

Historic Fires

Stand-replacing fire frequency in pre-settlement spruce-fir forests ranged from 300 to 400 years; most stand-replacing fires were a few hundred to a few thousand acres. Small fires occurred approximately every decade per 2,500 acres.

Historic fires on the GMUG demonstrate that most fires do tend to remain small and infrequent in the subalpine zone, but during extreme fire weather, fires can grow large, as demonstrated by the 2013 West Fork Complex of fires on the adjacent San Juan and Rio Grande National Forests. Three relatively recent fires in spruce/fir and aspen are indicative of fire behavior and fire size on the GMUG. Each of these fires burned during drier fire seasons but under non-extreme weather condition; if local weather, particularly winds, had been more extreme significantly more fire growth would likely have occurred. The Beaver Fire in July, 2002 burned 344 acres of north facing spruce/fir with a significant aspen component. The resistance to control on this fire was significant due to heavy surface fuel loadings, patchy and spotty burn patterns, and snag patches; as a result this fire was transitioned to a Type 2 Incident Management Team. The Alta Fire in July, 2005 burned 120 acres of spruce/fir and patches of aspen in the Wildland Urban Interface near Telluride. Containment and control of this fire took several days and required heavy equipment and significant aerial resources. The East Fork Fire in June, 2013 burned approximately 447 acres in spruce/fir and patches of aspen near Wildland Urban Interface in the Cimarron Creek drainages. The East Fork Fire required heavy use of aerial resources to protect structures; crews experienced resistance to control issues caused by heavy surface fuel loadings and extremely high elevations. Between 2003 and 2012, 43 fires burned approximately 24,000 acres on the GMUG. The median fire size for these years was 171 acres and 25 percent of the fires which burned during this period were 41 acres or smaller. For the period between 1993 and 2002, 32 fires burned a total of 39,000 acres. The majority of these fires (21) burned during the fire seasons of 1996 and 2002.

The West Fork Complex started June 20, 2013 on the Rio Grande National Forest and was composed of three fires, the West Fork, Papoose and Windy Pass, which burned 110,000 acres, the second largest area burned by any fire in Colorado since 1910. Water-repellent soils were estimated to cover about 21,000 acres as a result of the West Fork and Papoose fires (USDA Forest Service 2013a, West Fork BAER Report). The West Fork and Papoose fires burned in

spruce-fir, a majority of which was beetle-killed and in the "dead and grey" stage. Fire behavior was often labeled "extreme. " Recent science indicates that the presence of spruce beetle kill alone does not influence subsequent fire severity (Berg and Anderson, 2006; Kulakowski and Veblen 2007), though such research indicates that stand conditions play a large role. Whether due to pre-beetle stand conditions or the beetle epidemic or both, when combined with the extreme weather conditions, the West Fork and Papoose stand-replacing fires were more than 2 orders of magnitude larger than pre-settlement fires.

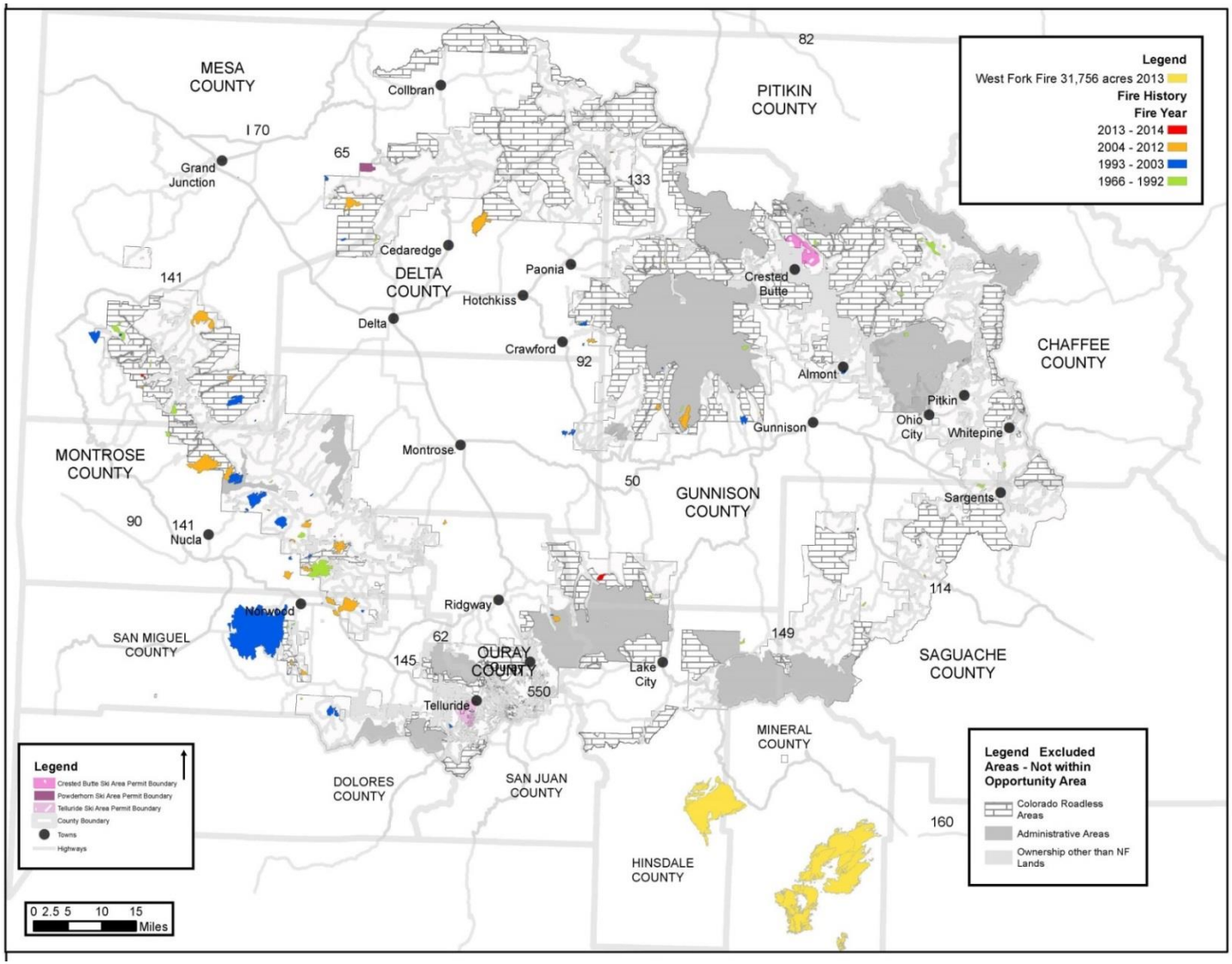

Figure 23. Fire history of the GMUG.
Note that 2015 fires were not included, however fires in this year were very small and few in number.

Fuel Loads

Several characteristics associated with fuel loading affect fire behavior; these include the total weight of fuels in an area and the size and the arrangement of the fuels. Surface fuels, such as fallen branches, are classified into categories called timelag classes based on their diameter and the time it takes them to move toward equilibrium with the moisture in the local environment. The timelag fuel categories are <1/4" (a blade of grass or small twig); ¼-1" (a small fallen branch); 1-3" (a medium fallen branch) and >3" (a log or large branch) in diameter, called 1-hour, 10-hour, 100-hour and 1000-hour fuels, respectively. Canopy fuel loads are those fuels in the canopies of trees. Smaller diameter fuels ignite and burn more rapidly, whereas larger diameter fuels may not ignite as fast, but burn longer. Fuel models are numeric representations of different fuel situations based on loading of fuels by timelag category, fuel bed depth and other fuel characteristics. Fuel models can be used to generate potential fire behavior using fire behavior modelling applications.

Although total fuel loadings are influenced greatly by the amount of 1000-hour fuels, fire *behavior* often depends more highly on the amount and arrangement of smaller fuel classes. The 1, 10 and 100-hour fuel loadings may not make up the majority of the fuel loading on a site, but they may drive the rate of spread and flame length of the fire more so than 1000-hour fuels. The 1000-hour fuels can burn for long periods of time and transmit heat to soils and plants, and so are more important than the smaller fuels in predicting fire *effect*s.

Spruce

Fuel loadings and the associated potential fire behavior in beetle-affected stands depend on the vegetation type, age class structure, the stage of or time since beetle attack, and management activities. In Engelmann spruce stands, which are often mixed with subalpine fir (*Abies lasiocarpa*), other conifer species or aspen, surface loadings of 1000-hour fuels are generally less than 20 tons/acre (Jenkins et al. 2008), and total fuel loadings usually range from 9 to 20 tons/acre (USDA Forest Service 2011).

In stands experiencing epidemic levels of spruce beetles, 1000-hour fuel loadings can be approximately 30 tons/acre. Within 20 years after the beetle epidemic, 1000-hour fuels can increase to 50 tons/acre as dead trees fall, and may not drop below 40 tons/acre for a century (Jenkins et al. 2008).

Aspen

Aspen stands generally only burn well under very dry conditions and when other plants or trees provide dry surface fuels, such as grass, brush, or conifer needles. Depending on the age, mortality and structure of the stand, total downed woody loadings could be anywhere from 3

tons/acres in recently regenerated stands to 20-35 tons per acre in stands where significant numbers of dead trees have fallen (USDA Forest Service, Digital Photo Series).

Table 143. Fuel Scenarios, Fuel Models Assigned and Fuel Characteristics.
Note that these fuel models were chosen to represent only surface fuels, not canopy fuels associated with standing trees. All values in the 1 hour and fuel bed depth columns are standard values associated with assigned fuel models (Scott and Burgan 2005) unless otherwise noted. Fuel characteristic values for fuels models in parenthesis are also in parenthesis)

Fuel Scenario	**Representative fuel models**	**1-hr fuels t/a**	**Fuel bed depth ft**	**Total surface dead woody fuel loads**
Aspen, pure stands, or stands mixed with some conifer	Western Aspen (low-forb)	0.035[1]	0.18	Not available
Spruce-fir stands without significant disease, windthrow and not overmature	TL3	0.5	0.3	7[4]
Over mature, live Spruce-fir, the most common stand and fuel scenario in spruce/fir on the GMUG	TL5	1.15	0.6 or 1-2[2]	9[2] to 20[2,3] and up to 70[3]
Spruce-fir dead 2-20 years, no treatment	SB2[6]	4.5	1	Generally 50[4, 5] and up to 95[4,5]
Salvage logged spruce-fir; no surface fuel reduction	SB2	4.5	1 or 1-2[2]	35-40[3] or generally 50[5] and up to 95[5]
Salvage logged spruce-fir; surface fuels reduced to meet forest plan guidelines guidelines in management areas 1A, 1B and 1D	TL3[7]	0.5	0.3	10 or less
Salvage logged spruce/fir or aspen about 10 years post-treatment with grass and shrub regrowth	GS2	0.5	1.5	Not available
	SH6	2.9	2	Not available

[1]10-hour fuels used for aspen, 1-hour not available
[2]Grand Valley EA (USDA Forest Service 2011)
[3]La Garita EA (USDA Forest Service 2013)
[4]Jenkins et al. 2008
[5]Cahill et al. 1951
[6]Note that in dead or dying spruce with needles and fine branches still intact, crown fire potential is high and is not captured by fuel model SB2, which is meant for modeling surface fire.
[7]A TL3 fuel model which is 'moderate load conifer litter' is used to exemplify surface fuel loading and surface fire behavior despite the fact that this fuel model has standing trees in it whereas an area that is salvage logged would not. Any crown fire modeled with this fuel model would not apply.

Potential Fire Behavior

In general, embers produced by torching and active crown fire can be lofted up to several miles ahead of afire, allowing the fire to "skip" across the landscape, yielding much higher rates of spread. Large quantities of embers can ignite many spot fires ahead of the main fire front, and can lead to mass ignition, where a large area ignites at once, fueling large fire growth (Charles

McHugh, pers. comm.). Torching is when individual tree canopies or small groups of trees ignite from heat produced by burning surface fuels. Active crown fire is a fire which presents a solid wall of flame in both surface and tree crown fuels.

Spruce-Beetle Affected Stands

There are seeming conflicts in the literature about the effect of bark beetle outbreaks on fire behavior (Jenkins et al. 2008; Pollet and Omi 2002; Hart et al. 2015). Sibold (pers. comm.) found that across the Rocky Mountains as a whole, beetle outbreaks in lodgepole and spruce did not correlate to increased fire occurrence/frequency. Some studies on the relation between spruce beetle outbreaks and fire activity showed no increase in fire severity or extent (Berg and Anderson, 2006; Kulakowski and Veblen 2007; Bebi et al. 2003). However, Kulakowski and Veblen did find that the age of the stand did affect fire, with young stands burning less severely; they also found that blowdown was the most important variable in determining fire severity.

The character of potential fire behavior changes with time since the inception of beetle infestation. While trees are being infested, but still appear green, they will have lower foliar moistures (Page et al. 2014), enabling ember production, torching, and crown fire to more easily occur.

As needles dry and turn “red,” there can be a higher potential for active crown fire and torching due to much lower foliar moistures and more flammable foliar chemistry (Hicke et al. 2012, Perrakis et al. 2014, Page et al. 2014).

Once trees lose needles (grey phase), and when they begin to shed smaller branches and fall, a threshold can be crossed where there is no longer enough fuels in the canopy to support crown fire. The potential for crown fire may be reduced in stands with high amounts of beetle mortality for 1 to 2 decades after attack due to a reduction in the fine fuels which make up the canopy (DeRose and Long 2009). However, in recently dead, grey-phase spruce, many fine branches still exist which can support torching, as well as lichens and loose bark which are some of the materials most likely to be lofted as burning embers, responsible for fires spreading quickly through spotting (Charles McHugh, pers. comm.). As fuels which were once in trees are transferred to the forest floor, surface fire properties and torching potentials increase (Hicke et al. 2012, Jenkins et al. 2014). Additionally, without a significant canopy to shade and shelter the forest floor from the sun and wind, understory herbaceous plants, grasses and shrubs may increase, and the additional sun and wind may dry fuels, increasing surface fire rates of spread and flame lengths.

Table 144. Surface Fire Behavior Characteristics in Sample Fuel Types Given 90th Percentile Weather.

Note that these fire behavior characteristics do not account for crown fire behavior. The first set of values for flame length and rate of spread were generated using 90th percentile weather from Lujan RAWS and the second set were generated using 90th percentile weather from McClure Pass RAWS. Estimated using BehavePlus 5.0.5.

Fuel Scenario	Representative fuel models	Slope %	Surface flame length (feet)	Surface rate of spread (chains per hour)
Aspen, pure stands, or stands mixed with some conifer	Western Aspen (low-forb)	0	1.7/1.8	3.6/4.2
			1.8/1.9	3.9/4.5
Spruce-fir stands without significant disease, windthrow and not overmature	TL3	0	1.7/1.8	4.1/4.8
		30	1.8/1.9	4.5/5.1
Over mature, live Spruce-fir, the most common stand and fuel scenario in spruce/fir on the GMUG	TL5	0	3.5/3.7	11.2/13.5
		30	3.6/3.9	12.1/14
Sprucedead 2-20 years with no treatment or spruce after salvage logging with no fuels reduction.	SB2	0	10.2/11	39.6/46.8
		30	10.5/11.3	42.7/49.9
Salvage logged spruce, after fuels reduced enough to meet forest plan guidelines in management areas 1A, 1B and 1D	TL3	0	1.7/1.8	4.1/4.8
		30	1.8/1.9	4.5/5.1
Salvage logged spruce/fir or aspen about 10 years post-treatment with regrowth – shorter grass/forb	GS2	0	1.2/1.5	5.4/5.4
		30	1.5/1.5	5.4/5.4
Salvage logged spruce/fir or aspen about 10 years post-treatment with regrowth – taller grass/forb/brush	SH6	0	10.7/11.4	30.3/34.5
		30	11.4/11.7	34.5/36.8

Despite the conflicts in the literature about the effect of bark beetle outbreaks on fire behavior, it is possible that post-epidemic stands, which have lower crown fuels but higher surface fuels, may have higher rates of spread due to spotting, higher fireline intensities due to large-size fuels and large amounts of dead fuel, and will create greater soil heating. Fire behavior modelling applications used to predict potential fire behavior in beetle-affected stands have produced contradictory results. However, field observations during fires suggest these stands experience increased probabilities of torching, crowning and spotting.

Fire Suppression in Spruce-Beetle Affected Stands

Regardless of changes in potential fire behavior, fire suppression activities in beetle-killed stands may be hampered by the presence of many snags, higher numbers of fallen trees and branches on the forest floor (Cahill 1951, Jenkins et al. 2014) and increased localized fire intensity due to these larger fuels. Standing or fallen dead material may provide a receptive and susceptible fuelbed for fire spread through spotting. Additionally, falling snags and live trees weakened by fire are very hazardous to fire suppression personnel, and clearing fire areas of dangerous snags takes additional effort and time. Clearing fireline through heavy downed logs requires more

effort and time than fireline construction without these obstacles. Building direct fireline adjacent to fires burning intensely due to large, downed fuels is not particularly feasible. For these reasons, suppression efforts are hampered and may become unsafe for fire personnel to proceed with line construction efforts. Logs and heavy down fuels burn longer than surface fires in lighter fuels, requiring prolonged fire suppression efforts long after the main flaming front has passed (Hicke et al. 2012).

Aspen

Fire behavior characteristics in aspen are generally much lower than that of spruce. Due to lush herbaceous and understory growth and moist conditions, fire generally does not burn through pure aspen stands. Fire may burn through aspen stands with other conifer species by consuming the needles cast by the conifers. Surface fires may also burn in aspen with a cured grass, down woody material (sticks), or shrub component. Most often wildfires will slow and may even stop upon burning into an aspen stand.

Fire Effects

Fire effects vary not only by vegetation type, which influences fuels, but also by the topography and the particular weather which precedes and occurs during the fire. In spruce, fires are generally small during average fire seasons and associated effects are low. During drier years, live spruce-fir mortality from wildfires can be 75-90 percent. Fire effects in aspen depend on the vegetation type in which it is found. In aspen-dominated stands, in which fire can be carried by the cured understory plants, pockets of aspen may be killed and resprout. In stands with a minor aspen component, which have largely succeeded to spruce-fir, fire may burn intensely through the conifer component, and aspen will sprout from roots protected by soil (USDA Forest Service Fire Use Forest Plan Amendment, Appendix E, 2007).

There is little research on the effects of fires on soils in beetle-affected stand conditions. It is assumed that because spruce has coexisted with disturbances due to beetles and fire, these ecosystems would be capable of recovering from fire effects in post-epidemic stands. Harvey et al. (2014) found that fire severity was generally not driven by beetle outbreak, however, they did find slightly higher surface fire severity after fires burning in grey-stage stands in extreme weather. Below-ground ecosystem structure, functioning and processes are impacted by the amount of soil heating, including formation of a hydrophobic layer, or a layer which repels water. The maximum soil temperatures in forest fires are generally 200-300 degrees C, but can be as high as 400 under slash. Typically, soil heating may only travel about 5 cm deep in soil, but under high accumulations of slash, temperatures may reach 250 C at 10 cm down, and can exceed 100 C as far as 22 cm below the surface (Neary et al. 1999). After the West Fork fire, 40 percent of the area classified as high and moderate severity was found to have water repellency (West Fork BAER Report).

Desired Condition

The desired conditions for the proposed SBEADMR project emphasize 1) improved protection of people and community infrastructure via a) reducing the hazards of falling trees, b) increasing the extent of defensible space around values at risk, and c) providing safe locations from which firefighters can initiate fire management actions; 2) recovery of salvageable timber; and 3) resiliency treatments to increase stand vigor and promote regeneration.

Specific to improving fire management the SBEADMR project will create desired conditions by removing dead snags and reducing the hazard of falling trees (1a and 1c above) in areas so that firefighters can be more effective in managing or suppressing fire on the landscape. One of the greatest risks, and causes of fatalities, to firefighters is falling snags that have either burned through or that are blown down by winds associated with wildfires. Firefighters do not enter areas that have significant snag hazards until the snags have been mitigated (cut down), which can take hours or days. By reducing the number and extent of snags in key locations throughout the SBEADMR project area much of this 'mitigation' work required by firefighters will be completed prior to a needed fire management action, enabling firefighters to more quickly and effectively protect site specific values as well as manage fire across the landscape.

The SBEADMR project will create desired conditions by creating defensible space near infrastructure, WUI areas, and other values at risk on the landscape (1b above). Defensible space is the immediate area around a structure or value in which the vegetation has been managed to reduce fire danger, specifically by reducing flame length and fire spread, and increase firefighter safety. Defensible space reduces the risk that fire will spread from the surrounding vegetation to the value at risk and provides firefighters access to, and a safer area to defend, a value. Firefighters often will not attempt to protect a value without adequate defensible space, as it is less safe and less likely to succeed. It should be noted that defensible space enables a point specific defensive tactic that firefighters can utilize to protect a specific value on the landscape but that it typically does not have an impact on managing the overall spread or perimeter of a fire; in other words, the value may have been protected from the fire but the fire is still actively moving across the landscape.

The SBEADMR project will also create desired conditions for fire management by creating more locations across the landscape from which firefighters can safely and effectively manage, or suppress fires (1c above). These locations may be along travel corridors along which fuels and snags have been reduced, or may be created by linking together fuel reduction treatments and natural barriers across the landscape. These areas are typically more linear in nature and allow firefighters to manage fire growth or control a fire perimeter by establishing anchor points for fireline construction and/or implementing backfiring operations.

Multiple locations on the landscape are often needed to effectively manage fire because quite frequently fires may not be controlled with the first attempt fire suppression resources make.

Often fires burn through firelines before they are completed or embers blow over the fireline and ignite spot fires across the line that can't be contained. Additionally, in order to manage wildfires for resource benefit, multiple control options on the landscape are necessary to allow fires to burn, yet provide reasonable protection to communities and structures. It is also essential to have defensible space around structures and other values at risk as a last, defensive resort, in addition to one or more cleared roads, firelines, treatment areas, or natural fire breaks on the landscape. Having defensible space adjacent to structures allows fire suppression resources to either remain in place to defend structures, or reenter an area to protect structures soon after the fire front passes. Additionally, structures with defensible space can have a higher chance of surviving a fire with no suppression resources defending them.

These tactics were exemplified on the Antelope Complex in California in 2007 where the fire moved through several linear bands of fuels treatments during the first and second day of growth while fire conditions were extreme and before suppression forces were fully in place. After weather conditions were slightly more suitable, suppression resources used another linear band of fuel treatments on the fire's east side to stop the fire from spreading down into a nearby valley with a major travel corridor and private properties (Fites et al. 2007). The multiple lines of defense enabled more effective wildfire suppression to protect values at risk.

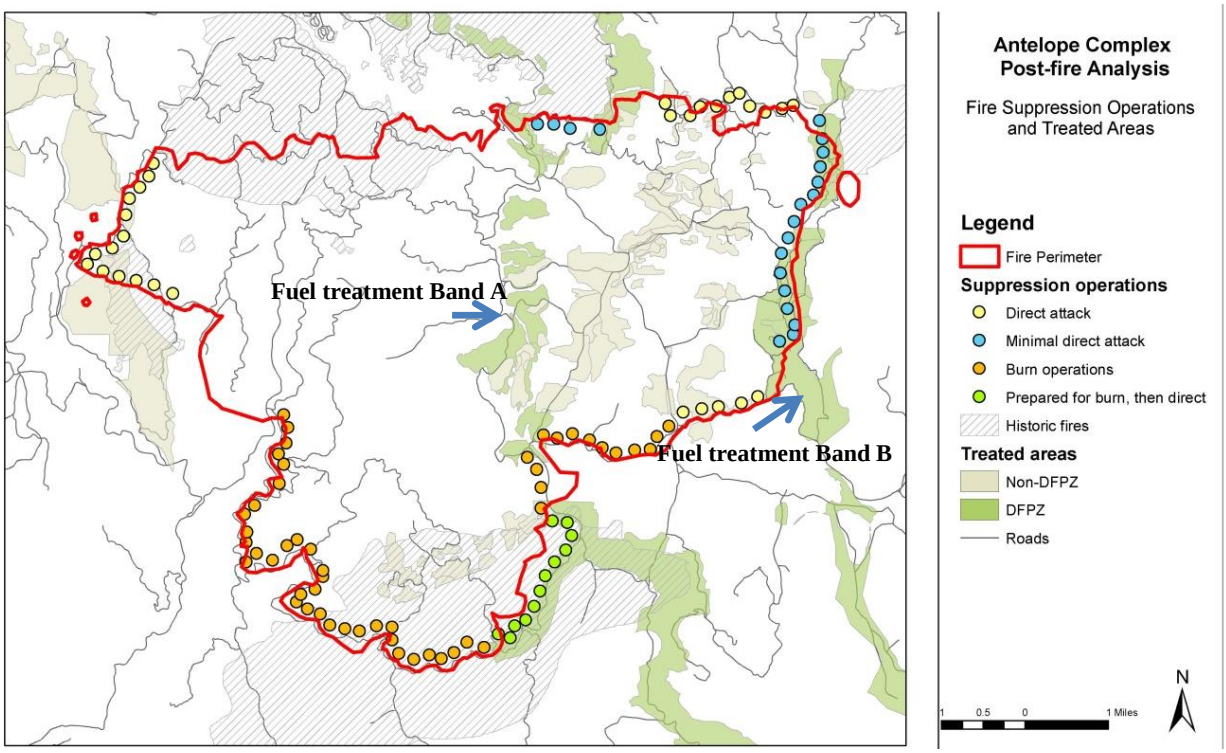

Figure 24. Map illustrating the benefit of redundant fuel treatments on the landscape to enhance wildfire management capabilities.

Treated areas within and near the fire perimeter and locations of suppression operations for Antelope Complex, California, 2007 (Fites et al. 2007). In Band A of Figure 24, the fire location, intensity, and rate of spread were such that this area was not usable to control the fire. In Band B, this treatment area was used successfully when suppression resources were available and when fire intensity was lower. Minimal direct attack was needed to control the perimeter due to lower fuel loadings and lower fire intensity. DFPZ is a defensible fuel profile zone.

The standard and guide in the GMUG Forest Plan requires that under 90 percent fire season weather conditions, potential fires would burn with less than 100 BTU/ft/sec, which correlates to 4-foot flame lengths. This reduced fire intensity/flame length enables firefighters to utilize defensible space and other treated areas on the landscape to protect values, and control or manage wildfires (1b and 1c above). The GMUG will comply with this standard and guide by treating surface fuels to keep flame lengths of potential wildfires under 4 foot in management areas 1A, 1B an 1D.

By reducing the hazard of falling trees, creating defensible space around values, and increasing locations on the landscape from which to manage fires, desired conditions on the landscape can be more fully realized; fire managers will have improved ability to both safely protect values as well as to safely suppress fires or use fire to enhance resources. Additionally, these same conditions will improve public safety by reducing the hazards of falling trees along travel corridors, enhancing safe evacuation of the public during wildfires, and reducing fire intensity in areas where the public may be ‘sheltering in place’, for example at structures and campgrounds.

Fire and Fuels Indicators

Indicators for treatment success relative to fire and fuels desired conditions and objectives include the following: surface fuel loading, ladder fuels, canopy continuity, defensible space, snag density (particularly near values at risk and travel corridors), presence of young aspen stands (particularly near WUI), modeled surface fire intensity, and crown fire potential.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

This alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. It assumes no implementation of the proposed action and the action alternatives. No trees would be harvested and no noncommercial mechanical and prescribed burning treatments would occur.

Under Alternative 1, all fuels in beetle-infected spruce stands would remain untreated and unaltered by silvicultural activities, unless treatments are authorized under separate decisions. If hazard tree removal needs to be authorized under separate decisions, there would be delay in such treatments, such that risks to the public and firefighter safety would remain elevated for a

longer period of time. The immediate effects of not using prescribed fire would result in higher surface fuel loadings and less aspen regeneration in comparison to the action alternatives.

Fuel Loadings and Fire Behavior

Spruce

Under the No Action alternative, no dead or dying trees would be removed. Surface fire behavior in beetle-affected stands may be relatively low initially, until needles, branches and whole trees begin to fall. From the time trees are green-yet-beetle-infested to the time when needles fall, the potential for torching and active crown fire will be higher than in unaffected and/or untreated stands (see discussion on the West Fork Complex under 'Historic Fires', above).Trees killed by bark beetles would begin to weaken and fall over the course of the next several decades. With more dead trees on site over a longer period of time, there would be increased surface fuels as trees fall relative to the action alternatives. This would increase the amount of down woody debris in all categories (1-1000 hour). The smaller diameter fuels would increase surface fire rates of spread and flame lengths. As trees die and fall, more sunlight and wind can reach surface fuels and increase drying and therefore fire behavior. The heavy surface fuels would increase the soil burn severity when a wildfire occurs, meaning potential increases in erosion and runoff after wildfires. Yet after needles and branches fall to the ground, canopy fuels will be lower, lowering the potential for crown fire relative to green stands and standing dead and diseased stands.

Under the No Action Alternative, no resiliency treatments would be implemented. Current canopy continuity in green stands would remain, with an abundance of large trees, such that stand conditions would remain ripe for high-intensity, stand-replacing fires that can spread unchecked across the landscape as crown fire. Under more likely extreme weather in the coming decades, such stand-replacing fires are more likely to be larger in extent than the historic and presettlement wildfires.

Aspen

As sudden aspen decline (SAD) continues unchecked, aspen trees would weaken, die and add to surface fuel loadings in aspen and mixed aspen/spruce stands and more sunlight and wind would reach surface fuels and increase drying and therefore fire behavior. The effects of not completing any broadcast burning treatments in aspen would be increased surface fuels in the near term, and decreased rates of stand regeneration compared to the action alternatives. Future wildfires may not slow or extinguish in these stands, relative to treated and/or undiseased stands. Additionally, these aspen stands may convert to either shrub or later-seral species such as spruce, both which have higher potential fire behavior than young aspen stands. Over long periods of time, aspen stands mixed with shade tolerant conifer species might shift dominance to later-successional species such as spruce, which can burn in high-intensity fires.

Landscape Scale

At the landscape scale, the effect on wildfire of not implementing recovery and resiliency treatments may be relatively small, largely because of the small percentage (4 percent of the GMUG) proposed for treatment, and because large fires are generally weather-driven in the project area. However, without treatments in affected and green stands to encourage canopy discontinuity, promote younger trees, and reduce surface fuels in some locations, the ability of land managers to safely defend values at risk and manage wildfire in spruce-fir and aspen for resource benefit would be constrained.

Wildfire Management and Suppression

Falling trees are a significant hazard for fire suppression operations. Without a reduction in snag hazards from active treatments, fire management resources may need additional time and money to deal with snags during active wildfire management operations. It is possible that fire resources could not engage fires directly in areas with too high of a snag hazard. Additionally, without treatments, there would be fewer areas which could serve as anchor points or defensible space around values during wildfires, reducing the ability of firefighters to safely and effectively protect values or manage wildfires for resource benefit or for control objectives.

Alternative 1 (No Action Alternative) – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no change to fire or fuels would result from the implementation of the No Action Alternative. The direct and indirect effects of natural processes in combination with past, ongoing, and future activities could result in cumulative effects to fire and fuels characteristics.

Current and future activities on the GMUG that are authorized by other decisions are located in Chapter 3 – Cumulative Impacts – Actions Considered & Analysis Approach. It is important to recognize that some of these future activities, such as oil and gas development and ski area and coal mine expansions, which together total approximately 266 acres, along with off-Forest development of subdivisions, second homes, and other improvements on private lands within and adjacent to the National Forest, will increase the fire protection needs on and adjacent to the Forest. This protection need will continue to change the focus of the fire program slightly toward more fire suppression and fuels treatment to protect these additional values. On the other hand there are up to 176,000 acres of ongoing or future timber sales (4,760 acres) and fuels treatments (171,239 acres) over the next 10 years. These treatments would generally affect the fuels complex, modify stand structure, and/or change age classes, and are moderately beneficial to fire management in that they create more safe areas from which firefighters can engage in fire management activities, reduce wildfire resistance to control in specific areas of the landscape, and increase opportunities to manage fire on the landscape to obtain resource benefits.

Under the No Action Alternative most aspen would remain untreated and, with the accumulation of falling trees, would lead to increased surface fuel loadings; recent research demonstrates that dead aspen in SAD-affected stands will fall within 16-17 years after death (Shepperd, Smith, and Pelz 2015), so surface fuel loading would increase in the medium and long-term. Additionally, as SAD stands decline they may be replaced by shrub species and the fire regime may shift to more frequent, mixed severity fires; this effect could result in increased flammability of vegetation across the landscape, particularly if adjacent oak dominated mountain shrub communities invade and replace SAD stands over time. Also, with the loss of canopy in the long term the replacement vegetation would be more exposed to heat and wind and could subsequently be drier and more flammable. These processes, when coupled with the potential impacts of climate change to other vegetation types on the GMUG, could lead to landscape scale increases in fire occurrence and larger fire sizes.

In spruce-fir, the relationship between increased fuel loadings (surface, ladder, or canopy) and wildfire is complex. At the landscape-scale, the cumulative effects on wildfire of increased fuels under the No Action may be insignificant, because wildfires in spruce-fir are generally weather-driven. At the site-scale, however, in the medium- and long-term, untreated areas would experience higher surface fuel loading as dead trees fall. With increased surface fuel loading, the likelihood for higher-severity impacts to soil in the event of wildfire is increased; nutrient cycling can be disrupted, water can be repelled, and pioneer species establishment can be reduced in severely burned soils. For wildland firefighters engaging a wildfire to protect values at risk in the wildland urban interface, increased fuel loadings in spruce-fir would lead to more unpredictable, and therefore more hazardous, conditions.

As noted in Chapters 1 and 2, the changing climate will be more conducive to more frequent and more extensive wildfires in these higher-elevation forests than we have historically experienced. In the context of increasing population pressures and associated increasing infrastructure in the wildland urban interface, the combination of increased fire occurrence and fire size attributed to climate change, increased fuel loadings attributed to spruce beetle, and more standing snags (hazard trees) would likely lead to much more hazardous conditions for wildland firefighters to safely and effectively protect values at risk, control fire perimeters, and manage fires for resource benefit.

Activities Common to All Action Alternatives – Design Features

The following Design Features have been developed for all fire and fuels management treatments. Each of the design features are incorporated into the effects analysis common to all action alternatives.

Objectives of fire and fuels-related Design Features include:

- Use current science, as well as best silvicultural, fuels, and fire management practices to maximize positive effects of fuels treatments while mitigating, or minimizing, negative effects on soils, hydrology, vegetation, wildlife, and future fire risk.
- Reduce negative impacts of machine pile burning.
- Additional Design Features from other disciplines will be applied as appropriate for fire and fuels treatments (See Appendix B, Design Features).

Table 145. Design Features Specific to Fuels Impacts. Excerpt from Appendix B, Design Features.

Design Feature	Trigger for Use	Description	Effect
SP-1	Treatment unit is <100 acres; AND aspen regeneration is the main treatment objective; AND not near infrastructure OR in management areas 1A, 1B or 1D.	Retain slash on the ground.	Deter elk browse of aspen seedlings.
SP-2	All mechanical treatments.	A minimum and maximum fuel loading will be specified. Generate associated Brush and Disposal (BD) plan.	Reduces fuels near infrastructure and leaves material onsite for seedling establishment, wildlife benefit and soils health.
SP-3	Treatments in Management Areas 1A, 1B and 1D, (developed recreations sites, ski areas, utility corridors)	Remove residual fuels such that they produce less than four foot flame lengths under 90% of burn conditions.	Avoids increased fuel loading in proximity to high-use areas and infrastructure.
SP-4	All pile burning.	Piles at landings, where soils are impacted by previous yarding and loading, can be up to 20-30’ in diameter, or 400-900 square feet. Piles in interior areas of treatment units, where soils are less disturbed, should be limited to 10-20’ in diameter (100-400 square feet). Attempt to keep total area covered by piles/acre under ~5% (<2,500 square feet/acre covered by piles). Too many small piles (<10’ diameter) results in inefficiency in burning them. Where landing piles are burned, the previously impacted soils should be rehabilitated by scarification following burning. When possible, do not place green material exceeding 8” in burn piles. If practicable, design treatments so activity fuels larger than 8” are removed from the site. Build machine piles in such a manner that keeps them free of topsoil to facilitate more efficient burning and combustion. Piles should be spaced adequately away from leave trees to reduce damage to trees during burning.	Minimizes soil impacts from pile burning (sterilization)

Design Feature	Trigger for Use	Description	Effect
SP-5	In areas treated for recovery where beetle kill is prominent.	Piles will be burned as soon as burn conditions for pile burning occur (usually first adequate snowfall event). Piles will need to be located in proximity to roads that prescribed burn personnel can reach the site either by motorized vehicle (truck, UTV, ATV, or snowmobile) or by foot without having to hike or ski more than ¼ to ½ mile to reach the piles.	Reduces the likelihood of piles to serve as brood material for beetles.
SP-6	All mechanical treatments.	Reduce activity-generated fuels in compliance with the treatment Brush and Disposal (BD) plan. Fuels, silviculture and timber resources management personnel would develop prescriptions considering economical harvest methods, activity fuels and residual site conditions.	Avoids increased fuel loading.
SP-7	All pile burning.	Slash piles should not be located within 2 tree lengths of the tallest residual snags or groups of snags in salvage treatments or within 2 tree lengths of the perimeters of salvage units. If possible, this design feature should be applied to resiliency treatments as well, though due to smaller size and higher percentage of live canopy in resiliency treatments, it may be less applicable.	To increase safety of firefighters operating under better dispersal (windy) conditions.
SP-8	All pile burning.	Monitor a sample of pile burn scars for bare soil and— on scars located on slopes and in swales—for the presence of rills, gullying, or soil movement. If >100 sq ft of burn scar consisting of bare soil; minor rilling or gullying present within or adjacent to burn scar; minor deposition of soil downslope of scar, treatment bare soil and erosion according to District protocols, which may include one or two of the following: addition of mulching, scarification, inoculation with adjacent soils, seeding, etc. If monitoring reveals >200 sq ft of burn scar consisting of bare soil; multiple rills, or gullying, or gullying 2-3" deep within burn scar; significant deposition of soil downslope of scar, elevate treatment application. **(Also a decision-making trigger identified in Chapter 2.)**	Eliminate/minimize soil damage from machine pile burning

Effects Common to All Action Alternatives

The general effects to fuels and potential fire behavior that are common to all of the action alternatives are discussed in this section by general treatment method, and by silvicultural

prescription/vegetation type. For reference the detailed silvicultural prescriptions are located in Appendix A.

Prescribed Burning

Prescribed burning includes both broadcast burning and pile burning.

Broadcast burning is the controlled use of fire across the entirety of a designated area to achieve specific objectives. Broadcast burning is often designed to mimic natural fire and fire effects and utilizes the on-site vegetation's natural response to fire to achieve management objectives. Broadcast burning primarily reduces surface fuels, but can also reduce ladder fuels and canopy fuels as well. This usually results in decreased surface fire intensity and rate of spread in the future and may also result in lower potential for crown fire and spotting. Most broadcast burning treatments associated with this project are designed to 1)stimulate, or enhance, aspen regeneration, 2)reduce the presence of spruce and other conifers in the understory of an aspen stand, and/or 3)reduce surface fuel loadings either as a fuels reduction treatment or to prepare a site for regeneration. Burning of stands with an aspen component will help to regenerate healthy, resilient aspen stands that can persist on the landscape for decades, which will also promote areas where wildfires would be less likely to burn or would burn with low intensity.

Pile burning is localized burning of piles of slash, or fuel, which is often the product of mechanical or hand treatments. Piling and burning slash rapidly reduces fuel loads to a specific target level. For more on prescribed fire see the silvicultural prescription effects section below.

Mechanical Treatments

Mechanical treatments that will affect fire and fuels, as well as future fire behavior, include spruce salvage cutting, spruce-fir resiliency group selection, coppice cuts to stimulate aspen regeneration, mastication to regenerate aspen and/or reduce spruce-fir in aspen understories, lop and scatter to reduce understory spruce-fir, cut and pile to reduce understory spruce-fir, roadside hazard tree removal and, specific to WUI, spruce-fir understory thinning. In general terms mechanical treatments such as thinning and harvest tend to reduce canopy fuels, or the fuels in the crowns of trees, by thinning trees and increasing the spacing between trees, but mechanical treatments tend to increase surface fuels by adding branchwood and unmerchantable material to the forest floor (Vaillant et al. 2009). This could result in increased surface intensity but lower potential for crowning and spotting. Mechanical treatments such as mastication and piling tend to re-size or rearrange fuels. Mastication tends to reduce torching and crown fire potential by rearranging and re-sizing brush and young trees into compact surface fuel. Fuel that is piled and subsequently burned is removed, resulting in reduced surface fire intensity and rate of spread.

More specific effects of each of the mechanical treatments are discussed below.

Spruce Salvage Cutting

Spruce salvage cutting will remove 100 percent of the overstory, though there will be as much advanced regeneration (young understory trees) left in the treatment areas as possible. This overstory removal will effectively eliminate the potential for torching, crowning, and spotting, though with the young trees left there could be minor potential for torching and short range spotting. Harvest activities could remove approximately 32 tons/acre of dead standing trees, which would no longer be present to contribute to future surface fuel loading in treatment units (La Garita EA). This reduction in future down woody fuels would lead to lower surface fire characteristics such as rate of spread and flame length and potential fire effects in the longer term, until these effects would become reduced by new vegetation growth. Residual fuels, or those fuels created by the activities associated with treatment, vary depending both on the condition of the stand and on the type of treatment utilized. Whole-tree yarding, which utilizes a feller-buncher to move whole trees to a central landing where the trees are then de-limbed, removes the majority of slash from the woods and centralizes it in large piles at the landing. Although some limbs and branches are broken off during transport of bunches of trees, the resulting surface fuel load is only slightly increased over what it was pre-treatment. The large piles would be constructed according to the Design Features, which limits them to less than 5 percent of the area, or <2,500 sq ft/acre and the piles would be burned at a later time to remove the debris/fuel. Conventional logging, which utilizes chainsaws to fell trees and limb and top them in the woods prior to skidding the boles to a central landing, results in a significant increase of slash, or surface fuel in the woods. The site specific silvicultural prescription will determine whether this slash is piled and burned within the treatment unit, left in place to create microsites for future regeneration, or will be broadcast burned to remove it. In salvage treatments in stands where a number of unmerchantable trees are found, the unmerchantable trees may be piled, left on the surface to create microsites, or be broadcast burned, again, according to the site specific silvicultural prescription.

Very little information is available in the literature pertaining to fuel loadings associated with salvage logging in spruce-fir, so assumptions must be made given the information available. In surveys done in beetle-killed Engelmann spruce at the end of a 10-year outbreak on the White River National Forest in 1951, some of which was salvaged, most plots had about 50 tons/acre of fuels, and some plots had loadings as high as 95 tons/acre. Collins et al. (2012) found that salvage logged areas had 3 times higher surface fine (smaller diameter) fuel loadings as untreated areas, though decomposition could negate such effects within approximately two decades. Peterson et al. (2015) found that salvage logging initially increased small and medium surface fuels to a small extent, but decreased large diameter fuels in the longer term. In lodgepole stands affected by mountain pine beetle which were salvaged, Griffin et al. (2013) found that, "following harvest, dead woody surface fuels in all size categories doubled." In a windthrown mixed-confier forest in OR, Johnson et al. (2013), found that salvage logging combined with pile and burn decreased all of the smaller woody fuel categories, and 1000-hour fuels increased. Any

increase in surface fuels from salvage logging can be expected to potentially increase future fire behavior as well as resistance to control. In many locations this may be undesirable, particularly where there are adjacent values at risk; in these locations slash will be piled and burned, or broadcast burned, to reduce both the surface fuel loading as well as future fire behavior and resistance to control.

Treatments alter surface fire behavior in stands relative to untreated stands. Fire modeling completed for this analysis is indicated in 4, and indicates variation in expected flame length and rate of spread for surface fire.

Spruce-fir Resiliency Group Selection

Spruce-fir resiliency group selection treatments will remove small groups of trees, or individual trees, from a 'green' stand with the intent to increase the number of age classes, or understory layers, within the overall stand. The 'matrix' or remaining stand, will still be present over approximately 60-80 percent of the area. The 20-40 percent of the stand that is treated will be very similar, from a fuels standpoint, to what is described above under salvage, but will consist of very small openings (ranging in size from single tree to 2 acres). Surface fuels in these small treatments will be treated using similar options to salvage, (whole tree yarding, pile and burn, lop and scatter) although broadcast burning of fuels will not be utilized due to the small size of the openings. Surface fuels treatment will depend on the site-specific silvicultural prescriptions. For larger scale stand level descriptions of fuels and fire behavior refer to the Resiliency section of Table xx below.

Coppice Cuts to Stimulate Aspen Regeneration

Coppice cuts are treatments that remove the aspen overstory to stimulate the regeneration of aspen to create young, healthy aspen stands that can persist for a century or more. Coppice cuts may be commercial, or non-commercial, depending on the value, and market, for the overstory aspen trees. In some cases there may be 'encroaching' spruce and fir in the understory that would also be removed. With commercial coppice cuts the majority of material is removed as a product, leaving tops, branches, and some unmerchantable trees on site. Due to the mesic nature of most aspen sites the residual material from a commercial coppice cut would be left on site to decompose within a few years. While the material is on site, prior to decomposition, it would serve as microsites for regeneration, as well as discourage use of the area, and subsequent impacts to re-sprouting aspen, by browsing animals. Although surface fuel loadings would be higher for a few years following treatment the impact to fire behavior is likely to be negligible due to the relatively small amount of material being added, the mesic nature of the sites, and the amount of green herbaceous and shrub vegetation that is typical for these locations during the fire season. Non-commercial coppice cuts could be implemented through either cutting or mastication of the overstory trees. With non-commercial treatment all material would be either lopped and scattered on site, piled and burned, or would be masticated (see below for the effects

of mastication). Lopping and scattering all the material could lead to a significant increase in surface fuels, due to the boles of all trees being left on site. This surface fuel load could remain on site for one to two decades, but, as mentioned previously, due the mesic nature of these sites, the herbaceous and shrub vegetation is typically green and lush during most fire seasons so the fuels would be largely unavailable to fire. Piling of material for burning would quickly reduce surface fuel loadings to near pre-treatment levels. Removal of the canopy through coppice cuts would increase the amount of sun and wind reaching the surface for 5-10 years before the aspen regenerates and grows enough to shade the site, the lack of overstory could cause increased drying and potential fire behavior for a short period of time, though this would likely be offset by the green herbaceous and shrub vegetation during most fire seasons.

Over time, as aspen regenerates and grows, the healthy young aspen stands would serve as fire resistant vegetation type on the landscape; this impact of aspen on the landscape as a fire barrier could be anticipated to last for several decades and perhaps up to a century.

Mastication

Mastication is the grinding up of woody vegetation either to remove target vegetation or to rearrange, or resize, the fuel.

Mastication of aspen stands as a coppice treatment, discussed previously, would grind or chip branches and boles of aspen and encroaching conifer species in an aspen stand instead of removing them through cutting. In aspen stands with significant amounts of conifer invasion, the potential flame lengths after mastication could be reduced because a continuous pre-treatment understory of young conifer increases flammability of the stand due to increased needle litter and the addition of more volatile conifer ladder fuels in the understory. When the young conifers are masticated, and that fuel is compacted to a smaller area near the ground, flame lengths and rates of spread can be reduced.

Mastication could also be used to remove encroaching conifer species from an aspen stand without removing the overstory aspen. With this treatment scenario the masticated conifer species would add fuel loading to the understory but not nearly to the same level as if the entire aspen stand was also masticated. Additionally, the overstory aspen would still be present to shade the surface fuels and to reduce wind at the surface. The masticated conifer species would decompose within 5-10 years in this scenario. Overall the residual aspen stand would be less flammable for many decades and would persist for longer on the landscape due to the removal of the encroaching understory conifer species.

Mastication could also be used to re-arrange or re-size surface fuels such as slash or debris from another type of treatment. In this scenario the fuel loading (tons/acre) remains the same but the size and arrangement of fuels is changed, subsequently flame length and rate of spread are typically reduced. Note that masticated fuels typically burn and smolder longer, which increases

negative impacts to soils (see Soils Design Features for mitigations). With mastication of surface fuels the decomposition rate of the material increases due to smaller particle size and it's availability as a fuel subsequently decreases more quickly.

Lop and Scatter to Reduce Understory Spruce-fir

Lop and scatter treatment consists of utilizing chainsaws or other mechanical equipment to cut the target vegetation down and lop it into pieces so that no debris is more than 2-3' above the surface. Lop and scatter will be utilized to remove encroaching conifer species from aspen stands to improve the health and longevity of the stands as well as to thin, or remove, the young spruce and fir trees from some mature spruce-fir stands in the WUI with the intent to reduce wildfire risk near values (<4' flame length desired). Lop and scatter treatments will remove ladder fuels, in the form of young conifers, from a stand, reducing the potential for torching, crowning, and spotting in the stand. However, with lop and scatter treatment the surface fuel loading in the understory, in the form of slash, will increase, partially mitigating the positive impacts of removing ladder fuels. Lop and scatter treatments will only be done in areas with limited target vegetation since the slash will remain on the surface and be available as fuel, to decompose; if there is too much target understory vegetation the surface slash fuel loading will increase dramatically to an undesirable level, resulting in higher surface flame lengths and increased resistance to control. In the case of having too many ladder fuels to lop and scatter, either mastication or cut and piling would be the preferred treatment method. Lop and scatter treatments are typically utilized on vegetation smaller than 6-8" dbh; the needles, branchwood, and smaller material usually decompose in 5-10 years while the larger material may remain on site for two or more decades. Potential surface flame lengths and rates of spread, which are mostly driven by smaller size material, will increase following lop and scatter treatments as a result of increased surface fuel loads, but will quickly decline as the smaller material decomposes. As mentioned previously, the potential for torching, crowning, and spotting is decreased following lop and scatter treatments, and this effect will last for several decades or until young conifer become reestablished in the understory. Specific to lop and scatter treatments in aspen stands, the residual aspen stand would be less flammable for many decades and would persist for longer on the landscape due to the removal of the understory conifer species.

Cut and Pile to Reduce Understory Spruce-fir

Cut and pile treatments consist of using chainsaws to remove the target vegetation and piling the debris for future burning. Cut and pile treatments will be utilized to remove encroaching conifer species from aspen stands to improve the health and longevity of the stands as well as to thin, or remove, the young spruce and fir trees from some mature spruce-fir stands in the WUI with the intent to reduce wildfire risk near values. Ladder fuels, in the form of young spruce and fir, will be reduced through cut and pile, resulting in a significant reduction in the potential for torching,

crowning, and spotting. In areas near values this can have a significant impact on reducing wildfire risk and in increasing the safety of firefighters working in the area. Surface fuel loadings will not change noticeably through cut and pile since all debris from the treatment will be piled and burned shortly after treatment. More ladder fuels can generally be removed through cut and pile than by lop and scatter since the fuel is concentrated onto piles. However, there is also a limitation to how much fuel can be piled due to the need to have enough space, or openings, away from residual overstory trees to pile the debris; piles that are too close to adjacent residual trees could produce flamelengths that may scorch, and occasionally kill the adjacent residual trees.

Roadside Hazard Tree Removal

The majority of hazard tree removal is anticipated to be done by commercial means, though in areas where trees are un-merchantable or do not contain enough value, removal may be done non-commercially. In locations where a high percentage of the canopy is dead or dying a commercial salvage treatment may be utilized adjacent to the road to accomplish the objectives of hazard tree removal; in these situations the effects to fuels and fire would be similar to those analyzed in 'Spruce Salvage Cutting', above. Commercial hazard tree removal would remove the majority of material from the area in the form of the bole, leaving the branches, top, and any other un-merchantable material on site. Non-commercial hazard tree removal would fell the tree on site, so that it is no longer a falling hazard, but would leave the entire tree on site. Roads can be excellent locations for firefighters to manage or control fires from; removal of hazard trees will make these locations significantly more useable by decreasing the risk to firefighters from burnings/falling trees. This will allow firefighters more options and opportunities to manage fires and will improve the capability of fire managers to utilize some fires to meet resource objectives. Depending on treatment method (commercial or non-commercial), fuel loadings could be increased to the point that the value of the road as a control feature is compromised. Commercial treatment will not increase fuel loadings substantially, though in areas with a high density of hazard tree removal, the added branchwood, tops, and unmerchantable material could increase fuel loading, and subsequent fire behavior, at least until these loadings decompose, to the extent that the use of the road as a control feature is compromised. With non-commercial treatments all of the material, including the bole, could be left on site; this impact to fuel loadings could be substantial and, with the addition of the large persistent boles, could last for decades. Under these conditions the ability of firefighters to use the road as an effective control feature could be in doubt. When density of hazard tree removal, either by commercial or non-commercial means, begins to impact subsequent fuel loadings, removal of the material through piling and burning, mastication, or other means, will be included in the project so that use of the road as a control feature is not degraded.

Mechanical Treatments Followed by Prescribed Burning Treatment

When prescribed burning treatments are used after, and in conjunction with, mechanical treatments, the result can be a reduction in surface, ladder, and canopy fuels. Mechanical treatments that are followed up with prescribed fire generally have the most potential to reduce future flame length, rate of spread, torching, crowning, and spotting due to reductions in both understory and overstory fuels.

Treatments in the Wildland Urban Interface

Both Alternative 2 and 3 have emphasis on WUI, though to varying degrees; the differences in emphasis will be discussed later under effects specific to each Alternative. There are several effects from the proposed treatments in WUI that are common to both Alternative; these will be discussed here and include: 1)a reduction in fuel loadings near values such that future surface flame lengths will not exceed 4 feet where values are at risk, 2)reduced potential for torching, crowning, and spotting near values at risk through removal of ladder fuels in adjacent spruce/fir stands (as allowed by the SRLA), and 3)reduced risk of wildfire impacting the WUI and other values at risk through creation of additional locations across the landscape where wildfires can be managed from.

Wildfire risk is a concept that attempts to describe the magnitude of the wildfire problem for an area. Quantification of wildfire risk typically includes 1)the probability of a wildfire occurring, 2)the intensity of the wildfire, and 3)the presence and susceptibility of values. Although treatments in SBEADMR may not have a quantifiable impact on the probability aspect of wildland fire, fuels reduction can reduce the intensity of a wildfire. Locations that have reduced fuels, as well as areas where hazard trees have been removed, will also allow firefighters to engage, or remain engaged, in an effective suppression response, reducing the susceptibility of values to wildfires.

A requirement of the GMUG Forest Plan is that fuels in management areas 1A, 1B and 1D will be treated to the extent that flame lengths in a potential fire would be lower than 4 feet. Reducing fuels, and subsequent flame lengths, to this level near WUI and other values creates defensible space near values, decreases resistance to control, increases firefighter safety so that firefighters can more quickly manage, or suppress a wildfire, and increases the potential that a value can survive a wildfire in the absence of firefighters. Where the reduction of surface fuels such that future flame lengths are <4’ is associated with an overstory treatment the effect could last for several decades, depending primarily on the vegetation that recolonizes the area following treatment; brush species would decrease the length of time the effect lasts to a decade or two, while aspen would increase the effect to multiple decades and potential for a century or more. Recolonization by spruce and fir would keep the effect on the landscape for multiple decades.

Removal of young spruce and fir in the understory of spruce-fir stands in the WUI and adjacent to other values at risk will reduce the potential for torching, crowning, and spotting in these locations by keeping the fire on the surface, where firefighters can better control it. This will also allow firefighters to more safely remain in the area, will reduce the fire's resistance to control, and reduce the potential for long range spotting and mass ignition (the simultaneous ignition and rapid spread of many spotfires) near values at risk. This effect will remain on the landscape for 2-3 decades, or until young spruce and fir become well established in the understory again.

Treatments across the landscape, and particularly within 1-2 miles of WUI and other values at risk, will give firefighters multiple opportunities to control or manage a wildfire before it impacts the WUI and other values. In the short term this reduces risk to values from individual wildfire events. In the long term it allows fire mangers to manage (and utilize) wildfires in a manner that continually breaks up landscape level fuel complexes into different age classes and vegetation types, further decreasing wildfire risk to the WUI and other values as it simultaneously improves landscape level health and resiliency. This effect could last for multiple decades or a century or more as fuels complexes are continually modified and young stands are continually regenerated across the landscape through fire events.

Table 146. Effects of Silvicultural Prescriptions (Individual Treatments or Multiple Treatments) by Spruce Vegetation Type, on Fuels and Fire Behavior/Fire Management.

<table>
<tr><th>Vegetation/ Silvicultural Prescription*</th><th colspan="2">Effects on Fuels</th><th>Effects on Fire Behavior and Fire Management</th></tr>
<tr><td rowspan="3">Single Story Spruce

Resiliency Prescription</td><td colspan="2">-Canopy continuity will be reduced through creation of .25-2 acre openings (patch cuts) over 20-40% of the stand

-Ladder fuels will not be present in openings, except where minimal pre-existing advanced regeneration may be left

-60-80% of the matrix (untreated) canopy fuels will remain, including any surface fuels in the matrix understory

-Stand scale canopy /age classes will be diversified by 20-40%, with the treated areas (patch cuts) being less flammable within 1-5 years of treatment as any scattered slash decomposes or is removed though pile burning

-Regeneration of grasses/forbs and shrubs will add a live surface component to the fuels complex within 5-10 years of treatment, during dry years these live fuels may be available as fuel if live fuel moisture decreases.

-Changes to the fuels complex will last for 25-50 years and would slowly diminish after that as young spruce and fir mature and surface fuels slowly build up</td><td rowspan="3">-Where slash is lopped and scattered there will be a short-term increase in surface fire potential while the 1 and 10 hour fuels are still present; this potential will drop within 1-3 years as needles and branchwood decompose. 100 and 1000 hour fuels will remain on site for 2-3 decades and herbaceous vegetation and shrubs will grow through them, which could elevate surface fire potential during dry years when live fuel moisture decreases.

-Where slash is piled and burned surface fire behavior, as well as potential, will be greatly lowered for several years and will only increase in potential within 5-10 years as herbaceous vegetation and shrubs grow, and when these species become dry enough to burn.

-Within the treatment areas there will no potential for crown fire and very limited potential for torching and spotting due to canopy removal and only minimal advance regeneration being left on site.

-Fire could still burn in the matrix (untreated) areas of the stand with potential for limited intense surface fire in jackpots with occasional torching, particularly where there is scattered spruce mortality, though without significant understory ladder fuels in the matrix crowning is unlikely. Typically fires would smolder and skunk around in the remaining matrix except under very high winds and droughty conditions.

-Intense fires in the matrix would burn with much less intensity when they encounter treated areas of the stand and would have significantly less resistance to control. Overall, landscape level fire risk would decrease through the creation of openings that contain less fuel and younger, less burnable age classes. This landscape level decrease in fire risk can be expected to last for 25-50 years.</td></tr>
<tr><td>w/ Lop and Scatter</td><td>-Slash fuels will remain on site following removal of the canopy.

-Fuel loads up to 20-25 tons/acre may be present. Within 5 years of treatment mostly 100 and 1000 hour fuels will remain as 1 and 10 hour fuels decompose</td></tr>
<tr><td>w/ Pile and Burn</td><td>-Surface fuels will return to near pre-treatment levels within 2-3 years of treatment due to pile burning of most fuel, some smaller fuels will initially remain on the surface but will decompose within 1-5 years post-treatment.</td></tr>
</table>

<table>
<tr><th>Vegetation/ Silvicultural Prescription*</th><th colspan="2">Effects on Fuels</th><th>Effects on Fire Behavior and Fire Management</th></tr>
<tr><td rowspan="4">Multi-Story Spruce
Resiliency Prescription</td><td colspan="2">-Canopy continuity will be reduced through creation of .25-2 acre openings over 20-40% of the stand
-Advanced regeneration will become a new, though lower and more sparse, canopy
-60-80% of the matrix (untreated) canopy fuels will remain, including any surface fuels in the matrix understory and the advanced regeneration that is likely to be present
-Stand scale canopy /age classes will be diversified by 20-40%, with the treated areas being less flammable within 1-5 years of treatment, though, due to the advanced regeneration present, will have slightly more fire potential than the single story resiliency treatment above
-Regeneration of grasses/forbs and shrubs will add a live surface component to the fuels complex within 5-10 years of treatment, during dry years these live fuels may be available as fuel if live fuel moisture decreases.
-Changes to the fuels complex will last for 25-50 years and would slowly diminish after that as young spruce and fir mature and surface fuels slowly build up</td><td rowspan="4">-Where slash is lopped and scattered there will be a short-term increase in surface fire potential while the 1 and 10 hour fuels are still present; this potential will drop within 1-5 years as needles and branchwood decompose. 100 and 1000 hour fuels will remain on site for 2-3 decades and herbaceous vegetation, shrubs, and advanced regeneration will grow through them, which could elevate surface fire potential, as well as minimal torching and spotting, during dry years when live fuel moisture decreases.
-Where slash is piled and burned surface fire behavior will be unlikely for several years and will only increase in potential within 5-10 years as herbaceous vegetation, shrubs, and the remaining advanced regeneration grows, and when these species become dry enough to burn.
-Within treatment areas there will be very limited potential for crown fire, torching, and spotting and only where advanced regeneration is present along with surface fuels from lop and scatter treatments. This potential can be expected to increase slightly more quickly than in the single story spruce resiliency treatment due to the advanced regeneration on site.
-Fire could still burn in the matrix (untreated) areas of the stand with potential for limited intense surface fire in jackpots with occasional torching, particularly where there is scattered spruce mortality remaining in the matrix, though without significant understory ladder fuels in the matrix crowning is unlikely. Typically fires would smolder and skunk around in the remaining matrix except under very high winds and droughty conditions.
-Intense fires in the matrix would burn with much less intensity when they encounter treated areas of the stand and would have significantly less resistance to control. Overall, landscape level fire risk would decrease through the creation of openings that contain less fuel and younger, less burnable age classes. This landscape level decrease in fire risk can be expected to last for 25-50 years.</td></tr>
<tr><td>w/ Lop and Scatter</td><td>-Slash fuels will remain on site following removal of the canopy.
-Fuel loads up to 20-25 tons/acre may be present. Within 5 years of treatment mostly 100 and 1000 hour fuels will remain as 1 and 10 hour fuels decompose
-Surface slash fuels will be interspersed with advanced regeneration</td></tr>
<tr><td>w/ Pile and Burn</td><td>-Surface fuels will return to near pre-treatment levels within 2-3 years of treatment due to pile burning of most fuel, some smaller fuels will initially remain on the surface but will decompose within 2-3 post-treatment.</td></tr>
</table>

<table>
<tr><th>Vegetation/ Silvicultural Prescription*</th><th colspan="2">Effects on Fuels</th><th>Effects on Fire Behavior and Fire Management</th></tr>
<tr><td rowspan="4">Single Story Spruce

Salvage Prescription</td><td colspan="2">-Treated patches of 5-100 acres in size will have no canopy

-Very few young trees will remain in the treatment area, though occasional isolated trees or small patches of young trees may be present

- Landscape scale canopy continuity will be reduced through the creation of numerous large openings. (Although the canopies of beetle killed stands are decreasing in density as needles, branches, and eventually the boles fall, there are still canopy flammability and safety issues in untreated stands that are eliminated with salvage treatments.)

-Regeneration of grasses/forbs and shrubs will add a live surface component to the fuels complex within 5-10 years of treatment, during dry years these live fuels may be available as fuel if live fuel moisture decreases.

-Changes to the treatment area fuels complex will last for 100 or more years, or until conifer species mature and begin regenerating new understory cohorts and shedding new surface fuels

-Where regeneration of shade intolerant conifer species occurs, or is enhanced by planting, as a climate change adaptation strategy, there will be a very slow shift to a more frequent, less intense, fire regime.</td><td rowspan="4">-Due to the larger size of these treatments the removal of the canopy will expose the surface to additional solar radiation, increased surface winds, increased drying, and, where surface fuels remain after treatment (primarily lop and scatter), increased potential for surface fire occurrence and fire behavior.

-Where slash is lopped and scattered there will be a short-term increase in surface fire potential while the 1 and 10 hour fuels are still present; this potential will drop within 1-3 years as needles and branchwood decompose. 100 and 1000 hour fuels will remain on site for 2-3 decades and herbaceous vegetation and shrubs will grow through them, which could elevate surface fire potential during dry years when live fuel moisture decreases.

-Where slash is piled and burned surface fire potential and behavior will be greatly reduced for several years and will only increase in potential within 5-10 years as herbaceous vegetation and shrubs grow, and when these species become dry enough to burn.

-Where slash is scheduled for broadcast burning there will be a short term increase in surface fire potential prior to burning. Once burning is implemented there will be very little potential for surface fire behavior for 5-15 years due to consumption of fine slash fuels as well as a portion of the litter and duff that were on site.

-Surface fire potential will increase slightly within 5-10 years as herbaceous vegetation and shrubs recolonize the area. Typically at these elevations live fuel moistures in these species remain high throughout the fire season, making them unavailable to fire except in the driest years.

-Crown fire potential will be eliminated for many decades. Torching and spotting will be greatly reduced except in isolated areas where pockets of advanced regeneration are present.

-On portions of the landscape in and around locations where salvage has been implemented the potential for large scale, intense fires in the spruce-fir would be reduced. Crown fire would move to the surface when encountering treated areas and resistance to control would be decreased. Firefighters could utilize these openings to manage large fires more readily and more successfully. This impact to fire behavior would last for 50-100 years or more. This impact to fire management is greater than with single story spruce</td></tr>
<tr><td>w/ Lop and Scatter</td><td>-Slash fuels will remain on site following removal of the canopy.

-Fuel loads up to 20-25 tons/acre may be present. Within 5 years of treatment mostly 100 and 1000 hour fuels will remain as 1 and 10 hour fuels decompose</td></tr>
<tr><td>w/ Pile and Burn</td><td>-Surface fuels will return to near pre-treatment levels within 2-3 years of treatment due to pile burning of most fuel. Some smaller fuels will initially remain on the surface but will decompose within 2-3 years post-treatment.</td></tr>
<tr><td>w/ Broadcast Burn</td><td>-The majority of slash will initially be lopped and scattered. Within 2-3 years of treatment the fuels will be reduced through broadcast burning. Typical objectives for slash reduction through burning are to remove 70-90% of the 1 and 10 hour fuels and 30-60% of the 100 and 1000 hour fuels. Additionally, some residual litter and duff will be removed, leaving some areas with very limited fuels.</td></tr>
</table>

Vegetation/ Silvicultural Prescription*	Effects on Fuels		Effects on Fire Behavior and Fire Management
			resiliency treatments since the treatment areas are larger and more usable for firefighters
Multi-Story Spruce Salvage Prescription	-Treated patches of 5-100 acres in size will have no overstory canopy, though the advanced regeneration (understory trees) will create a partial, though lower and more sparse, canopy. -Ladder fuels will be reduced but, due to the multi-story nature of the pre-treatment stand, will still be present in some locations, though the overstory will be eliminated or modified dramatically. -Landscape scale canopy continuity will be reduced through the creation of numerous large openings -Regeneration of grasses/forbs and shrubs will add a live surface component to the fuels complex within 5-10 years of treatment, during dry years these live fuels may be available as fuel if live fuel moisture decreases. -Changes to the treatment area fuels complex will last for 50-100 or more years, or until the advanced regeneration matures and begins regenerating new understory cohorts and shedding new surface fuels -Where regeneration of shade intolerant conifer species occurs, or is enhanced by planting, as a climate change adaptation strategy, there could be a very slow shift to a more frequent, less intense, fire regime.		-Where slash is lopped and scattered there will be a short-term increase in surface fire potential while the 1 and 10 hour fuels are still present; this potential will drop within 1-3 years as needles and branchwood decompose. 100 and 1000 hour fuels will remain on site for 2-3 decades and herbaceous vegetation and shrubs will grow through them, which could elevate surface fire potential during dry years when live fuel moisture decreases -The addition of lop and scatter fuels to the remaining advanced regeneration in these treatment areas could lead to some torching, minimal crowning, and spotting under worst case, droughty year fire scenarios -Where slash is piled and burned surface fire behavior will be unlikely for several years and will only increase in potential within 5-10 years as herbaceous vegetation and shrubs grow, and when these species become dry enough to burn. Live fuel moistures in these species at this elevation are seldom low enough to burn. -Crown fire potential will be eliminated for many decades. Torching and spotting will be reduced, but not eliminated due to the advanced regeneration that will be present. -On a landscape scale the potential for large scale, intense fires in the spruce-fir would be reduced due to the presence of numerous large areas on portions of the landscape where fuels have been modified. Intense fire behavior moving into treated areas from adjacent untreated areas would be modified, though there would still be potential for some torching and spotting, due to the advanced regeneration present. Firefighters could utilize these treatment areas to assist in managing large fires more readily and more successfully. This impact to fire behavior and fire management would last for 50-100 years or more but would decline over time as the advanced regeneration matures and begins to contribute dead fuels to the surface.
	w/ Lop and Scatter	-Slash fuels will remain on site following removal of the canopy. -Fuel loads up to 20-25 tons/acre may be present. Within 5 years of treatment mostly 100 and 1000 hour fuels will remain as 1 and 10 hour fuels decompose	
	w/ Pile and Burn	-Surface fuels will return to near pre-treatment levels within 2-3 years of treatment due to pile burning of most fuel. Some smaller fuels will initially remain on the surface but will decompose within 2-3 years post-treatment.	
	w/ Broadcast Burning	-Broadcast burning will not be utilized in this prescription due to the negative effects to the advanced regeneration remaining from mechanical treatment	

Vegetation/ Silvicultural Prescription*	Effects on Fuels		Effects on Fire Behavior and Fire Management
Roadside Hazard Tree Removal	-Overstory would be reduced by 10-100% in small pockets or -Snags would be reduced by 70-100%		-Snags would be removed, enhancing firefighter safety. This will allow firefighters to remain in the area and possibly utilize the road as a control point to suppress or manage wildfires. -There will be fewer dead standing trees that will act as spotting sources and receptor fuels along a potential control line -Fire behavior may be maintained at a level that allows firefighters to utilize the road as a control point. Lop and Scatter - Increased resistance to control, fire behavior,and residence time may increase to the extent that the use of the road as a control point is no longer feasible, or is compromised Pile and Burn -Fire behavior may be maintained, or even decreased, to a level that allows firefighters to utilize the road as a control point
	Commercial Removal	-Surface fuels would increase slightly (5-10 tons/acre) with the addition of tops, branches, and unmerchantable material. Boles would be removed from the site	
	w/ Lop and Scatter	-Surface fuels could increase dramatically (up to 10-15 tons/acre) as trees are felled and left on the surface	
	w/ Pile and Burn	-Surface fuels could be maintained at, or even below, pre-treatment levels with conscientious piling	

*The general effects of the individual 'Treatment Methods' were discussed narratively in a previous section. In this table the combined effects of multiple treatment methods to spruce-fir fuels complexes, fire behavior, and fire management are discussed.

Table 147. Effects of Silvicultural Prescriptions (Individual Treatments or Multiple Treatments) by Aspen Vegetation Type/Condition, on Fuels and Fire Behavior/Fire Management.

Vegetation	Treatment Method*	Effects on Fuels	Effects on Fire Behavior and Fire Management
Aspen without SAD or <50% SAD	-Coppice Cuts -Broadcast Burning	Coppice Cuts -The canopy will be removed over small, or large portions of the stand -Surface fuels will vary depending on silvicultural prescription/treatment method: commercial treatment will result in slight increases in surface fuel loadings (10 tons/acre), non-commercial treatment will result in all material being left on site and will add substantially to surface fuel loadings (20-25 tons/acre), material masticated will rearrange fuels to be less available to support significant fire behavior and will enhance decomposition, material piled and burned will maintain pre-treatment fuel loadings Broadcast Burning -20-50% of the canopy will be killed in a mosaic pattern	-Where non-commercial coppice treatments are used surface fire occurrence could increase for 1-5 years until 1 and 10 hour fuels decompose and lush herbaceous vegetation and resprouting aspen dominate the site. -Where commercial coppice cuts, piling and burning, and broadcast burning are utilized surface fire occurrence will decrease or remain at pre-treatment levels due to a reduction in surface fuels or maintenance at pre-treatment levels

Vegetation	Treatment Method*	Effects on Fuels	Effects on Fire Behavior and Fire Management
		-Surface fuels will be reduced substantially over 30-70% of the stand in a mosaic pattern -Within 5-10 years trees that were killed by the burn will fall and begin to increase surface fuel loadings, particularly in the 1000 hour category. Both Treatment Methods -Herbaceous vegetation and shrubs will increase post-treatment and may be available as fuel during dry years if live fuel moisture decreases. -Young, healthy aspen will regenerate, adding age and size class diversity to the landscape that will persist for 50-100 years or more	-Where trees killed by prescribed burning begin to accumulate as surface fuels there will be slight increases in fire residence time and resistance to control. These impacts are likely to be offset by the fire resistant nature of the young resprouting aspen stands. -Long-term landscape scale fire potential will be maintained at a lower level over time due to the presence of young, fire resistant aspen stands on the landscape -Fire management can utilize areas with fire resistant aspen to help protect values at risk and to control or manage wildfires -The impacts to fire management of treating aspen stands will remain on the landscape for 50-100 years or more.
Aspen with >50% SAD	-Treatment is typically ineffective at regenerating stands, however, give special consideration to implementing treatments near WUI/values at risk	Without treatment these SAD impacted stands will likely continue to decline and disappear from the landscape. Many of these stands will be replaced by shrub species that may be more flammable. Coupled with the buildup of surface fuels from dead aspen trees this could increase fire potential and fire risk. Where this is occurring in the WUI or near values at risk it would be prudent to consider intensive coppice type treatments to attempt to regenerate fire resistant aspen on the site instead of allowing it to succeed to more flammable brush species.	Brush species that may replace dying aspen may add fire potential to the landscape and increase fire risk near WUI or values at risk. Maintaining aspen on the landscape near WUI or values at risk will reduce fire potential and risk.
Aspen Overstory and Spruce-fir Understory	-Coppice Cuts in Mature Stands -Broadcast Burning -Understory Spruce/Fir Removal	Coppice Cuts -The canopy will be removed over small, or large portions of the stand -Surface fuels will vary depending on silvicultural prescription/treatment method: commercial treatment will result in an increase in surface fuel loadings (10-15 tons/acre) as aspen boles are removed but branches, tops, and all spruce/fir understory trees are left on site, non-commercial treatment will result in all material being left on site and will add substantially to surface fuel loadings (25-30 tons/acre), material masticated will rearrange fuels to be less available to support significant fire behavior and will enhance decomposition, material piled and burned will maintain pre-treatment surface fuel loadings -In the long-term most of the encroaching spruce/fir will be removed from the site and young, fire resistant aspen stands will be regenerated. These aspen stands should persist for 50-100 years. Broadcast Burning	-Where non-commercial coppice treatments are used surface fire occurrence and fire intensity could increase for 5-10 years until 1 and 10 hour fuels decompose and lush herbaceous vegetation and resprouting aspen dominate the site. This effect will be more significant in aspen stands with spruce/fir in the understory than in pure aspen stands because of the addition of spruce/fir material to the fuel loading --Where commercial coppice cuts, piling and burning, and broadcast burning are utilized surface fire occurrence will decrease or remain at pre-treatment levels due to a reduction in surface fuels or maintenance at pre-treatment levels

Vegetation	Treatment Method*	Effects on Fuels	Effects on Fire Behavior and Fire Management
		-30-60% of the canopy will be killed in a mosaic pattern -Spruce and fir in the understory will be killed over 30-60% of the stand -Surface fuels will be reduced substantially over 40-70% of the stand --Within 5-10 years the aspen, and young spruce and fir that were killed by the burn will fall and begin to increase surface fuel loadings; the greatest increase will be in the 1000 hour category, although 1, 10 and 100 hour categories will also increase to a lesser degree. Overall fuel loadings could increase by 10-15 tons/acre. -In the long-term 30-60% of the encroaching spruce/fir will be removed from the site and young, fire resistant aspen stands will be regenerated. These aspen stands should persist for 50-100 years. Understory Spruce/Fir Removal -Young spruce/fir will be masticated, lopped and scattered, or piled and burned. Surface fuel loadings would remain static to increase slightly from the addition of young spruce/fir to the surface. Ladder fuels would be removed from the understory and healthy, more persistent, aspen stands will remain on the landscape.	-Where trees killed by prescribed burning begin to accumulate as surface fuels there will be an increase in fire residence time, fire behavior, and resistance to control for 5-10 years. These impacts are likely to be offset by the fire resistant nature of the young resprouting aspen stands. -Long-term landscape scale fire potential will be maintained at a lower level over time due to the presence of young, fire resistant aspen stands, or stands without understoryspruce/fir encroachment, on the landscape -Fire management can utilize areas with fire resistant aspen to help protect values at risk and to control or manage wildfires -The impacts to fire management of treating aspen stands will remain on the landscape for 50-100 years or more.
Mixed Conifer with Aspen	-Coppice Cuts -Broadcast Burn -Removal of Spruce/Fir and Stimulation of Aspen	Coppice Cuts -The canopy will be removed over small, or large portions of the stand -Surface fuels will vary depending on silvicultural prescription/treatment method: commercial treatment will result in an increase in surface fuel loadings (15-20 tons/acre) as aspen and spruce-fir boles are removed but branches, tops, and a significant portion of unmerchantable trees may be left on site, non-commercial treatment will result in all material being left on site and will add substantially to surface fuel loadings (>30 tons/acre), , material piled and burned will maintain pre-treatment surface fuel loadings. Mastication of coppice cut material is not a good option on these sites due to the volume and depth of material that would be created. -Shade intolerant conifer species (ponderosa pine and Douglas-fir) would be left on site to the extent possible. -In the long-term all of the encroaching spruce/fir will be removed from the site and young, fire resistant aspen stands will be regenerated. Where ponderosa pine and Douglas-fir are present, these species would be left on site to the extent possible. These aspen stands should persist for 50-100 years. Broadcast Burning -30-60% of the canopy will be killed in a mosaic pattern -Spruce and fir may be killed over 30-60% of the stand -Surface fuels will be reduced substantially over 40-70% of the stand for 5-10 years -More fire tolerant species such as ponderosa pine and Douglas fir, would tend to survive the fire.	-Surface fire behavior may increase if residual slash fuels are lopped and scattered. With all other slash treatment methods the surface fire behavior would be reduced substantially. If broadcast burning is used without prior mechanical treatment the post-burn fuel loads will gradually increase by 10-15 tons/acre as killed trees fall to the surface, resulting in a slow increase in the potential for surface fire. -The potential for torching, crowning, and spotting would be decreased dramatically within the treated areas. -Potential risk would decrease for values near treated stands -On a landscape scale young, fire resistant aspen stands with occasional fire resistant conifer species, would be present. This would result in decreased potential for large fires to move across the landscape. This would also enhance fire management by providing safe and effective locations from which firefighters could control, or manage landscape scale fires. -These impacts to fire management would remain for 50-100 years, or until shade tolerant species become reestablished, and mature, in the stands.

Vegetation	Treatment Method*	Effects on Fuels	Effects on Fire Behavior and Fire Management
		--Within 5-10 years the aspen, spruce, and fir that were killed by the burn will fall and begin to increase surface fuel loadings; the greatest increase will be in the 1000 hour category, although 1, 10 and 100 hour categories will also increase to a lesser degree. Overall fuel loadings could increase by 15-20 tons/acre over a 10 year period. -In the long-term young, fire resistant aspen stands, some with ponderosa pine and Douglas-fir as part of the composition will be regenerated over 30-60% of the treatment area. These stands should persist for 50-100 years Removal of Spruce/Fir and Stimulation of Aspen -Surface fuels will depend on how the spruce/fir debris is managed: lop and scatter will increase surface fuel loadings by 10-20 tons/acre, which may be desirable if broadcast burning will be used as a follow up to regenerate the aspen stand. Mastication will rearrange fuels, subsequently modifying fire behavior and enhancing decomposition, although mastication may not be applicable if the resulting volume and depth of debris is too large. Pile and burn would maintain surface fuels near pre-treatment levels. If spruce/fir is removed commercially the residual branch, top and unmerchantable debris could be lopped and scattered, adding 10-15 tons/acre of debris or could be piled and burned with little impact to surface loadings. -Ladder fuels would be removed from the majority of the stand -Canopy closure would decrease significantly with the remaining canopy being primarily aspen though some pine and Douglas-fir could be present as well. -Aspen would be stimulated by activities associated with spruce/fir removal, resulting in a mosaic of regenerating aspen in the understory of the treatment area. -Shade intolerant species such as ponderosa pine and Douglas fir would be left on site -Aspen stands would persist on the landscape for 50-100 years or more, but would slowly be encroached on by spruce/fir again. Combinations of Treatment Methods -Combining mechanical treatments with broadcast burning would be very effective in removing spruce/fir from these stands, reducing fuel loads, stimulating young healthy aspen stands, and maintaining shade intolerant ponderosa pine and Douglas-fir on the landscape. -Long-term aspen and fire adapted species would be present on portions of the landscape for 50-100 years.	

*The general effects of the individual 'Treatment Methods' were discussed narratively in a previous section. In this table the combined effects of multiple treatment methods to aspen and aspen/spruce-fir fuels complexes, fire behavior, and fire management are discussed.

Effects of Future Adapted/Potential Future Treatment on Fuels and Fire Management

If all, or a large portion, of planned resiliency treatment areas see increased beetle mortality these areas would be considered for salvage treatment, instead of resiliency treatments (See discussion of differences between salvage and resiliency treatments under 'Mechanical Treatments' in the 'Effects Common to All' section above). This change would impact fuels and fire management in the following ways:

There could potentially be lop and scatter treatments (preferred in some Geographic Areas) that cover larger areas than with resiliency treatments, adding surface fuel loadings, and increased surface fire potential, to more area

There could potentially be significantly more pile burning and broadcast burning of slash resulting from salvage treatment, potentially leading to a backlog of fuels to burn with these fuels persisting for several years. This could potentially increase fire risk on the landscape for several years until the backlog is caught up.

There will be more, and larger, areas without canopy cover; 20-40 percent of resiliency stands vs ~100 percent of salvage stands would have no canopy. This could reduce the potential for high intensity fire across larger portions of the landscape, as well as create more locations from which fire fighters could manage fires effectively.

Effects of Prescribed Burning on 'Incidental' Vegetation Types Included within the Non-Commercial Polygons

The non-commercial priority treatment polygons were developed with the intent to use both mechanical treatments and prescribed fire to obtain the desired objectives: to increase aspen regeneration, maintain healthy aspen stands, and restore healthy aspen stands on the landscape. The mechanical treatments that will be developed to meet these objectives can be applied to very specific target locations and aspen vegetation types on the landscape as per a contract or treatment plan. On the other hand, the application of prescribed fire to the landscape to meet these objectives is unique in that we must incorporate, or develop, control lines to keep the prescribed fire from spreading undesirably across larger portions of the landscape. Due to this fact the majority of non-commercial treatment areas were designed to include prescribed burn control features within the analyzed polygon by slightly expanding the perimeters of these polygons around the high priority target vegetation types; i.e., we tried to include roads, drainages, ridgelines, less burnable vegetation types, and changes in topography within these non-commercial polygons in order to facilitate better planning and control of the proposed prescribed burning. Developing effective control lines also enhances firefighter safety by creating preplanned locations for control where firefighting hazards can be objectively evaluated and mitigated. By expanding these polygons to include prescribed burn control features we also included some lower priority aspen treatment areas and, more

significantly, a few other vegetation types that are not the target vegetation types of the EIS. The most significant of these additional vegetation types, from an acreage standpoint, are sagebrush, oak dominated mountain shrub, lodgepole pine, grasslands, ponderosa pine, and Douglas-fir. Other vegetation types consisting of very small acreages or very scattered stands were also included within the noncommercial polygons but, due to their small size, lack of fuels, or limited use as 'control lines,' these were eliminated from further analysis (See below for vegetation types, acres, estimated maximum burn acres, and justification for inclusion or exclusion from the Effects analysis).

It is not the intent of the FEIS to target these additional vegetation types for treatment but simply to utilize effective control lines when developing burn units and implementing prescribed fire to meet the aspen objectives of the FEIS. Mechanical treatments will not be implemented in these additional vegetation types except to the extent necessary to enhance or create linear control lines for prescribed burning. Typically this will be accomplished in narrow (10-100 foot) treatment strips within which some surface and ladder fuels are removed to reduce fire intensity near the perimeter of the burn unit; within this strip a mineral soil control line 12-18" wide can then be established prior to prescribed burning.

In this section we will develop some general guidelines for burning these incidental vegetation types and analyze the specific impacts of prescribed burning on them. This will 1) provide guidance for fire managers as they develop burn plans and implement prescribed burns and 2) disclose the environmental impacts of prescribed burning on limited amounts of these additional vegetation types. When planning prescribed burns care should be taken to include only minimal amounts of these incidental vegetation types with the primary intent of locating, creating, and utilizing quality control lines; burn planners need to focus on the larger aspen objectives when planning individual burn projects.

Sagebrush

Guidelines

Note: District sage grouse specialists should be consulted to determine appropriateness of including specific sagebrush areas into the burn units and in the refinement of guidelines. Guidelines for burning sagebrush outside of critical habitat for Gunnison sage grouse may include: 1) Burn no more than 20-40 percent of the sagebrush within the burn unit, 2) Reduce 1 and 10 hour fuels by 50-70 percent within the burned area, 3) Create a mosaic of burned and unburned areas with average burn patch size no larger than 5 acres, 4) Rejuvenate grass and forb species, and 5) Where cheatgrass is present, avoid, and if necessary, isolate the cheatgrass pocket.

Effects Analysis

Effects were analyzed for the subspecies *vaseyana* of *Artemesia tridentata*. Since burning of sagebrush within Gunnison sage grouse critical habitat was eliminated from all alternatives, most

burning of sagebrush will occur at higher elevations around aspen stands where *vaseyana* is the common subspecies.

Fire return intervals for sagebrush range from 25-100 years, depending largely on elevation and adjacent vegetation types. Long periods without fire make sagebrush types susceptible to invasion by some conifer species. Sagebrush is typically killed by fire with even lower intensity fires killing plants. Fires can burn intensely over hundreds of acres in the presence of constant winds and consistent topography or they may burn with varying intensity, creating varying patch sizes, if weather and topographic conditions are variable. Reestablishment of sagebrush on a site following fire will take a minimum of 15 years with sagebrush being reestablished by seed from adjacent, unburned sage patches. Locally, grasses and forbs respond very well in the openings created by treatment with sagebrush seedlings also becoming established within a few years of treatment. Over time herbaceous vegetation decreases as sagebrush increases in density. There is potential for cheatgrass invasions following burning of sagebrush, particularly in lower elevation sage types or when there are cheatgrass invasions nearby, subsequently, special consideration should be given to monitoring for cheatgrass both within and adjacent to treatment areas to ensure cheatgrass is not present or present only in isolated locations. In some instances it may be desirable to seed native grasses and forbs, and possibly sagebrush, into a burned area immediately following the burn to compete with cheatgrass. Often times prescribed fire may be difficult to apply to sagebrush types due to a lack of fine herbaceous fuels in the interspaces. (Mountain Big Sagebrush, 2015)

Treatment of sagebrush to enhance or create control lines for prescribed burning will typically be done using mastication or mowing. Swaths 10-30’ wide will have all shrubs removed. Debris from the treatment will typically be scattered throughout the treatment area less than 1-2” deep with many areas not being covered by debris at all. Debris will decompose on most sites within 2-3 years or will burned during ignition of the prescribed burn. Herbaceous vegetation usually becomes established within 1-2 seasons of sagebrush removal. A control line 12-18” wide to mineral soil may be created using handtools or a small ATV plow. Rarely, chainsaws may be used to remove a short section of sagebrush to connect existing control lines. In this case debris will be scattered either inside or outside of the control line for burning or natural decomposition.

Oak-Dominated Mountain Shrub

Guidelines

Guidelines for burning oak-dominated mountain shrub communities may include the following: 1) Top kill or ‘clean burn’ oak and other shrubs over 50-70 percent of the area, 2) Leave 30-50 percent of the shrubs unburned in a patchy mosaic, 3)Avoid ignition of savannah-like oakbrush patches with stems greater than 4”.

Effects Analysis

Oak dominated mountain shrub communities included in this analysis are dominated by Gambel oak but also have smaller amounts of serviceberry, snowberry, sagebrush, bitterbrush, and mountain mahogany, though the latter two species, being more xeric species, are significantly less common in these mountain shrub communities located near aspen stands.

Oak dominated mountain shrub communities typically burn with high intensity fire that consumes the canopy of most of the shrub species or kills the above ground parts through radiant heat or basal kill due to high temperatures at the surface. Burned patches can vary in size from small patches less than an acre to large, landscape scale patches several hundred acres in size. Gambel oak, along with serviceberry, snowberry, and mountain mahogany quickly re-sprout following fire, while bitterbrush and most sagebrush species typically do not re-sprout after being burned. After a fire understory grasses and forbs quickly respond to the newly available sunlight, water, and nutrients but this flush of herbaceous growth is quickly dominated within 1-2 growing seasons by the re-sprouting Gambel oak and other shrubs. Within 10 years of burning most Gambel oak dominated mountain shrub communities have recovered to, or beyond, their pre-fire density, making benefits from treatment in this community type relatively short term. Multiple treatments of a site over a short period of time (burning followed by mechanical treatment, or mechanical treatment followed by heavy shrub grazing, over a 2-3 year time period) can reduce the density of Gambel oak but this is often difficult to coordinate due to burn prescriptions, grazing rotations, or funding. (Gambel Oak, 2015) (Rocky Mountain Gambel Oak/Mixed Montane Shrubland in the Southwest, 2015)

Mastication of mountain shrub communities to enhance, or create control line will result in 20-60’ wide swaths in which all of the shrub species have been removed from the area. Chips and debris from the treatment will typically be 1-2” deep and scattered throughout the treatment swath. The majority of this debris will either be burned during the prescribed burn treatment or will decompose within 2-3 seasons due to the mesic conditions in these areas. A mineral soil control line 12-18” wide is typically constructed by hand or with a small ATV plow near the center of the swath. Within 1-2 years of mastication and burning the re-sprouting shrubs once again begin to dominate the site. As mentioned previously, grasses and forbs will respond quite well to the opening created by the mastication/burning but will only dominate the site until the shrubs re-sprout and begin to overtop the herbaceous component. Occasionally chainsaws will be used to cut swath 10-20’ wide through the mountain shrub community to create a control line. Debris and slash typically is moved outside of the burn area and scattered among standing shrubs, since moving this debris interior to the burn unit creates higher burn intensity near the perimeter than is desired. This debris can be moved back across the control line to reduce the visual impact, reduce future erosion, and to discourage off road vehicle travel in the area, or it can be left to decompose over 5-10 years.

Lodgepole Pine

Guidelines

Guidelines for burning lodgepole pine may include the following: 1) apply low intensity understory surface fire to 20-40 percent of the stand 2) apply moderate to high intensity understory surface fire to an additional 5-30 percent of the stand, 3) utilize variable fuel conditions due to stand age and stand condition to burn with variable fire behavior to obtain patchy fire effects, 4) target overstory mortality of 30-40 percent from both surface fire (basal kill and radiant heat) and occasional group torching, 5) in burned areas reduce surface fuels as follows: 1 hour by 70-90 percent, 10 hour by 50-80 percent, 100 hour by 30-50 percent, and 1000 hour by 10-40 percent.

Effects Analysis

Lodgepole pine as a species thrives under the influence of fire though most trees in a fire-affected stand are killed, both by a hot surface fires as well as crown fires; the cones are serotinous and release their seeds when heated, regenerating large numbers of trees, and a new stand, within a few years of the fire event. Fuel accumulation in a lodgepole pine stand varies, depending on stand development, insect and disease, and decomposition rates; this results in diverse fire behavior and subsequently fire effects can range from mixed severity to stand replacing. As lodgepole pine stands age both surface and ladder fuels accumulate both from downfall and the growth of shade tolerant species in the understory, this results in increased flammability of the stand; most extreme fire behavior in lodgepole pine stands happens in these older stands. In stands with limited surface fuels there is some potential for low intensity surface fires to burn under low wind and higher moisture conditions; this can result in a reduction in surface fuels and thinning of understory vegetation, though some individual trees will be killed due to their thin bark. Lodgepole pine on the GMUG NF has a fire return interval largely dictated by the cool, moist summers at the higher elevations with return intervals probably ranging from 100-200 years; most summers are too cool and moist for fires to occur, allowing for fuels to build up over decades or even centuries. When fires finally do occur they may burn as mixed severity to stand replacing. Fire damaged lodgepole pine are more susceptible to insect attack. (Lodgepole Pine, 2015)

Mechanical treatment to create and enhance control lines in lodgepole pine will consist of masticating or thinning understory trees in strips 30-60 feet wide and removing a portion of the down logs on the surface. Larger trees will not be removed. Masticated debris will be spread throughout the treated area and may be 2-3” deep in some locations and will be burned during ignition or will decompose within 3-4 years. If thinning using chainsaws is the treatment method the resulting slash will be lopped and scattered either within or outside of the burn unit, or may be piled and burned with snow on the ground prior to broadcast ignition. A control line may be constructed 12-18” wide within the treatment swath using hand tools or an ATV plow.

Grasslands (Including Forbs)

Guidelines

Note: Work with the District sage grouse specialists to determine appropriateness of including specific grass/forb areas into the burn units and in the refinement of guidelines. Guidelines for burning in grasslands may include: 1) Remove conifer and shrub invasions from open meadows and parks, 2) Burn 70-90 percent of the grass/forb area to remove decadent grasses and stimulate forb and grass regrowth, and 3) Where cheatgrass is present avoid, and if necessary, isolate the cheatgrass pocket

Effects Analysis

Grasslands, as included in this analysis, contain a great variety of both graminoid and forb species and, due to the diversity of elevation, aspect, and moisture regime across the area covered by the FEIS, are quite diverse. Most of these open grasslands are currently grazed by domestic livestock on a recurring basis and therefore do not often contain enough fuel loading to support fire; because of this coupled with the aggressive, and successful nature of fire suppression over the past century, many of these grasslands have not had a fire event in many decades. Over time the composition of many of these grasslands has changed to include woody shrub and conifer species that in the past may have been removed through periodic fire. Additionally, there may be some impact to graminoid and forb composition due to the late successional age of many of these grasslands; early seral species may have been outcompeted decades ago and without fire as a disturbance these species cannot become reestablished. Cheatgrass invasions are also a significant concern throughout these grasslands.

Fire return intervals in these grasslands probably ranged from 20-40 years and may have been very dependent on fires moving into them from other vegetation types, such as ponderosa and lodgepole pine, that ignite more readily. Fires in grasslands would typically occur during the late spring prior to green-up, during the fall after an early frost, or perhaps during drought years when the grasses and forbs cured early. Most of the above ground biomass would be removed by these fires, leaving the root crowns and root systems in place. Perennial grasses would rapidly regrow during that season or early the following season. Annual grasses would regenerate from seeds left in the soil, while many forbs would regenerate from seeds. Many woody shrubs or young conifers that had encroached into the grasslands since the previous fire event would be killed, resulting in long term persistence of the grassland. (Rocky Mountain Subalpine-Montane Mesic Meadows, 2015)

Prescribed fire in grasslands will mimic many of these natural effects with the most valuable aspects being regeneration of young vigorous grasses and forbs and removing some of the woody shrub and young conifer species that may have invaded the grasslands. Concerns with prescribed fire, much like in sagebrush systems, include the presence of cheatgrass; prior to any prescribed fire being implemented in grasslands and sagebrush types, careful monitoring of the area and adjacent areas

for cheatgrass populations should be undertaken. Any cheatgrass found should be controlled using standard treatment methods prior to implementing prescribed fire.

Generally control lines will be established through grasslands utilizing a small ATV plow to create a mineral soil line 12-18" wide. No other mechanical removal of adjacent grasses or forbs will be necessary.

Ponderosa Pine

Guidelines

Guidelines for ponderosa burning may include: 1) Limit mortality of trees greater than 8" dbh to <5 percent, 2) Raise the crown base height by 2-5' to protect the stand from future wildfires, 3) reduce dead and down fuels by 50 percent, 4) increase exposure of mineral soil by 5-10 percent to increase opportunities for natural regeneration, and 5) reintroduce fire as a natural ecosystem process to the ponderosa pine.

Effects Analysis

The effects of prescribed burning in ponderosa pine are multiple and generally very positive. Ponderosa pine is a species that, more than any other pine species in the West, is adapted to fire; healthy, fire-influenced trees have thick, insulating bark, limited lower branches, and an open canopy, and the species regenerates well on bare mineral soils exposed by fire. Where fires have occurred regularly stands of pine are typically open grown with fewer trees/acre than stands that have not seen fire for several decades. In fire-influenced stands the grass, forb and shrub species in the understory are often abundant, diverse, and healthy. (Fire Effects Information System)

Prescribed burning ponderosa pine will kill some shade tolerant species in the understory, such as Douglas-fir, subalpine fir, and spruce, and may kill young ponderosa pine, particularly those under 3-4" dbh. By removing these species and size classes from the stand the residual stand will be more open grown with less competition for nutrients, water, and sunlight and will subsequently be more healthy. Fire intensities (flamelengths) during prescribed burning are typically such that trees greater than 8" dbh are not negatively impacted. There may be scorch of the lower canopy on some of the larger trees due to flamelengths greater than 4' but most trees can withstand 50-60 percent or more canopy scorch and survive and actually can be healthier and more protected from future wildfires. Occasionally a few larger trees may be killed, or scorched severely enough that they die within 2-3 years of burning. This impact helps to create patchiness in a pine stand by creating openings as well as bare mineral soil where young pine seedlings can become established. In fire influenced stands this patchiness is very common, consisting of patches of different age classes that range in size from 1/10 of an acre to 2-3 acres in size. Typically with low to moderate intensity fire the lower limbs on most ponderosa pine are scorched and subsequently die and are shed within a few years. This raises the crown base height, sometimes by 5-10 additional feet. Prescribed fire also kills some young trees and shade tolerant species in the understory as well as the above ground

parts of many shrub species, subsequently reducing the ladder fuels in the stand. Prescribed fire will also remove 20-70 percent of the litter, duff, branchwood, and logs from the surface, reducing fuel loadings substantially. By removing surface fuels, ladder fuels, and lower branches of the residual pine through prescribed burning, ponderosa pine stands will not support high intensity wildfires for 2-3 decades and will subsequently be less impacted by future wildfires. Additionally, any associated, or adjacent, high value resources, whether timber, wildlife habitat, private property with improvements, or powerline corridors and communication sites, will be less at risk from future wildfires. Following prescribed burning understory grasses, forbs and shrubs typically respond very well, providing forage and habitat for a variety of wildlife species and for domestic livestock grazing. Watershed and soil conditions are also improved due to an increase in root structure associated with the grass, forb and shrub response, though in the short term (1-2 years) there may be some bare soil exposed, though this typically occurs on less than 15 percent of the prescribed burn area. (Ponderosa Pine, 2015)

Where mechanical treatment is used to enhance control lines through ponderosa pine stands the following impacts can be expected. Treated strips will typically be 20-50' wide, regardless of the mechanical treatment method used, and only shrubs and young understory trees as well as the lower limbs of some larger pine, will be removed; pine greater than 4-5" dbh will typically not be removed. When mastication is used to grind young trees and shrubs from a strip, the masticated material will typically be less than 2-3" deep and will be scattered throughout the area; within 2-3 seasons most of the masticated material will decompose, and the part of the material that is located within the burn unit will be burned when the unit is ignited. When hand thinning is used to remove young trees and shrubs the resulting slash will typically be moved well into the burn unit and will be burned when the prescribed burn is ignited. Occasionally hand thinning debris may be piled, in which case the piles will be burned with snow on the ground a season or two prior to main ignition of the burn unit. A 12-18" wide mineral soil control line within the treated strip will be created using handtools or a small ATV plow.

Douglas-fir

Guidelines

Guidlines for Douglas-fir burning may include: 1)Burn 50-70 percent of each unit to reduce fuels and future spread potential of wildfires, to stimulate aspen regeneration, and to reintroduce fire to the Douglas-fir stands, 2)Keep mortality of Douglas-fir greater than 12" DBH less than 30 percent, 3)Keep average stand scorch height of overstory Douglas-fir (>12" DBH) less than 50 percent of crown, 4)Reduce surface fuel loadings by 30-60 percent to reduce future surface fire intensity, and 5)Remove 30-50 percent of the ladder fuels and raise crown base height to 10-15' to reduce the intensity of future wildfires.

Effects Analysis

Douglas-fir, like ponderosa pine, has a thick corky bark that insulates it quite well from fire. However, this bark does not become established on a tree until around 40 years of age. Young seedlings and saplings are easily killed by surface fires prior to the bark thickening. Douglas-fir can also be killed by basal cambium kill if a majority of the bole circumference is scorched and also by crown scorch if 60 percent or more of the crown is scorched. Douglas-fir is also susceptible to post-fire insect attack. Where fires have occurred regularly Douglas-fir stands are more open grown with larger trees, contain fewer young Douglas-fir saplings, and contain very few shade tolerant spruce or true firs; unfortunately, there are few stands on the landscape today that have had regular fire applied to them to maintain them in a healthy state. Fires in Douglas-fir in western Colorado tend to be of mixed severity, with low intensity surface fire burning portions of a stand and higher intensity fire torching and crowning other portions, dependent on stand density, fuel condition, topography, and weather. Return intervals in western Colorado range from 25-50 years or more, allowing ample time for young trees and shade tolerant species to become established in some locations, which increases the potential for a future fire to be of mixed severity.

Prescribed burning in Douglas-fir stands will kill most shade tolerant species such as spruce and fir and will also kill many young Douglas-fir that have not yet developed thicker, insulating bark. Stands that have had fire applied to them will be more open grown with less competition for sunlight, water, and nutrients. Pockets of larger trees may be killed in areas with higher fire intensity, or may be killed by post-fire insect attacks; this will result in openings in the stand that will support herbaceous and shrub species, or aspen regeneration. Prescribed burning will also remove duff, litter, and branchwood from the surface, creating additional areas where herbaceous vegetation and Douglas-fir seedlings can become established. Following prescribed burning the intensity of future wildfires will be reduced for 10-40 years due to a decrease in surface and ladder fuels. (Douglas-fir, 2015)

Mechanical treatment of Douglas-fir to enhance or create control lines can be done either through mastication, or by hand thinning followed by lop and scatter or piling and burning. Treated strips will typically be 20-50’ wide, regardless of the mechanical treatment method used. Target vegetation for removal will primarily by young shade tolerant spruce and fir, young Douglas-fir, and occasional shrubs. Additionally, the lower limbs of some larger Douglas-fir will be removed. Typically Douglas-fir greater than 8” will not be removed. When mastication is used to grind young trees and shrubs from a strip, the masticated material will typically be less than 2-3” deep and will be scattered throughout the area; within 2-3 seasons most of the masticated material will decompose, and the part of the material that is located within the burn unit will be burned when the unit is ignited. When hand thinning is used to remove shade tolerant trees and shrubs the resulting slash will typically be moved well into the burn unit and will be burned when the prescribed burn is ignited. Occasionally hand thinning debris may be piled, in which case the piles will be burned with

snow on the ground a season or two prior to main ignition of the burn unit. A 12-18" wide mineral soil control line within the treated strip will be created using handtools or a small ATV plow.

Alternative 2 (Agency Preferred Alternative) – Direct and Indirect Effects

The majority of direct and indirect effects of Alternative 2 are analyzed above in the "Effects Common to All Action Alternatives" section. These effects will take place within the proposed treatment area by treatment type as outlined in Table 148 and Table 149. Although there are 257,823 acres available for potential treatment in the potential treatment areas outlined in Table 148 and Table 149, the maximum acreage which can be treated across the GMUG is 120,000 acres, (60,000 acres of commercial and 60,000 acres of non-commercial), throughout the lifetime of the project.

Table 148. Potential Treatment Acres Available for up to 60,000 Acres of Commercial Treatment for the Preferred Alternative (Alternative 2).

Geographic Area	Treatment Type	Proposed Action Acres
Grand Mesa	Combination	8,808
	Resiliency	6,163
	Salvage	486
	Total	**15,457**
Gunnison Basin North	Combination	6,897
	Resiliency	6,663
	Salvage	1,825
	Total	**15,385**
Gunnison Basin South	Combination	11,334
	Resiliency	4,419
	Salvage	12,061
	Total	**27,815**
North Fork Valley	Combination	3,356
	Resiliency	5,025
	Salvage	544
	Total	**8,925**
San Juans	Combination	7,773
	Resiliency	2,595
	Salvage	1,830
	Total	**12,198**
Uncompahgre Plateau	Combination	14,997
	Resiliency	17,634
	Salvage	357
	Total	**32,988**
Grand Total		**112,768**

Table 149. Potential Treatment Acres Available for up to 60,000 Acres of Non-Commercial Treatment for the Preferred Alternative (Alternative 2).

Geographic Area	Proposed Treatment Type	Acres by Treatment	Total Acres
Grand Mesa	Burn and Mechanical	21,920	
	Mechanical	1,445	**23,365**
Gunnison Basin North	Burn and Mechanical	48,386	**48,386**
Gunnison Basin South	Burn and Mechanical	18,500	**18,500**
North Fork Valley	Burn and Mechanical	12,225	
	Mechanical	920	**13,144**
San Juans	Burn and Mechanical	430	**430**
Uncompahgre Plateau	Burn and Mechanical	41,231	**41,231**
Grand Total			**145,055**

Alternative 2 Fuels and Fire Emphasis

In Alternative 2 treatments could occur in any location within Potential Treatment Areas that have spruce or aspen vegetation types, including Wildland Urban Interface areas, near other values at risk, or in more remote areas within the PTA, subject to constraints previously outlined. Effects to fuels, fire behavior, and fire management would subsequently include reduced risk of wildfires impacting WUI and other values at risk, an improved mosaic of fire resistant vegetation types within the larger PTA, and improved fire management opportunities across the larger landscape. As a combination of treatments partially designed 1) to protect WUI and other values at risk, and 2) to restore more fire resistant vegetation types and age classes to the greater landscape, are implemented fire management will benefit in the following ways:

-increased ability to safely protect WUI and other values at risk through the creation of defensible space around values, strategically placed fuels treatments adjacent to values, and creation of patches of fire resistant vegetation across the landscape

-increased ability to manage wildfires as a natural process in more remote areas through the creation of patches of fire resistant vegetation across the landscape and the existence of multiple opportunities to control the fire edge and protect values between the managed fire and the value

-increased ability to utilize prescribed fire adjacent to values and in more remote areas to accomplish resource objectives through the creation of patches of fire resistant vegetation across the landscape, and

-reduced risk to firefighters when suppressing or managing wildfires, protecting values, and implementing prescribed burns and other fuels management activities.

In Alternative 2 the potential effects, and benefits to fire management, would occur across a larger portion of the landscape (70 percent more potential area), and are more diverse, than in Alternative 3 (257,823 PTA acres in Alternative 2 vs 151,800 PTA acres in Alternative 3).

Effects of Future Adapted/Potential Future Treatment on Fuels and Fire Management

If all, or a large portion, of the planned resiliency treatment areas in Alternative 2 see increased beetle mortality these areas would be considered for salvage treatment, instead of resiliency treatments (See discussion of differences between salvage and resiliency treatments under 'Mechanical Treatments' in the 'Effects Common to All' section above). In Alternative 2 there are currently 36,000 acres available for resiliency treatment, of which 20-40 percent would be treated under the resiliency prescription (7,200-14,400 acres of actual treatment). If most of the GMUG is affected by the beetle epidemic the entire 36,000 acres could be converted to actual treatment through salvage under the adapted management strategy (see discussion of the Effects of Future Adapted Treatment on Fuels and Fire Management in the Effects Common to All section above)

Analysis of Effects by Geographic Areas

Most effects to fuels and fire are similar across all GAs and have been discussed under the Effects Common to All Alternatives section above. Five specific fuels and fire effects were identified that vary by GA, as well as between Alternatives 2 and 3: 1) percent of potential treatment acres that are WUI, 2) short term impacts to surface fire potential as a result of treatment methods, 3) the ratio of salvage/resiliency treatment acres, 4) long-term landscape level flammability as a result of treatment, and 5) potential acres of adapted treatment, i.e., shifting from resiliency to salvage with increasing beetle mortality.

A description of these specific fuels and fire effects and their significance for fire management considerations follows:

> 1) Percent of Potential Treatment Acres that are WUI: Those Geographic Areas having a higher percentage of potential treatment that are WUI would have a greater likelihood that potential wildfire risk to the WUI would be decreased since more treatments are likely to be closer to WUI.
>
> 2) 1-10 Year Post-Treatment Surface Fire Potential: This is based largely on whether post treatment surface fuels will be lopped and scattered or piled and burned/masticated/ broadcast burned post-treatment slash vs. pile burning. Where fuels from treatments are not removed or treated to reduce flammability there will be a slight increase in surface fire potential for several years post-treatment.
>
> 3) Salvage/Resiliency Ratio: Those GAs having a higher ratio of salvage treatments would exhibit more of the effects associated with salvage, including having a greater reduction in

large fire potential than areas with a lower ratio. Salvage treatments will treat close to 100 percent of each treatment unit while resiliency treatments will treat 20-40 percent of each treatment unit. Salvage treatments, due to their larger size (5-100 acres) and greater overall reduction of treatment area fuel complexes, have more impact than the small group selection (.25-2 acres) and individual tree treatments prescribed in resiliency treatments; small group selection treatments are more likely to have embers blow over them than the larger salvage treatments. Additionally, small group selection treatments offer less opportunity, and less of a safety margin, for firefighters to control a fire relative to larger salvage treatments.

4) Long-Term Landscape Level Flammability: Those GAs having a larger reduction in later seral spruce, aspen/spruce, and aspen types as a result of treatment will have a greater reduction in long-term (50-100 year) landscape level flammability, i.e., the conversion of older, later seral stages to younger, early and mid-seral stages, generally reduces long-term landscape level flammability. The first number is the post-treatment percent of late seral in each GA, the second, negative number is the percent decrease in late seral due to treatment. The 2005 GMUG Comprehensive Assessment made recommendations for desired seral stages by Geographic Area; for a discussion on the ecological aspects of that shift relative to this FEIS see the silvicultural section.

5) Potential Adapted Treatment Acres: These are resiliency acres that could be converted to salvage acres. The higher the acres the more potential there is for landscape scale fuels complexes to be reduced across the landscape.

Table 150. Summary of Effects to Fuels Indicators.

Geographic Area	Effects	Alternative 2	Alternative 3
Grand Mesa	Percent of Potential Treatment Acres that are WUI	72%	100%
	1-10 Year Post- Treatment Surface Fire Potential	Low	Low
	Salvage/Resiliency Ratio	32:68	6:94
	Post-Treatment Long-Term Landscape Level Flammability	82% -7%	84% -5%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	10,567	6,247
Gunnison Basin North	Percent of Potential Treatment Acres that are WUI	72%	100%
	1-10 Year Post- Treatment Surface Fire Potential	Low	Low
	Salvage/Resiliency Ratio	32:68	6:94
	Post-Treatment Long-Term Landscape Level Flammability	82% -7%	84% -5%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	10,567	6,247
Gunnison Basin South	Percent of Potential Treatment Acres that are WUI	24%	100%
	1-10 Year Post- Treatment Surface Fire Potential	Low	Low
	Salvage/Resiliency Ratio	63:37	41:59
	Post-Treatment Long-Term Landscape Level Flammability	52% -4%	55% -1%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	10,086	1,818
North Fork Valley	Percent of Potential Treatment Acres that are WUI	75%	100%
	1-10 Year Post- Treatment Surface Fire Potential	Low	Low
	Salvage/Resiliency Ratio	25:75	1:99
	Post-Treatment Long-Term Landscape Level Flammability	56% -1%	57% -0%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	6,703	5,174
San Juan	Percent of Potential Treatment Acres that are WUI	42%	99.4%
	1-10 Year Post- Treatment Surface Fire Potential	Low	Low
	Salvage/Resiliency Ratio	46:54	20:80
	Post-Treatment Long-Term Landscape Level Flammability	82% -3%	84% -1%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	6,482	2,645
Uncompahgre Plateau	Percent of Potential Treatment Acres that are WUI	68%	100%
	1-10 Year Post- Treatment Surface Fire Potential	Moderate	Moderate
	Salvage/Resiliency Ratio	24:76	2:98
	Post-Treatment Long-Term Landscape Level Flammability	58% -10%	59% -9%
	Potential Adapted Treatment Acres (Potential Shift to Salvage)	25,132	12,269

Effects to WUI and Values at Risk

Under Alternative 2 the Grand Mesa, Gunnison Basin North, North Fork Valley, and Uncompahgre Plateau GAs have high potential to reduce the risk of fire to WUI and other values at risk; 64-75 percent of the acreage within the proposed treatment areas falls within the WUI zone in these 4 GAs. The San Juan GA has moderate potential to reduce the risk of fire to WUI and other values at risk; 42 percent of the acreage within the proposed treatment areas falls within the WUI Zone in this GA. The Gunnison Basin South GA has low potential to reduce the risk of fire to WUI and other values at risk; just 24 percent of the acreage within the proposed treatment areas falls within the WUI zone in this GA.

Post-Treatment Surface Fire Potential

Under Alternative 2 the Uncompahgre Plateau GA has a slightly higher potential for surface fire post treatment due to the lop and scatter method of slash disposal. This effect could last for 5-10 years before the 1 and 10 hour fuels decompose. The silvicultural reasons for leaving slash on the ground include providing microsites for germination and establishment of conifer seedlings, and the reduction of browsing pressure in the area during regeneration due to the difficulty large mammals have in accessing the area through the slash. Additional reasons for leaving slash scattered include increased nutrient availability/cycling, and soil stabilization.

Salvage/Resiliency Ratio

Under Alternative 2 the Gunnison Basin South and San Juan GAs have a high salvage to resiliency ratio, which, from a landscape scale fuels standpoint, has positive implications for future fire control and management on the landscape; those areas with more salvage have larger patches of fuels modification and subsequently more opportunities for fire management actions to safely and effectively take place. The North Fork Valley and Uncompahgre Plateau GAs have the moderate salvage to resiliency ratios. These numbers should not be used to prioritize treatments between GA's however, since there are many other aspects of treatment (total treatment acres, variations in fuels types, large amounts of aspen) that also impact fire management in a positive manner.

Long-Term Landscape Level Flammability

Under Alternative 2 the Grand Mesa and Uncompahgre Plateau GAs have the greatest decrease in late seral stages (-7 percent and -10 percent) on the landscape and subsequently the greatest decrease in landscape scale long-term flammability. The Gunnison Basin North and North Fork Valleys have the least decrease in late seral stages (-2 percent and -1 percent) on the landscape.

Potential Adapted Treatment Acres

The Uncompahgre Plateau has the greatest potential to shift acres from resiliency to salvage, however, if the spruce is not impacted by beetles this shift will not happen. The Grand Mesa,

Gunnison Basin North and Gunnison Basin South, have moderate potential to shift acres to salvage. The North Fork Valley and San Juan have the least potential to shift acres to salvage. Salvage treatments, as mentioned previously under Salvage/Resiliency Ratio above, have more positive impacts to future fire management than resiliency treatments do.

Incidental Vegetation Types for Prescribed Burning

For a general discussion of Incidental Vegetation Types and Effects see the Effects Common to All' section. Table 151 displays the incidental vegetation types, potential acres, and estimated maximum burned acres for Alternative 2. The last column is the maximum amount of each vegetation type that could be impacted by prescribed burning over the life of the project and is further discussed below.

Table 151. Alternative 2 Incidental Vegetation Types Included within Potential Burn Perimeters.

Vegetation Type	Acres within Non-commercial Polygons	Included/ Excluded in FEIS Effects Analysis	Justification for Including/Excluding	Estimated Maximum Burned Acres over life of FEIS
Sagebrush*	5,100* (13,186)	Included	Significant acreage, likely to have some RX applied	<1,000 (~20%)
Oak Dominated Mtn Shrub*	11,805* (13,591)	Included	Significant acreage, likely to have some RX applied	<1,800 (~15%)
Lodgepole Pine	8,390	Included	Significant acreage, likely to have some RX applied	<800 (~10%)
Grass/Forb*	7,580* (10,241)	Included	Significant acreage, likely to have some RX applied	<1,500 (~20%)
Ponderosa Pine	5,527	Included	Significant acreage, likely to have some RX applied	<1,100 (~20%)
Douglas-fir	1,132	Included	Significant acreage, likely to have some RX applied	<225 (~20%)
Willow	1,245	Excluded	Typically unburnable during RX windows	minimal
Blue Spruce	647	Excluded	Scattered small stands, undesirable to burn due to intensity and effects	minimal
Bristlecone Pine	54	Excluded	Minimal acres	minimal
Pinyon-Juniper	36	Excluded	Minimal acres	minimal
Limber Pine	5	Excluded	Minimal acres	minimal

*The sagebrush, oak-dominated mountain shrub, and grass/forb incidental vegetation types initially had significant acreage located within critical Gunnison sage grouse habitat. That portion located within critical habitat was removed so that no prescribed burn treatments will occur within critical habitat in these vegetation types. Sagebrush was reduced by 8,086 acres, oak dominated mountain shrub was reduced by 786 acres, and grass/forb was reduced by 2,661 acres to avoid critical habitat. The number in parenthesis was the original incidental acres and the * number is the non-critical habitat acres included.

There are approximately 5,100 acres of sagebrush outside of critical Gunnison sage grouse habitat included in the non-commercial polygons. We estimate that not more than 1,000 acres (~20%) of this sagebrush may be included in burn units through the life of this project, an average of 100 acres/year.

There are approximately 11,805 acres of oak-dominated mountain shrub outside of critical sage grouse habitat included in the non-commercial polygons. We estimate that not more than 1,800 acres (~15 percent) of the included oak dominated mountain shrub may be included in burn units through the life of this project, an average of 180 acres/year.

There are approximately 8,390 acres of lodgepole pine included in the non-commercial polygons. We estimate that not more than 800 acres (~10 percent) of the included lodgepole pine may be included in burn units through the life of this project, an average of 80 acres/year. Special consideration should be taken when including lodgepole pine in burn units because it typically burns with high intensity and could increase the risk of escape if control lines are not properly located and prepared.

There are approximately 7,580 acres of grasslands outside of critical sage grouse habitat included in the non-commercial polygons. We estimate that not more than 1,500 acres (~20 percent) of the grassland may be included in burn units through the life of this project, an average of 150 acres/year.

There are approximately 5,527 acres of ponderosa pine included in the non-commercial polygons. We estimate that not more than 1,100 acres (~20 percent) of the included ponderosa pine may be included in burn units through the life of this project, an average of 110 acres/year.

There are approximately 1,132 acres of Douglas-fir included in the non-commercial polygons. We estimate that not more than 225 acres (~20 percent) of the Douglas-fir may be included in burn units through the life of this project, an average of 23 acres/year.

Alternative 2 (Agency Preferred Alternative) – Cumulative Effects

The combination of Alternative 2 (~120,000 acres of treatment) , when combined with other reasonably foreseeable future activities (up to 171,000 acres of fuels and up to 7,800 acres of timber treatment), could result in up to 286,000 acres of vegetation treatments; this would be up to 9 percent of the GMUG National Forest. It is unlikely that this number of acres could be treated over the next 10-15 years since it includes the maximum manageable acres (MMA) for prescribed burns; these MMA acres are typically not all burned, but only provide a secondary area, or buffer, for prescribed burning operations. Many of these future 166,000 acres of potential treatment are focused on vegetation types other than spruce/fir or aspen with emphasis on creating wildlife winter and transitional range, restoring fire dependent vegetation types, and/or reducing fuels and subsequent fire behavior around private property and infrastructure. Because of this emphasis,

many of these treatments are located in lower elevation vegetation types ranging from pinyon-juniper and oakbrush to ponderosa pine and Douglas-fir. Additionally, the GMUG averages approximately 2,500 acres of wildfire impact/year and could reasonably expect up to 25,000 acres of wildfire impacts to vegetation over a 10-15 year time period. The cumulative effects of treating 120,000 acres of spruce/fir and aspen at the higher elevations, treating up to 166,000 acres of other vegetation types primarily at the lower and mid-elevations, and having approximately 25,000 acres of wildfire on the landscape over a 10-15 year period could result in fairly significant changes to the vegetative mosaic and fuels complexes across large areas of the GMUG. These vegetative treatments and wildfires would affect stand age, stand structure, species composition, and surface, ladder and canopy fuels and subsequently influence future fire behavior, spread potential, and resistance to control, across a significant portion of the GMUG landscape in a generally positive manner for long-term fire management. Additionally, with the emphasis on treating vegetation and fuels near WUI and other areas with infrastructure values, these combined effects would help reduce risk to these values across approximately 10-15 percent of the Forest, although this could be partially offset by the addition of more than 266 acres of values due to proposed future activities and ongoing development of private property adjacent to the Forest. Overall, the cumulative impacts to fuels and fire across the greater GMUG landscape would result in improved protection opportunities for WUI and other values, safer and more effective opportunities for fire suppression, opportunities to manage fires for resource benefits across more of the landscape and the restoration of a more natural fire regime in several vegetation types, particularly ponderosa pine, Douglas-fir, aspen, and spruce/fir.

Over the long-term post-SBEADMR period from 15-50 years in the future these cumulative impacts on the landscape would create a vegetation mosaic and fuels complex across the landscape that would allow future fire and resource managers to more effectively utilize future wildfires and other natural disturbance events, as well as future treatments that mimic more historical disturbance regimes, to continue to maintain, modify, regenerate, and restore vegetation and mosaics. There are currently several small landscapes consisting of National Forest and adjacent BLM lands where 20-30 years of persistent, focused treatment and restoration effort has been successful in creating landscapes where managers can now efficiently and safely utilize natural fires along with minor amounts of mechanical and prescribed burn treatments to manage the landscape within a historic range of variability. A recent analysis of indicated that up to 50 percent of the FS acres on the Uncompahgre Plateau could be managed primarily with natural fire under a more natural fire regime. That opportunity is available for additional portions of the GMUG with continued persistence in the implementation of both SBEADMR and other vegetation treatments and the appropriate use of managed wildfires to achieve resource benefits.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

The majority of direct and indirect effects of Alternative 3 are analyzed above in the “Effects Common to All Action Alternatives” section. These effects will take place within the proposed

treatment area by treatment type as outlined in Table 152 and Table 153. Although there are 151,800 acres available for potential treatment in the potential treatment areas outlined in Table 152 and Table 153, the maximum acreage which can be treated across the GMUG is 120,000 acres, (60,000 acres of commercial and 60,000 acres of non-commercial), throughout the lifetime of the project. There are the same number**s** of treatment acres available for both Alternative 2 and Alternative 3.

Table 152. Potential Treatment Acres Available for up to 60,000 Acres of Commercial Treatment for the WUI Alternative (Alternative 3).
Note: Some commercial treatments will occur in roadside hazard tree areas since the total below is less than 60,000.

Geographic Area	Treatment Type	Proposed Action Acres
Grand Mesa	Combination	5,283
	Resiliency	3,605
	Salvage	376
	Total	**9,264**
Gunnison Basin North	Combination	1,986
	Resiliency	2,245
	Salvage	732
	Total	**4,963**
Gunnison Basin South	Combination	1,637
	Resiliency	999
	Salvage	1,259
	Total	**3,896**
North Fork Valley	Combination	1,761
	Resiliency	4,293
	Salvage	56
	Total	**6,111**
San Juans	Combination	3,137
	Resiliency	1,076
	Salvage	652
	Total	**4,864**
Uncompahgre Plateau	Combination	8,766
	Resiliency	7,886
	Salvage	218
	Total	**16,869**
Grand Total		**45,967**

Table 153. Potential Treatment Acres Available for up to 60,000 Acres of Non-Commercial Treatment for the WUI Alternative (Alternative 3).

Geographic Area	Treatment Type	Acres	Total
Grand Mesa	Burn and Mechanical	17,310	
	Mechanical	1,445	**18,755**
Gunnison Basin North	Burn and Mechanical	35,581	**35,581**
Gunnison Basin South	Burn and Mechanical	7,291	**7,291**
North Fork Valley	Burn and Mechanical	9,477	
	Mechanical	897	**10,374**
San Juans	Burn and Mechanical	430	**430**
Uncompahgre Plateau	Burn and Mechanical	33,403	**33,403**
Grand Total			**105,833**

Alternative 3 Fuels and Fire Emphasis

In Alternative 3 treatments would be located in Wildland Urban Interface areas and near other values at risk within spruce or aspen vegetation types, with no treatments outside of WUI. This would concentrate the 120,000 acres of available treatment into an area that is 41 percent smaller than the area available for Alternative 2, resulting in a higher density of fuels reduction treatments. Effects to fuels, fire behavior, and fire management would subsequently include a reduced risk of wildfires impacting WUI and other values at risk, and improved fire management opportunities within WUI and adjacent to other values at risk. A significant difference between Alternative 2 and Alternative 3 is that there would not be an improved mosaic of fire resistant vegetation types outside of WUI within the larger PTA as a result of Alternative 3, this would result in unimproved fire management opportunities on the broader landscape; there would be fewer locations away from WUI to control, or manage wildfires and when large fires do occur the tactics could be much more defensive in nature due to the location of modified fuels only being located in the WUI and around other values at risk.

As treatments partially designed to protect WUI and other values at risk are implemented fire management will benefit in the following ways:

-increased ability to safely protect WUI and other values at risk through the creation of defensible space around values and strategically placed fuels treatments adjacent to values.

-somewhat increased ability to manage wildfires as a natural process in more remote areas since WUI and other values at risk are well protected. (As mentioned previously, with Alternative 3 there will be no creation of patches of fire resistant vegetation across the greater landscape away from WUI and large fires may subsequently move unimpeded across larger portions of the landscape.)

-increased ability to utilize prescribed fire adjacent to WUI and other values through the creation of patches of fire resistant vegetation in and around WUI areas (There will be no significant change to the use of prescribed fire in remote areas because remote fuels complexes will remain untreated), and

-reduced risk to firefighters when suppressing wildfires, protecting values, and implementing prescribed burns and other fuels management activities in the WUI. (The risk reduction will not apply to the greater landscape due to lack of treatments outside of WUI.)

In Alternative 3 the potential effects, and benefits to fire management, would occur across a smaller portion of the landscape (41 percent less potential area), and are less diverse, than in Alternative 2 (151,800 PTA acres in Alternative 3 vs 257,823 PTA acres in Alternative 2).

There are several other, treatment specific implications of focusing treatments into WUI as described below.

There is a higher likelihood that fewer broadcast burn treatments would be implemented under Alternative 3 than under Alternative 2. In Alternative 3, all treatments would be limited to the 1 mile buffer around WUI and other values at risk. Any broadcast burning, therefore, would only occur in the WUI. There are several factors that make broadcast burning in the WUI more challenging, including values at risk from an escaped prescribed burn, increased public interest and smoke management concerns, increased requirements related to control line preparation, tighter burn prescriptions, and larger, more expensive burn organizations. These factors will reduce the applicability of broadcast burn treatments in Alternative 3 relative to Alternative 2 from an estimate of approximately 25,000 acres to <20,000 acres. The positive benefits of prescribed burning for both fuels reduction and ecological processes will be reduced.

Mechanical treatments would be more focused on surface fuels reduction in the WUI. The Forest Plan requires surface fuel loadings near values at risk to be managed so that flame lengths will be less than 4’ under 90th percentile burn conditions. This will require increased mastication, piling and burning, and removal of fuels from these areas than with Alternative 2. The results on increased areas with surface fuels reduction will be a greater reduction of wildfire risk to WUI and values at risk relative to Alternative 2.

There will be increased removal of understory spruce and fir ladder fuels from spruce-fir stands to reduce the potential for torching, crowning, and spotting in the WUI. This will occur within the constraints of the SRLA.

Effects of Future Adapted Treatment on Fuels and Fire Management

If all, or a large portion, of planned resiliency treatment areas see increased beetle mortality these areas would be considered for salvage treatment, instead of resiliency treatments (See discussion of

differences between salvage and resiliency treatments under 'Mechanical Treatments' in the 'Effects Common to All' section above). There are currently 39,000 acres available for resiliency treatment in Alternative 3, of which 20-40 percent would be treated under the resiliency prescription (7,800-15,600 acres of actual treatment). If all of the 39,000 acres died, the entire 39,000 acres could be converted to actual treatment through salvage under the adapted management strategy (see *Effects of Future Adapted Treatment on Fuels and Fire Management* in the *Effects Common to All* section above). This could potentially be 600-1200 acres more salvage than the adapted/potential future treatments for Alternative 2. Under Alternative 3 this could result in a fuels complex in the WUI that is dramatically altered through clearcutting type treatments concentrated in the WUI areas of most commercial PTAs.

Analysis of Effects by Geographic Areas

Refer to the 'Analysis of Effects by Geographic Areas' section, and Table 150, under Alternative 2 above for a description of the effects considered and a comparison of Alternative 3 with Alternative 2.

Effects to WUI and Values at Risk

Under Alternative 3 there would be very high potential to reduce the risk of fire to WUI and other values at risk in Potential Treatment Areas located in all Geographic Areas since all treatments would be required to be located in WUI areas and around other values at risk. Ninety-nine to 100 percent of the potential treatment acres are located within WUI in Alternative 3. This is a dramatic increase over Alternative 2, where 24-75 percent of the potential treatment acres are located within WUI.

Post-Treatment Surface Fire Potential

There is no difference in landscape level surface fire potential across the Geographic Areas relative to Alternative 2

Salvage/Resiliency Ratio

Under Alternative 3 the ratio of salvage to resiliency is very low in the Grand Mesa, North Fork Valley, and Uncompahgre Plateau GAs and is low in the Gunnison Basin North and San Juan GAs. The ratio is moderate in the Gunnison Basin South GA. From a landscape scale fuels standpoint this is not ideal because it is an indication that there are fewer large patches of modified fuels on the landscape available as opportunities for fire management actions to safely and effectively take place. These numbers should not be used to prioritize treatments between GAs however, since there are many other aspects of treatment (total treatment acres, variations in fuels types, large amounts of aspen) that also impact fire management in a positive manner.

Long-Term Landscape Level Flammability

Under Alternative 3 the Grand Mesa and Uncompahgre Plateau GAs have the greatest decrease in late seral stages (-5 percent and -9 percent) on the landscape and subsequently the greatest decrease in landscape scale flammability. The other 4 GAs have the least decrease in late seral stages (-0 percent to -1 percent) on the landscape.

Potential Adapted Treatment Acres

Under Alternative 3 the Uncompahgre Plateau has the greatest potential to shift acres from resiliency to salvage, however, if the spruce is not impacted by beetles this shift will not happen. The Grand Mesa, Gunnison Basin North and North Fork Valleys have moderate potential to shift acres to salvage. The Gunnison Basin South and San Juan GAs have the least potential to shift acres to salvage. Salvage treatments, as discussed previously under Salvage/Resiliency Ratio above, have more positive impacts to future fire management than resiliency treatments do.

Incidental Vegetation Types for Prescribed Burning

For a general discussion of Incidental Vegetation Types and Effects see the Effects Common to All' section. Table 154 displays the incidental vegetation types, potential acres, and estimated maximum burned acres for Alternative 3 as well as the decrease of incidental burn acres relative to Alternative 2.

Table 154. Alternative 3 Incidental Vegetation Types Included within Potential Burn Perimeters.

Vegetation Type	Acres within Non-commercial Polygons	Included/ Excluded in FEIS Effects Analysis	Justification for Including/Excluding	Estimated Maximum Burned Acres over life of FEIS	Percent Decrease from Alt 2
Sagebrush	4,346	Included	Significant acreage, likely to have some RX applied	<900 (~20%)	-10%
Oak Dominated Mtn Shrub	9,332	Included	Significant acreage, likely to have some RX applied	<1,400 (~15%)	-32%
Lodgepole Pine	5,440	Included	Significant acreage, likely to have some RX applied	<550 (~10%)	-32%
Grass/Forb	4,185	Included	Significant acreage, likely to have some RX applied	<850 (~20%)	-44%
Ponderosa Pine	4,388	Included	Significant acreage, likely to have some RX applied	<900 (~20%)	-18%
Douglas-fir	708	Included	Significant acreage, likely to have some RX applied	<150 (~20%)	-33%

There are approximately 4,346 acres of sagebrush outside of critical Gunnison sage grouse habitat included in the non-commercial polygons. We estimate that not more than 900 acres (~20 percent) of this sagebrush may be included in burn units through the life of this project, an average of 90 acres/year. This is a 10 percent reduction in incidental sagebrush burning relative to Alternative 2.

There are approximately 9,332 acres of oak-dominated mountain shrub outside of critical sage grouse habitat included in the non-commercial polygons. We estimate that not more than 1,400 acres (~15 percent) of the included oak dominated mountain shrub may be included in burn units through the life of this project, an average of 140 acres/year. This is a 32 percent reduction in incidental oak dominated mountain shrub burning relative to Alternative 2.

There are approximately 5,440 acres of lodgepole pine included in the non-commercial polygons. We estimate that not more than 550 acres (~10 percent) of the included lodgepole pine may be included in burn units through the life of this project, an average of 55 acres/year. This is a 32 percent reduction in incidental lodgepole pine burning relative to Alternative 2. Special consideration should be taken when including lodgepole pine in burn units because it typically burns with high intensity and could increase the risk of escape if control lines are not properly located and prepared.

There are approximately 4,185 acres of grasslands outside of critical sage grouse habitat included in the non-commercial polygons. We estimate that not more than 850 acres (~20 percent) of the grassland may be included in burn units through the life of this project, an average of 85 acres/year. This is a 44 percent reduction in incidental grassland burning relative to Alternative 2.

There are approximately 4,388 acres of ponderosa pine included in the non-commercial polygons. We estimate that not more than 900 acres (~20 percent) of the included ponderosa pine may be included in burn units through the life of this project, an average of 90 acres/year. This is an 18 percent reduction in incidental ponderosa pine burning relative to Alternative 2.

There are approximately 708 acres of Douglas-fir included in the non-commercial polygons. We estimate that not more than 150 acres (~20 percent) of the Douglas-fir may be included in burn units through the life of this project, an average of 15 acres/year. This is a 33 percent reduction in incidental Douglas-fir burning relative to Alternative 2.

Alternative 3 (WUI Focus) – Cumulative Effects

In general, the cumulative effects of Alternative 3 would be very similar to the Proposed Action because the treatment types and total acres treated in the project lifetime would be the same. However, the cumulative effects would be more concentrated in WUI and roadside areas, resulting in slightly decreased risk to WUI and other infrastructure values over Alternative 2. Because treatments are focused closer to WUI there would be fewer acres treated in other locations on the

landscape, resulting in slightly decreased opportunities for fire managers to safely manage fire across the wider landscape.

GMUG Landscape –Scale: Effects Common to All Action Alternatives

On a Forest-wide scale there are several fuels and fire effects common to all alternatives that are highly relevant and beneficial to long-term fire management. The first three of these are quantifiable while the last two are more qualitative in nature.

Percent of Forest-wide WUI Treated

Within the WUI and around other infrastructure values there will be between 68,000 and 106,000 acres of treatment applied to the landscape, with an emphasis on reducing the risk to WUI and other infrastructure values. The GMUG has approximately 1,048,900 acres of identified WUI; treating between 68,000 and 106,000 acres of the total WUI would have a positive impact on approximately 6.5-10 percent of the WUI area on the Forest. This would have value in reducing wildfire risk to WUI by reducing fire behavior and resistance to control, and enhancing opportunities for firefighters to safely stay engaged in and near WUI during a wildfire incident.

Percent of Forest-wide Roads Treated

There could be a maximum of approximately 900 miles of roads treated to remove hazard trees to reduce risk to the public and firefighter within PTAs and along other roads identified for hazard tree removal. This removal would include disposal of associated slash as needed to maintain appropriate fuel loadings and subsequently reduce future fire behavior. Of the 3,720 miles of roads on the GMUG these 900 miles are 24 percent of the total road mileage on the Forest. Though this number seems high it should be realized that within Wilderness and Roadless areas of the Forest there are no roads (ie, roads are focused in the areas outside of Wilderness and Roadless areas, and the selection criteria for the commercial PTAs prioritized areas that were already roaded so that new road construction could be minimized. Roads are ideal locations for fire management personnel to control or manage wildfires or to implement prescribed burns from since they are linear features that already have vegetation and fuels removed from them and subsequently support less intense fire behavior. With the removal of hazard trees and associated slash fuels from areas adjacent to these roads, fire managers will have more opportunity to safely and effectively control and/or manage both wildfires and prescribed burns using these roads; subsequently WUI and infrastructure values can be better protected, wildfires can more readily be suppressed, managed wildfires can be utilized more frequently to obtain ecosystem benefits on the landscape, and prescribed burns can be implemented more effectively.

Long-term Decrease in More Flammable Late Seral Vegetation

Across the entire GMUG NF there will be a 3.5-5.5 percent decrease in the more flammable later seral vegetation types as a result of treatments. This 3.5-5.5 percent will shift to less flammable early and early-mid seral stages through treatment. Although this shift is concentrated entirely within the commercial and non-commercial PTAs it has the value of breaking up the larger landscape with concentrated areas of less flammable vegetation. Across the GMUG NF there are 712,200 acres of spruce and spruce dominated stands. Approximately 60,000 acres of this will be treated through the SBEADMR EIS, or 8.5 percent. Much of this treatment will convert older, more flammable seral stages to earlier, less flammable seral stages, some of it will have surface and ladder fuels treated to reduce future fire behavior, and in some locations more fire adapted species such as Douglas-fir and ponderosa pine will be regenerated along with spruce and subalpine fir. Across the GMUG NF there are 833,500 acres of aspen and aspen dominated stands. Approximately 60,000 acres of this will be treated through the SBEADMR EIS, or 7.2 percent. The emphasis of aspen treatments will be on regenerating young aspen stands or removing spruce, fir, and other conifer species from existing stands. This will lead to significantly less flammability in the treated aspen types within the PTA.

These treatments will enhance fire management opportunities by creating areas on the landscape where fire is less likely to occur, and, if it does occur, it will burn with less intensity and have less resistance to control. This will allow fire managers to more safely and efficiently control wildfires, manage some wildfires for resource benefits, and implement prescribed burns more efficiently. Much of this shift to earlier seral stages and less flammable stands will occur in the WUI and would reduce risk to WUI as discussed above under ‘Percent of Forest-wide WUI Treated.’

Climate Change Resiliency Relative to Fire Management

With the increasing potential for climate changes to continue over the next 50-100 years, fire managers across the western United States are anticipating that wildfires will continue to increase in frequency, intensity, and size. This changing fire regime can have devastating effects on natural resources, improvements, infrastructure, and human life and safety as witnessed with the West Fork Complex on the adjacent San Juan and Rio Grande National Forests in 2013. By treating some of the older, more flammable seral stages and vegetation types on the GMUG, and in the process 1) converting some of them to less flammable aspen and younger spruce stands, 2) encouraging regeneration of more fire adapted species such as ponderosa pine and Douglas-fir, and 3) reducing surface, ladder, and canopy fuels in residual stands, the GMUG will be working to improve landscape resiliency to potentially more frequent, intense, and larger fire events in the future.

Combined Effects on the Ability to Manage Fire Across the GMUG Landscape

Table 155 lists each of the above impacts to fuels and fire management across the entire GMUG NF.

Table 155. Forest-wide Impacts to Fuels and Fire from SBEADMR Treatments

		Current Forest-Wide	Treated through SBEADMR	Percent Treated on Forest
WUI		1,048,900 acres	68,000-106,000 acres	6.5-10%
Roads		3,720 miles	~900 miles	24%
Long-Term Flammability	Decrease in more flammable seral stages	1,440, 205 acres	48,362-79,666 acres	3.5-5.5%
	Spruce Dominated Stands	712,200 acres	60,000 acres	8.5%
	Aspen Dominated Stands	833,500 acres	60,000 acres	7.2%

The combination of WUI treatments, road treatments, and reduction in long-term flammability and resistance to control across the SBEADMR PTAs on the GMUG landscape will enable fire managers to 1) better protect WUI, infrastructure, and human life, 2) control and suppress wildfires more effectively, 3) have more opportunities to enhance resource conditions through management of some wildfires, 4) utilize prescribed fire more effectively to achieve specific objectives, and 5) safely achieve the above fire management activities without undue risk to firefighters and the public.

Biological Environment

Compliance with Regulatory Direction

Forest Service Policy and Direction:

Forest Service Manual 2670: Directs Forest Service to manage habitat for existing native and desired nonnative plants, fish and wildlife species, as well as threatened and endangered species, and to develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service Actions."

Forest Service Manual Rocky Mountain Region (Region 2) 2670.32: "Integrate available scientific information, including Regional species evaluations, species and ecosystem assessments, and conservation strategies, into Forest Service planning and implementation…"; The Manual also includes direction on conducting inventories and monitoring sensitive species, and managing for sensitive species in groups and habitat complexes when feasible.

Botany

Analysis and Determinations of Effects on Sensitive Species

Methodology

The following analysis is based upon professional knowledge, the best available science, and existing best available information. Effects are analyzed for known occurrences and for potential habitats which will be discussed in the context of occupied habitats. As the main difference between the alternatives is the spatial area that they could occur in, a comparison of Priority Treatment Areas, hazard tree treatments, and new roads that are outside PTA's (all three activities together will be referred to as "potential affected areas") will be a proxy for magnitude of impacts. Commercial and/or non-commercial treatments will be applied within identified treatment areas only.

Scope of Analysis

This project uses the potential affected areas to indicate areas on the GMUG where these activities could occur. The potential affected areas are assessed spatially by Geographic Area of occurrence (Grand Mesa, Gunnison Basin North, Gunnison Basin South, North Fork Valley, San Juan, and Uncompahgre Plateau). Treatment types have been identified along with estimated acres associated with each action in each treatment area. Based on current stand conditions and alternative we expect 7-15 percent salvage, 47-49 percent variable retention regeneration (combination), and 38-44 percent resiliency treatments. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. This latter scenario is also analyzed and is referred to as "adapted treatment type".

Assumptions Made

There are assumptions we used, that relate to the alternatives considered in this document and their effects on sensitive plant species.

- Use of the design features will minimize or reduce direct and indirect impacts (Appendix B).
- The action alternatives have areas common to all; where these alternatives overlap, the impacts and effects to sensitive plant populations will be identical.

- Fens, meadows, and riparian areas will not have pile burning, heavy machinery, vehicle traffic, or timber harvest occurring in them;
- It is assumed that the types of impacts that have the potential to affect sensitive species are the same to all action alternatives. The effects will be dependent on the location where the treatments occur and whether there are sensitive species present or potentially could occur.

Criteria Used to Determine Impacts

The following criteria were used to determine whether sensitive plant species would be affected by project implementation:

- Whether the species occurs or has the potential to occur within the treatment area;
- The likelihood of impacts to suitable habitat;
- The nature and extent of impacts anticipated as a result of each alternative;
- The life cycle of the species present or potentially present, and the resulting anticipated response to disturbance;
- The existence of or potential for other impacts to sensitive plant species within the cumulative effects analysis area.

For the purpose of this analysis, cumulative effects are bound in space by the Forest Boundary. Cumulative effects will be bound by ten to twelve years into the future because this encompasses the life of the project. Past effects will be considered a part of the baseline conditions as presented in affected environment.

Affected Environment

Species Considered for Analysis

Of the two federally threatened and twenty-two sensitive plant species with the potential to occur on the GMUG, ten sensitive species were determined to fall within the elevation and distributional ranges of the project alternatives, and to have suitable habitat that could be impacted by any of the alternatives. Neither of the threatened species will be affected by any of the alternatives. Species that will be considered in effects analysis include:

Lesser panicled sedge (*Carex diandra),* round leaf sundew *(Drosera rotundifolia),* Chammiso's cottongrass (*Eriophorum chamissonis),* slender cottongrass (*Eriophorum gracile),* sageleaf willow (*Salix candida),* sphagnum moss (*Sphagnum angustifolium),* lesser bladderwort (*Utricularia minor),* park milkvetch (*Astragalus leptaleus),* Colorado tansy aster *(Machaeranthera coloradensis),* and peculiar moonwort (*Botrychium paradoxum).*

Features considered for eliminating a species from consideration from further analysis include:

1. Species is outside of the known distributional and elevation range of the areas potentially affected by alternatives (e. g., alpine species, low elevation species)
2. Species is not known to occur near roads used for project activities
3. Species is known to occur in specific edaphic types (plant communities associated to specific soil types) that are not included in any of the SBEADMR alternatives.

The primary target habitat for the SBEADMR project is Engelmann spruce-subalpine fir (*Picea engelmannii-Abies bifolia*) and aspen (*Populus tremuloides*) vegetation types. Both spruce-fir and aspen occur as or within a matrix of other vegetation types. Spruce-fir forms the primary matrix systems of the subalpine zone in the Southern Rocky Mountains (Gregg 1963, Johnston and others 2001). Aspen is a common constituent in this vegetation type, but also can form homogeneous stands; aspen can also occur in the lower-elevation montane zone (Johnston and others 2001). The plant species considered in this analysis generally occur in rare or unusual habitats within the montane and subalpine zones.

For purposes of analysis and description the species considered in effects analysis will be grouped for discussion (Table 156). This approach is useful in this effects analysis as the sensitive species are in varying degrees dependent on some threshold of habitat integrity, or some habitat constituent. This dependence is generally based on some sort of ecosystem process (e.g., disturbance) or physiological preference/adaptation (e.g., high hydrologic needs). When approached from this angle, impacts to the integrity of the habitat can be inferred to be associated with the suitability and sustainability of the habitat for individual populations.

Table 156. Sensitive Plant Species on the GMUG, by Habitat

Habitat	Sensitive Plants
Montane parks and alpine	Colorado tansy aster
Moist swales and riparian meadows	park milkvetch
Fens and other wetlands	lesser panicled sedge round leaf sundew Chammiso's cottongrass slender cottongrass sageleaf willow sphagnum moss lesser bladderwort
Lightly-disturbed microsites (old roads and road cuts) within mesic coniferous stands	peculiar moonwort

Mesic Conifer Forests

Peculiar moonwort is found in habitats with some overhead canopy, often where past disturbance has occurred historically, such as closed roads or regenerating roadside pullouts. Overhead canopy can be provided by young trees or medium-height to small forbs. Potential habitat could be found within the aspen, spruce-fir, lodgepole, and cool-moist mixed conifer cover types in alpine and subalpine zones. Mycorrhizal relationships are very important, for all *Botrychium* species have a mycorrhizal relationship with soil fungi (Beatty and others 2003). This would be the habitat constituent that is the most critical for maintaining suitable habitat for *Botrychium.* This habitat is present throughout the forest, and is difficult to quantify as far as baseline conditions.

Peculiar moonwort is a plant of mesic subalpine mountain meadows dominated by grasses, sedges and in some cases, dense herbaceous and shrubby cover (Farrar 2011). In Colorado, suitable habitat has not been clearly determined, but peculiar moonwort has been found in open rocky alpine or subalpine areas at elevations above approximately 10,500 feet. Peculiar moonwort occurs from south central Utah and Colorado northward to Montana and Washington and into southern British Columbia, Alberta and Saskatchewan, and is disjunct in the Sierra Mountains of east-central California. The Colorado distribution is limited to one location on the Grand Mesa, Uncompahgre and Gunnison National Forest in Crested Butte.

There is little information about impacts to peculiar moonwort in Colorado. It is known from a single population at this time and it is sensitive to extirpation through this part of its range.

There is the potential for peculiar moonwort to occur throughout SBEADMR activity areas where suitable habitat exists, primarily in old roadbeds throughout the spruce-fir and other mesic conifer types.

Montane Parks

Colorado tansy aster is found in areas with open exposure and soils in montane parks, and usually occurs on certain geological formations, tuffs with some tendency toward higher pH, limy in character (Beatty and others 2004). On Colorado tansy aster sites, species cover varies widely, from nearly barren slopes, to Idaho fescue (*Festuca arizonica)* grasslands, to low sagebrush or rabbitbrush shrublands; but the Colorado tansy aster plants always occur in open microsites within those communities.

Colorado tansy aster also occurs on alpine slopes, again in open microsites and associated with limy geologic substrates (Beatty and others 2004). Colorado tansy aster is endemic to Wyoming and Colorado, ranging from southern Colorado to the Medicine Bow National Forest in southeastern Wyoming. In Colorado known populations exist in Chaffee, Gunnison, Hinsdale, La Plata, Lake, Mineral, Park, Pitkin, Saguache, and San Juan Counties. Colorado tansy aster is known from at least 36 populations in Colorado, with approximately half of these on the GMUG.

Colorado tansy aster is vulnerable to threats because of the restricted geographic range. The populations at greatest risk are those lower elevation populations adjacent to, or in roads. Other potential threats include motorized and non-motorized recreation, trail and/or road construction and maintenance, reservoir expansion, housing development, changes to natural disturbance regimes, livestock, and invasive species.

Colorado tansy aster is known to occur in SBEADMR activity areas, and has the potential for additional populations where suitable habitat exists. This species appears to be somewhat resistant to trampling, since it has been observed in beds of seldom-used roads, and seems to do well in areas frequented by cattle or deer.

Wetlands

Wetlands, including fens, are estimated to occupy about 0.4 percent of the GMUG (Johnston and others 2012), that is, about one in every 223 acres. Few of these wetlands occur associated with a stream, but most are round or oval. In the subalpine and montane zones, wetlands are dominated by obligate wetland plants (Lichvar 2012), which on the GMUG include species such as beaked sedge (*Carex utriculata*), water sedge (*C. aquatilis*), and sometimes one or more willow species.

Use of wetlands on the National Forests, and access to them, is managed by the Forest Service under the Clean Water Act[10] and its implementing regulations, especially the wetland mitigation regulations.[11] In the Forest Service, wetlands are surrounded by a buffer called the *water influence zone* (USDA Forest Service 2006b). Since laws, regulations and Forest Service policies and best management practices (USDA Forest Service 2012c) severely restrict any activities in wetlands and limit activities in the water influence zone around them, activities implementing this project will avoid wetlands (WQSP-2A, Appendix B). The following are discussions on the specific types of wetlands that sensitive plants are known to occur in.

Moist Swales and Riparian Meadows

Park milkvetch grows in lower elevation riparian areas and sub-riparian swales, typically sedge-grass dominated meadows, swales and hummocks, and streamsides; its population and distribution is not well known, however. Park milkvetch is considered a regional endemic that is known from Colorado, Idaho, Montana and Wyoming. In Colorado it is known from Jackson, Larimer, Summit,

[10] 33 U. S. Code § 1251 and following.

[11] 33 Code of Federal Regulations 325-332 and 40 CFR 230; see Federal Register 73(70):19594-19705 of April 10, 2008.

Park and Gunnison Counties. On the GMUG, park milkvetch is known to occur in the Gunnison Basin, and has the potential to occur in FS lands on the Gunnison District.

Riparian and sub-riparian grass-sedge swales occur near streams or stream courses; most of these areas would be included within riparian areas according to the definition in the current Forest Plan (USDA Forest Service 1991c), and so would fall under the direction for Management Area 9A in that plan. Park milkvetch is thought to be vulnerable primarily due to loss, degradation and/or fragmentation of habitat. As park milkvetch is known from lower elevation riparian areas and hay meadows, it is thought to have vulnerability to invasive species, activities that dry habitat out like hay farming, and livestock grazing. Other potential threats include off-road vehicles, camping, road development, drought, and potentially closing of the forest canopy due to fire suppression.

There is the potential for park milkvetch to occur in the SBEADMR activity areas, especially on the Gunnison District in areas where suitable habitat exists.

National and regional best management practices include buffers around streams, called water influence zones (USDA Forest Service 2006-2012). The water influence zone is a minimum of 100 feet on either side of the stream, usually expanded to include the distinctive riparian vegetation and often the floodplain as well (WQSP-2A, Appendix B). It is likely that populations of park milkvetch would occur within the water influence zone.

There are special restrictions on use of water influence zones, especially with road construction and other activities involving heavy equipment. It is not known how large the populations of park milkvetch are, but seems likely they are fairly small in extent, and so would be relatively easy to avoid by activities planned in this project.

Fens

Fens are “wetlands with waterlogged substrates and approximately 30 cm or more of peat accumulation” (Chadde and others 1998, also see Johnston and others 2012), characterized as having water tables near the soil surface. Fens are types of peatland that have been characterized for the GMUG as having 30 cm of peat in the top 80 cm, and anaerobic conditions where peat is accumulating (Johnston and others 2012). Fens are hydrologically dependent on groundwater discharge, and generally experience saturation to soil surface (Bedford and Godwin 2003). Acidic fens (also referred to as “poor fens”) are generally dominated by bryophytes with scattered vascular plants.

Seven of the sensitive species considered in this EIS are known to occur in fens (lesser panicled sedge, round leaf sundew, Chammiso’s cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, and lesser bladderwort). Round leaf sundew and sphagnum moss are known to prefer acidic fens. Neutral to alkaline fens (also known as “rich fens”) and generally dominated by vascular

plants, primarily sedge species (Chadde and others 1998). Lesser panicled sedge and sageleaf willow are known to occur primarily in rich fens.

A fen inventory conducted on the GMUG in 2009-2010 estimates that there are approximately 1,738 fens covering 11,034 acres, with half of them being less than four acres in size. Fens on the GMUG are concentrated in the Grand Mesa, Sawatch Mountains and San Juans, and most are known to occur between the elevations of 9,000 to 11,900 feet. This inventory also rated fen condition, finding 81 percent of the fens in "high" condition, 18 percent in moderate condition, and 1 percent in low condition. Fen communities are very sensitive to hydrologic alterations, and once function has been impaired, restoration may be possible but is a lengthy and expensive process. The primary factors on the GMUG that are known to be causal agents of degradation or disturbance in and adjacent to fens are browsing and grazing; historic mining activities; construction, use and maintenance of roads and trails; and flooding, and beaver activity. The lowest-scored condition class fens were highly altered by flooding from adjacent reservoirs, historic mining and grazing activities (causing channelization and hence dewatering), all of which are activities that alter the hydrologic functioning.

The recommended buffer around fens is a minimum of 100 feet from the outer edge of the wetland complex which defines the water influence zone for fens (WQSP-2A, Appendix B). Fens are usually considered irreplaceable because the peat in fens accumulates at such a slow rate (U. S. Fish and Wildlife Service 1999, USDA Forest Service 2011d). For these reasons, Forest Service policy is to conserve or restore fens (USDA Forest Service 2011d).

On the GMUG, fens occupy about 0.14 percent of the landscape, that is, about one acre in every 715. Fens are small to very small features. Forest Service policies and best management practices nationally (USDA Forest Service 2012c) and regionally (USDA Forest Service 2006b) severely restrict any activities in wetlands (including fens) and limit activities in the water influence zone around them (WQSP-2A, Appendix B); as a result, activities implementing this project will avoid fens.

Alternative 1 (No Action Alternative) - Direct and Indirect Effects

This alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. It assumes no implementation of any elements of the proposed action or the action alternatives. Under the no action alternative, spruce-fir mortality and aspen decline are anticipated to continue unmitigated. The actual trajectory of mortality is not predictable, but it is assumed that in the spruce-fir, unless some carrying capacity for the beetles is reached, they will continue to move into uninfested areas and kill large diameter trees first, and then move to the smaller diameter trees. It is also assumed that aspen will continue to decline, and may experience sudden periodic decreases as were seen with the recent sudden aspen decline epidemic. These events will result in overstory mortality in both spruce and aspen stands. In spruce stands, dead trees will mostly remain

standing for several decades[12], but in dead aspen stands, there will be high levels of down trees in the forest.

Scientists are divided on whether a large-scale spruce beetle epidemic (such as we are experiencing) increases fire behavior, effects and fire risk. The actual risk of fire is at this time unknown. However, fires in beetle-killed spruce will be larger and may burn with more surface fire intensity. High-severity wildfire could result in passive indirect effects to sensitive plant species including changes to microhabitat making it less or more suitable.

Recent large wildfires in southwestern Colorado have coincided with periods of drought, which will be more unpredictable and more severe as the climate changes (White and others 2013, Williams and others 2012). More severe drought periods will increase the likelihood of severe fires in the spruce-fir zone (Allen and others 2010), and greater likelihood of episodes of sudden aspen decline (Carnicera and others 2011, Worrall and others 2013).This situation could passively adversely affect all sensitive species by increasing interspecific competition, habitat loss, and indirect habitat loss due to increases in invasive plants. With abundant biomass, both standing and on the ground, resulting severe wildfires could result in areas with lethal soil heating which would adversely impact any sensitive species that was present, but also could impact vigor of populations by impacting mycorrhizal relationships (especially with *Botrychium* species).

Intense ground heating from severe wildfires usually results in conditions causing major erosion events (Robichaud and others 2000, Peppin and others 2010, Johnston 2012), potentially causing sedimentation events in fens. Sedimentation in fens retards (or even stops) the peat formation process (D. Weixelman, pers. comm. 2014), changes community structure and could cover, or bury sensitive plants. Lethal soil heating could also result in the direct mortality of individuals, or populations, or seed or spore banks.

Any beneficial passive impacts that wildfire might have on disturbance niche species such as Colorado tansy aster and peculiar moonwort, would be overcome by the soil and habitat loss following severe wildfires. These species appear to be stimulated by varying degrees of disturbance and reduced overstory cover. The relationship between specific coverage and optimal vigor is not known for these species, but given their known habitat, high severity fire would likely result in extensive soil and ground cover loss and removal of too much of the overstory, resulting in adverse impacts.

The primary difference with wildfire in spruce beetle-killed stands that would affect sensitive species is the increased intensity and residence time of fire on the soil (Robichaud and others 2000-2006). Analysis of the potential passive indirect effects of high severity wildfire is thus assessed in

[12] Roy Mask, pers. comm.

the analysis of the No Action Alternative, but while these effects are assumed to be more likely with No Action, no alternative eliminates this risk. There is a small risk of these passive effects.

Activities Common to Both Alternatives

Design features are an integral part of the effects analysis and determination. Design features were developed in response to the foreseeable adverse impacts to sensitive species as discussed in the effects analysis below (Table 157). Design feature development and emphasis focused on reducing, if not eliminating, impacts that were likely to lead to losses in viability.

Table 157. Design Features for Sensitive Species for all SBEADMR Project Alternatives.

Sensitive Species of Concern	Trigger for Use	Design Feature	Design Criteria Function in reducing effects
Upland (non-wetland) Sensitive Species	Potential habitat exists in the treatment area.	FSSP-10: Sensitive plant populations will be flagged and avoided for all ground disturbing activities with a buffer of 20 – 100 feet (as determined during treatment design).	Prevent take of individuals or populations that would lead to a loss in viability
		FSSP-10: Disturbances including road construction, reconstruction, landings, skid trails and staging areas in potential habitat for sensitive species will be surveyed by a qualified botanist in the proper season prior to implementation.	
All Sensitive Species	Potential habitat or wetland exists in the treatment area.	FSSP-2B: During prescribed fire operations (including aerial or ground broadcast burning), ignitions and other fuel treatment activities would be located away from sensitive plant species populations and wetlands.	Prevent toxicity to individuals or populations that would contribute to a loss in viability.
		FSSP-2C: Dust abatement (use of $MgCl_2$ or $CaCl_2$) will avoid sensitive species populations and wetlands by 500 feet.	
		FSSP-2D: Avoid sensitive species populations and wetlands with chemical weed treatments.	

Sensitive Species of Concern	Trigger for Use	Design Feature	Design Criteria Function in reducing effects
		FSSP-2A: Pre-treatment implementation assessment will be conducted by a qualified botanist. Notification will be given with sufficient time for field surveys during the proper season to be conducted for sensitive plant species expected to occur in the project area or affected by it.	Identification of sensitive plants in the treatment area to avoid potential impacts all together or selection of appropriate design feature to minimize impacts.
		FSSP-2E: Any Region 2 sensitive plant species new to list or located after contract or permit issuance will be appropriately managed by active coordination between permittee, contractor or purchaser, Forest Service line officer, project administrator, and botanist.	During implementation, coordination with botanist will ensure protection of sensitive plants through implementation of design features.
Colorado tansy aster, peculiar moonwort	Documented occurrence of the species in the treatment area.	FSSP-3A: Minimize traffic on roads passing through known sensitive species sites.	Prevent take of individuals or populations that would lead to a loss in viability.
		FSSP-10: Proposed road construction, reconstruction, landings and staging areas in potential habitat for sensitive species will be designed and marked on the ground only after the areas have been surveyed by a qualified botanist in the proper season.	
		FSSP-4B: If there is tree canopy covering occupied habitat, maintain pre-project tree canopy over habitat.	
Fen sensitive species: lesser panicled sedge, round leaf sundew, Chamisso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort	Documented occurrence of the species or a fen in the treatment area.	FSSP-6A: Keep roads and trails out of wetlands and their water influence zones (WIZ).[13]	Reduce potential for recreation-related resource damage to fens.
	Presence of a fen or riparian area in the treatment area.	FSSP-6B: Restore existing disturbed areas that are eroding and contributing sediment to the wetland.	Maintain fen hydrologic function by avoiding soil compaction, water diversion, and dewatering which would reduce suitability/sustainability of rare fen habitat.
		WQSP-2A: Delineate Water Influence Zone (WIZ) prior to treatment implementation according to Regional and National Standards.[14]	

[13] USDA Forest Service 2006.

[14] USDA Forest Service 2006, 2012.

Sensitive Species of Concern	Trigger for Use	Design Feature	Design Criteria Function in reducing effects
		FSSP-7A/B: No mechanized equipment operation will occur in the water influence zone (WIZ) of a wetland.	
		FSSP-7A/B: No treatment activities or vehicle use in wetlands or their water influence zones.	
	Presence of a fen or riparian area in the treatment area.	FSSP-7C:Prevent mineral sediment deposition from occurring in wetlands.[3]	Prevent take of individuals or populations that would lead to a loss in viability.
		FSSP-8A: Develop an erosion and sediment control plan to avoid or minimize downstream impacts using measures appropriate to the site and the proposed activity.[15]	
	When prescribed fire, pile burning or commercial mechanical treatments are proposed.	WQSP-5A: Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area.	Prevent sedimentation events that would reduce or impair wetland functions. Minimizes adverse impact to soil resources to less than 15% of an activity area. Maintaining healthy soil resource ensures long-term productivity of the site.
		FSSP-8C: Limit roads and other disturbed sites to the minimum feasible number, width, and total length. Minimize sediment discharge into streams, lakes, and wetlands during construction and stabilize and maintain disturbed sites to control erosion.	
		FSSP-8D: Maintain sufficient upslope ground cover to prevent sediment movement downward into wetland.	
		Water quality and soil production objective 8: Reclaim roads, landings and other disturbed sites when use ends.	Restoration of soil resource and re-establishment of vegetative cover.
		FSSP-9A: Avoid treatment activities and equipment use in wet or moist meadows.	Prevent sedimentation events that would reduce or impair wetland functions.
park milkvetch	Presence of wetlands, streams and moist meadows in the treatment area.	FSSP-9B: Design stream crossings at armored points, or armor them to prevent loss of functions in wet or moist meadows.	Reduce sedimentation and maintains functional floodplain.

[15] USDA Forest Service 2012, Austin 2008.

Sensitive Species of Concern	Trigger for Use	Design Feature	Design Criteria Function in reducing effects
		FSSP-9A: Avoid treatment activities and equipment use in wet or moist meadows.	Prevent sedimentation events that would reduce or impair wetland functions

Direct and Indirect Effects Common to Both Action Alternatives

Activities were identified from the action alternatives that have the potential to create environmental effects that may impact sensitive species or their habitats. These activities include:

- Increased vehicular traffic and moving of heavy equipment
- Creation and use of staging areas and landings
- Prescribed fire, ground ignition or aerial ignition, including pile burning
- Fireline construction
- Mastication (including chipping)
- Mechanical timber harvest, including site preparation
- Replanting trees and revegetation of new and reconstructed roads
- Road construction, reconstruction, and maintenance
- Road decommissioning
- Treatment of invasives and weeds
- Dust abatement
- Treatments for hazard trees or fuels reduction

This analysis considers management activities of all action alternatives and associated design features set forth in this EIS. Impacts to plants can be a direct result of the action or may result in a changed environmental condition that alters a biological or physical process that results in an indirect impact to the individual species.

Both direct and indirect impacts can result in adverse or beneficial effects that ultimately affect the overall capacity of the species to persist as an individual plant, as a single population, a group of populations in a local area, or as a biological entity.

Resulting environmental conditions that could lead to impacts (adverse or beneficial) to sensitive plants or their habitats have been identified for the action alternatives based on anticipated project-related activities (Table 158).

The activities associated with the action alternatives can result in similar resulting conditions; for example, both hand thinning and mastication would result in somewhat different levels of soil disturbance. The magnitude of the resulting condition and hence the magnitude of anticipated indirect or direct impacts will vary from different methods of treatment and associated activities.

Table 158. Environmental Conditions that Result from Activities Associated with the Action Alternatives.

Resultant Environmental Condition	Notes
Introduction or increase in invasive plants	
Soil disturbance	Beyond normal levels. Includes erosion, movement or removal of soil, alteration of hydrologic systems, and dust
Air pollution, including greenhouse gas emissions	Associated with machinery and other sources
Water pollution	Runoff from roads into streams, riparian areas, and wetlands
Soil compaction	
Hydrological alteration	Dams, ditches, culverts, other water-control structures
Toxicity	Includes chemical spills
Removal or damage of vegetation	Including overstory and understory trees, shrubs, or herbaceous vegetation
Alteration of successional pathways	
Removal of ground cover	Including mosses, lichens, litter and duff, gravel, stones and boulders
Soil heating	From prescribed fire
Changes in fuel quantity or quality	Physical alteration of biomass or fuels profile (increased fuels on ground)
Fragmentation or isolation of stands in landscape	Stands could be stands of trees, openings, shrub communities, or herbaceous communities

New or temporary road construction results in localized, but intense soil disturbance that leaves the road bed and banks devoid of previous vegetation. This can result in accidental removal of sensitive species or damage to individuals. This impact is most likely to affect Colorado tansy aster, peculiar moonwort, and possibly also park milkvetch as they have the greatest potential to occur where roads may be built. Colorado tansy aster will over time re-colonize old road banks, but the *Botrychium* species probably wouldn't as it is not thought to be tolerant of major disturbance and the microsite requirements for this species may be too greatly altered by road construction. Depending on the time of year that treatments are conducted, negative direct impacts to undetected peculiar moonwort and Colorado tansy aster individuals could also include trampling or crushing of above-ground vegetative and reproductive parts (summer to fall), or crushing the underground portions of the plant (year round) by road construction, reconstruction, or traffic. As *Botrychium* spend the first phase of their life completely underground, undetected individuals could be adversely directly impacted by crushing due to compaction of the soil. This impact would be reduced if treatments near known or unknown populations were over snow, although there probably would be some slight impacts if compaction was of enough magnitude to crush individuals.

Sensitive plant species could incur direct impact if broadcast burning were to consume an individual or population. Pile burning could directly impact Colorado tansy aster or peculiar moonwort by consuming individuals and killing underground portions of the plant, if the piles were constructed

over individuals or populations. There is also the potential that staging areas could occur on populations of these species, which could result in injury or mortality.

Park milkvetch, lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, and lesser bladderwort could be directly affected from foot traffic that tramples individuals. This could result in injury or mortality of individuals, but light foot travel[16] is not anticipated to have more than a localized impact; heavier foot travel or travel by motorized or mechanical equipment would cause significant impacts through alteration of the water table. Most of these species grow in habitats that often have standing water or high water tables. Legal and regulatory limitations on soil-disturbing activity in these areas reduce the potential for direct impacts.

Many of the activities included in the action alternatives will result in some level of soil disturbance, ranging from negligible disturbance from walking to substantial soil disturbance caused by road construction or mechanical timber harvest equipment. The creation of bare soil from soil disturbance could result in invasion by nonnative plants or weeds or growth of pre-existing infestations, which could adversely impact all sensitive species if they were to occur near the disturbances where invasive plants occur. However, in accordance with required soil standards soil displacement and adverse compaction will not exceed 15 percent of a harvest unit. The changes in microclimatic conditions where there is bare or disturbed soil could impact peculiar moonwort from the drying of the soil, which would result in desiccation or disruption of mycorrhizal networks and deterioration of plant health. Conversely, for disturbance niche species, some benefit could occur from creation of suitable habitat.

Any amount of bare soil exposed near a fen will result in some erosion and resulting sedimentation into the fen. Sedimentation in fens can affect sensitive species indirectly, by inhibiting peat formation (D. Weixelman, pers. comm., 2014) which will ultimately result in reduced suitability of habitat and population decline. Sedimentation could also bury individuals.

Dust and other airborne material created by vehicles on roads, soil-moving equipment, mastication equipment, etc. could settle on the leaves of sensitive plant species. This could result in decreased vigor and adversely impact photosynthesis, transpiration and respiration (Farmer 1993). This impact is likely to be short-term and negligible as when the rainy season begins, the dust will be washed off. This is more likely to impact species in the units with multiple entries and those adjacent to roads. If dust abatement compounds are used (MgCl2 or CaCl2), there is the potential for toxicity to sensitive plants growing close to treated roads, resulting in reduced vigor or mortality of individuals or populations; although most studies have shown effects of dust abatement compounds to be less than effects of road dust on untreated roads. There is a design feature that will greatly reduce, if not

[16] Less than two passes on the same trail per day.

eliminate this impact as it prohibits use of these compounds within 500' of known occurrences or fens and wetlands (FSSP-2C, Appendix B).

Reduction in tree canopy will be a consequence of many of the proposed treatments, such as timber harvest, mastication, prescribed fire, removal of hazard trees, and hand thinning. The magnitude of the resulting indirect impacts depends on the amount of tree canopy reduction. Target levels of post treatment canopy cover vary depending on pre-treatment stand conditions, affected vegetation type, and prescription objectives. Resiliency treatments in spruce stands would be only partial cutting, resulting in small reductions in live canopy, while treatments in aspen stands would affect a much larger portion of the tree canopy. The effect of tree canopy reduction with prescribed fire would not be a uniform reduction across the landscape, but would occur as a mosaic with patches of tree canopy loss, and adjacent areas with no net change. More uniform patterns of tree canopy removal would result from hand and mechanical treatments, though follow up prescribed fires could result in further decreases in tree canopy.

Introduction or Spread of Invasive Plant Species

Most actions associated with project implementation have the potential to increase invasive nonnative plant species abundance and distribution. However, consistent use of design feature IW-1 thru IW-4 (Appendix B) will significantly reduce the probability of spread through avoidance of areas having existing populations of invasive plants, proper pre-cleaning of equipment and aggressive treatment when populations are discovered. Species could be newly introduced, or there could be increases in abundance and distribution of invasive plant species that are already found within the project area. There is the potential for adverse impacts to sensitive plants species due to invasive plant species.

Merriam et al. (2006) found that the greatest factors correlated with non-native cover and abundance is overstory canopy, litter cover, duff cover and duff depth. Where vegetation is cleared and there is little to no overstory remaining, the risk for invasions by nonnative plant species is high, though generally localized. Reducing overstory canopy allows light to penetrate to the soil surface and this, combined with reduced water and nutrient competition from the shrub layer, can allow for invasive nonnatives to increase in distribution and abundance. The removal of overstory or understory can result in increased solar radiation, which changes evapotranspiration rates and changes microclimate in the understory. This has the potential to either create or eliminate suitable habitat, depending on the species of concern. The removal of vegetation can also open areas to access by recreating public, livestock, or big game, which may result in adverse indirect impacts to sensitive species by introducing or spreading invasive plants or trampling sensitive plant individuals or habitat.

Project activities can indirectly impact sensitive plant species by facilitating invasive species through:

1. Introduction of new species to the project area, or introducing invasive species to new areas in the project area.
2. Alterations of habitat that result in the increased abundance and distribution of invasive plant species already known to occur within the area.

Invasive species impact native communities and biodiversity of native species in several ways, including changes in plant community structure and changes in native species richness and abundance. The mechanisms responsible for these changes are often poorly understood, due to the complex nature of interactions between species and the various trophic levels in a community (Levine et. al 2003). Some of the mechanisms for changes in communities include changes in the soil chemistry (salt accumulation, changes in nitrogen cycling, allelopathy[17]), changes in site and food quality and quantity for other trophic levels, changes in soil biota, changes in soil moisture, competition for resources such as light and nutrients, and changes in ecosystem processes, such as hydrologic regimes or fire regimes. Invasive plant species also impact and alter successional pathways.

Pile Burning

Soil disturbance can result from burning piled slash. In locations where pile burning occurs, there is the potential for soil to rise to high temperatures due to increased residence time associated with concentrated fuels. The larger the pile being burned, the higher the soil heating temperatures, the deeper the heat pulse and the longer the soil will take to recover to normal temperatures (Massman et. al 2003). Depending on the size of the pile, soil heating, and residence time during burning operations, the soils below may become sterile and native seed banks will be reduced or eliminated, and can reduce soil microbial communities (Jiménez Esquilín and others 2007). Studies have found that the footprint of slash piles that have been burned can be vulnerable to invasive plants (Keeley 2006, Scherer and others 1999) which could negatively impact any sensitive species in the vicinity of burn piles. There could also be adverse impacts to peculiar moonwort if there were individuals in the underground stages where the piles were burnt, or if mycorrhizal relationships were eliminated due to the intense soil heating. However, as with all effects noted in this section, design features are identified to specifically minimize the effects (Appendix B).

Prescribed Fire

When the soil is exposed to heat, the physical, chemical and biological properties can be altered (Wohlgemuth and others 2006), and depending on fuel loading, there is a range of potential effects. Where fuel loading is high, effects could be similar to that for pile burning; though more frequently

[17] "a biological phenomenon by which an organism produces one or more [chemicals] that influence the growth, survival, and reproduction of other organisms" (en.wikipedia.org).

there will likely be lower intensity fire. With prescribed fire, the vegetation is consumed, nitrogen and phosphorus are often made available which could adversely indirectly impact sensitive plant species and their mycorrhizal symbionts by facilitating invasion of invasive exotic plant species, but could also beneficially impact sensitive plant species, such as peculiar moonwort, and their mycorrhizal symbionts in the short-term by freeing nutrients for their use (Johnson-Groh and others 2002). It has been shown that some fen species are colonized by arbuscular mycorrhizal fungi, which show a decrease in mycorrhizal colonization when phosphorus is added (Cornwell and others 2001). If phosphorus is released during fires in the vicinity of a fen, there could be a longer term adverse effect by this decrease in colonization, due to the short term increases in phosphorus availability.

Roads

Existing roads are corridors that can fragment populations and/or habitat, create dust, and spread and/or introduce invasive species. Roads result in localized soil compaction which can alter the hydrology of an area and disrupt mycorrhizal networks.

Road activities are likely the greatest contributor to invasive plant risk for this project (Birdsall and others 2012). Roads and their maintenance are comprised of areas where there is repeated soil disturbance. This disturbance creates prime suitable habitat for invasive plants to become and remain established. This is compounded by high concentrations of vectors for invasive species (vehicles, etc.). Road maintenance can also remove individual sensitive plants (or all of a population if it occurs within road). New or temporary road construction also results in localized, but intense ground disturbance that leaves the road bed devoid of previous vegetation. This can result in impacts to mycorrhizal symbionts. This impact is most likely to affect peculiar moonwort. This could result in interruptions to the mycorrhizal networks, reducing the health and vigor of populations.

Road use and construction can alter hydrologic function. Roads can divert water into a different course. Roads contribute to heightened sedimentation levels (Gucinski and others 2001) which if occurred upslope from a fen could result in sediment accumulation in the fen. As mentioned above, sediment in fen could smother sensitive plant species or result in retarded peat accumulation rates, diminishing suitable or occupied habitat health.

Mechanical Treatments

Mechanical treatments usually occur on slopes less than 40 percent, due to equipment limitations. Mechanical treatments in the wildland-urban interface could be on steeper slopes if access is available from an existing road. Mechanical treatments include hazard tree removal and would differ between spruce-fir and aspen vegetation types. Direct effects of mechanical treatments would

be limited to sensitive species that may be found in spruce-fir or aspen stands, notably peculiar moonwort.

All actions associated with mechanical treatments have the potential to introduce invasive species, or to increase the extent of existing infestations of invasive species. This would have adverse effects on sensitive plant species.

In aspen, the prescription is primarily for coppice cutting, which is a form of clearcutting. No sensitive species are known to occur in pure aspen stands, but may occur in areas that are adjacent to stands of aspen, or in mixed aspen-spruce-fir. However, most aspen stands, whether pure aspen or mixed with conifers, have abundant leaf litter. Most aspen clearcuts produce little bare soil on which weeds could invade, and what bare soil that is created is quickly covered with aspen sprouts and other vegetation. As in all vegetation types, design criteria should reduce soil disturbance to the minimum.

In spruce-fir vegetation types, prescriptions would vary, ranging from group selection treatments (small patch cuts) to uneven age harvesting (selected individuals cut). There is the potential for the promotion of invasive plant populations due to reduced canopy cover, soil compaction altering hydrologic regimes, or soil disturbance resulting in exposed soil that could erode downhill.

Heavy machinery can substantially disturb the soil, especially tracked machinery typically used to construct or rebuild roads. “Although other forest management activities usually occur on a larger proportion of the landscape, the erosion rates on roads are the dominant source of sediment in most managed forests” (Robichaud and others 2010). Soil disturbance can result in creation of suitable habitat for invasive plants, increases in erosion, alteration of the microtopography of the soil (changing the pathway of water), and disruption of mycorrhizal networks. Heavy machinery can also result in soil compaction which could alter surface and subsurface hydrologic flow or disrupt mycorrhizal networks. If a fen occurred in the same small watershed as extensive soil disturbance, surface erosion or disruption of groundwater could occur, resulting in impairment of functions of the fen.

A study conducted in the Colorado Front Range found that when chipping treatments were conducted, if a layer of woodchip was left in place, there was a reduction in understory growth (Wolk and Rocca 2009). Another study in the Front Range found no erosion in stands where chipping residue had been left (reported in Robichaud and others 2010). This effect would be beneficial if the woodchip reduced the potential for invasive plant establishment, but adverse if it smothered sensitive plant populations.

If timber harvest treatments result in high levels of aspen regeneration (possible in both aspen and spruce-fir-aspen mix) there is the potential for increased browsing from native ungulates and domestic grazers, which could cause more soil exposed and increase the likelihood of invasive plants.

Replanting and preparatory activities for replanting may occur in spruce-fir, especially where the stand is mostly dead from spruce beetles or other factors. Preparing the sites for replanting can involve soil disturbance, especially if scarification of the soil is used. This could result in disruption to mycorrhizal symbionts peculiar moonwort. There is also the potential for introduction of invasive plants.

Staging Areas and Landings

There will likely be high levels of soil disturbance and potentially soil compaction in staging areas and landings. The high levels of disturbance in these sites make them vulnerable to invasive plant introduction and proliferation. The introduction of invasive species at these sites has a high potential for adverse indirect impacts to sensitive species if present. This impact will be reduced by design features that require invasive plant surveys and treatment.

Cumulative Effects Common to All Action Alternatives

There are a number of Forest Service and other activities in the vicinity of the proposed alternatives that have the potential to result in cumulative impacts when combined with the impacts associated with the proposed vegetation treatments.

Table 159 displays the foreseeable actions that contribute cumulatively to impacts to sensitive species and their suitable habitat, and whether the impacts are anticipated to be similar to those described above in the effects analysis. Reasonably foreseeable activities are further detailed in Chapter 3, Cumulative Impacts – Actions Considered & Analysis Approach.

Table 159. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area.

Agency	District	Foreseeable Future Project	Impacts within the range of those described in direct and indirect impact (Yes/No) and effects analysis and additional comments.
USDA Forest Service, USDI Bureau of Land Management, Counties	Forestwide	Ongoing Grazing Activities	No, see below
	Forestwide	Fuels & Timber Projects	Yes, Design Features included to mitigate impacts to Colorado tansy aster and peculiar moonwort; to treat invasive plants.
USDA Forest Service, USDI Bureau of Land Management, Counties	Forestwide	Road maintenance	Yes

Agency	District	Foreseeable Future Project	Impacts within the range of those described in direct and indirect impact (Yes/No) and effects analysis and additional comments.
	Forestwide, multiple locations	Trail Management	Yes, similar to impacts from roads though greatly reduced.
	Forestwide, multiple locations	Minerals activities	Yes
Private landowners	N/A	Grazing	No, see below

The following is a brief summary of the potential range of impacts anticipated from the activities mentioned in the above table. These descriptions summarize the general potential indirect impacts through the pathway of changes to environmental conditions (e.g. increases in invasive species in the cumulative impacts analysis area, climate change, etc.).

Vegetation Management and Fuels Reduction Projects

The vegetation and fuels reduction projects involve vegetation treatment similar to those proposed in the action alternatives for this project, and thus direct and indirect impacts on site are similar to those assessed in this report. Conducting many projects across the landscape in close temporal and geographic proximity is likely to result in the effects described in this analysis being greater.

Grazing

Grazing, both on and off Forest Service lands, has the potential to add to the effects for all species. Grazing has been identified as potentially impacting sensitive fen species, park milkvetch, and potentially Colorado tansy aster. The impacts caused by grazing include trampling, browsing, and impacts in fens to hydrologic function and peat formation from hoof punches. This activity would interact with the proposed action alternatives by further decreasing the vigor of populations.

Invasive Plants

The continued introduction and spread of invasive plants will act with the proposed alternatives to decrease habitat suitability and increase competition for resources where they co-occur with sensitive plants. Continued invasive plant management would be a beneficial impact for sensitive plants, reducing impacts from invasive plants. Please see the Noxious and Invasive Weeds section in this EIS and the Invasive Plant Risk Assessment located in the project record for a full discussion of the anticipated impacts.

Recreational Activities

There has been a strong trend for several decades towards more recreation on National Forests. Although not due to actions from this EIS, we can expect more pressure on roads and trails, and more demand for off-road vehicle use. As a result, more invasive plant species will become introduced, and existing infestations could get larger due to spread by recreationists. There is also the potential for fen species to be impacted from illegal vehicular trespass, creating changes in hydrology.

Road Maintenance by State and County

County road maintenance was identified as a potential cumulative effect for Colorado tansy aster and peculiar moonwort. There are known populations of Colorado tansy aster occurring along county maintained roads. County road maintenance could result in additional impacts to individuals such as crushing, or removal by road maintenance equipment. This would act synergistically with the proposed action to add to the potential for decreased vigor and increased mortality of individuals, and could eradicate populations near or adjacent to roads where impacts could occur.

Comparison of Alternatives

Table 160 displays in tabular format the main differences in the alternatives in reference to factors that could affect sensitive species. The key distinguishing factor is where the treatments occur and whether there are sensitive plant populations and what activity type is utilized for implementation.

Table 160. Comparison of Overlapping Habitat for Sensitive Species by Alternative

Comparative descriptor	Alternative 1	Alternative 2	Alternative 3
Priority Treatment Areas	No Actions.	Approximately 4,437 acres of Priority Treatment Areas overlap aquatic habitat features (fen, riparian, wetland, waterbody)	Approximately 2,937 acres of Priority Treatment Areas overlap aquatic habitat features (fen, riparian, wetland, waterbody)
Hazard Tree Treatments Outside PTAs	No Actions.	Up to 17,388 acres will be treated. Of those acres, 570 overlap aquatic habitat features (fen, riparian, wetland, waterbody)	Up to 24,693 acres will be treated. Of those acres, 634 overlap aquatic habitat features (fen, riparian, wetland, waterbody).
New Roads (outside PTA's)	No Actions.	There will be approximately 213 acres of new and reconstructed roads outside PTAs. Of those acres, 5 overlap aquatic habitat features for this activity.	There will be approximately 169 acres of new and reconstructed roads outside PTAs. Of those acres, 4 overlap aquatic habitat features for this activity.
Invasive species	No actions.	Moderate use of mechanical treatment, moderate risk for introduction or spread of invasive plants. Potential for introduction and spread of invasive plants due to increased vectors over a larger area.	Area of treatment with highest concentrations of invasive plants, local introductions the greatest risk. Would occur primarily in areas that already have the highest infestations, making it more likely invasive plants would be spread.
Environmental Baseline	No actions.	There is the potential for greater change from baseline, as activities are proposed in more dispersed locations in comparison to Alternative 3.	Footprint of PTAs would occur in areas that have generally experienced the greatest ongoing habitat alterations (development) and would have the smallest change from environmental baseline to post implementation environment.
Fen, Wetlands, Riparian Waterbodies (aquatic habitat features)	No actions.	Has more potential to include aquatic habitat features. There is approximately 5,012 acres of aquatic habitat features within potential affected area (Johnston and others 2012)	Would include the fewest number of aquatic habitat features, and hence would likely adversely impact the sensitive species known from fens the least. There is approximately 3,575 acres of aquatic habitat features within potential affected areas. (Johnston and others 2012)

Alternative 2 – Direct and Indirect Effects

The residual effects from this alternative are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

The potential for impacts could be dispersed due to the larger ratio of treatment per area (that is, more acreage to spread the treatments within), resulting in potentially less direct and indirect effects. This alternative offers a larger number of acres to plan treatments in, which could have the

least amount of impacts to sensitive species. Conversely, there is also the potential for greater effects from invasive plant spread as this alternative has the potential to treat the same number of acres across a larger landscape and outside of the WUI, which could result in invasive species being introduced into the greatest amount of uninfested areas. Project Design Features (Appendix B) and the Pre-Treatment Checklist (Appendix C) would be followed in order to assure implementation of projects stay in compliance with and consistent with the Forest Plan.

Sensitive Species within Alternative 2 Area

One of the ten sensitive species (*Botrychium paradoxum*), has potential to be present or its habitat within lightly disturbed microsites (old roads and road cuts) within or close to mesic coniferous stands above 10,500 ft. in elevation. Potential habitat for *B. paradoxum* could be found within aspen, spruce-fir, lodgepole and cool-moist mixed conifer cover types in alpine and subalpine zones. Ninety percent of the potential affected area for Alternative 2 occurs above 8,500 ft. in elevation. Of that, 65 percent occurs on west, northwest, north, northeast, and east facing slopes and tends to be more mesic.

Seven of the ten sensitive species (*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor*), have the potential to be present, or their habitat may be present within wetland/fen areas. One of the ten sensitive species *Astragalus leptaleus* is most likely to occur in moist swales and riparian meadows. Most of these areas occur within riparian areas. The total acres within the potential affected area of Alternative 2 that overlap fen, wetland, riparian, or waterbodies is 5,012 (<1 percent of the total potential affected areas). Of those acres, 1 percent have a fen component, wetland 1 percent, riparian 95 percent, and waterbodies 3 percent. There are 4,437 acres of aquatic habitat features overlapping Potential Treatment Areas of which 72 percent occurs within non-commercial burn and mechanical treatment locations (Table 161).

Hazard Tree Treatments

There will be 570 acres (11 percent) of hazard tree treatment outside of PTAs that are within aquatic habitat features (Table 161). Design features have been established to minimize the impacts and hence decrease the residual effects of project associated activities within and adjacent to riparian habitat (Appendix B).

New Road Construction

There will be more acres of new and reconstructed roads outside PTAs in Alternative 2 (213 acres) in comparison to Alternative 3 (169 acres). Within the 20 ft. buffered areas on either side of new road (outside PTAs), there is approximately five acres of aquatic habitat features (Table 161) that

spatially overlap areas proposed for new road construction. For new roads inside the PTAs, aquatic habitat features were lumped into treatment areas.

Table 161. Areas within the Proposed Action where Design Features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be Applied (Appendix B). Units are in acres.

		Potential Affected Areas							
		Priority Treatment Areas							
		Commercial Treatment			Non-commercial Treatment				
Geographic Area	Category	Resiliency	Salvage	Combination Resiliency/Salvage	Burn and Mechanical	Mechanical Only	Hazard Trees (Resiliency/Salvage)	New Roads Outside PTA's	Total
Grand Mesa	Fen	2		10	0	0	2	0	**13**
	Riparian	114	0	88	538	45	49	1	**834**
	Water	17	0	22	19	1	2	0	**61**
	Wetland	1	0	1	11	0	0	0	**14**
Gunnison Basin North	Fen	0		0	0	0	0	0	**0**
	Riparian	176	22	89	1232	0	172	2	**1693**
	Water	3		0	15	0	0	0	**18**
	Wetland	0		0	20	0	1	0	**20**
Gunnison Basin South	Fen	0	0	0	0	0	0	0	**1**
	Ripaian	45	26	41	482	0	133	1	**727**
	Water	0	1	0	3	0	0	0	**4**
	Wetland	2	1	1	11	0	1	0	**15**
North Fork Valley	Riparian	126	3	38	276	10	107	1	**560**
	Water	8	0	3	8	0	1	0	**20**
	Wetland	2	0	0	0	0	0	0	**2**
San Juans	Fen	8	0	3	0	0	0	1	**12**
	Riparian	17	4	45	2	0	34	0	**102**
	Water	0	0	1	0	0	0	0	**1**
	Wetland	6	0	6	0	0	0	0	**13**
Uncompahgre Plateau	Fen	0	0	0	0	0	1	0	**1**
	Riparian	150	2	119	513	0	62	0	**846**
	Water	5	0	2	34	0	5	0	**47**
	Wetland	0	0	0	10	0	0	0	**10**
	Grand Total	**681**	**59**	**469**	**3173**	**55**	**570**	**5**	**5012**

Effects to Sensitive Species

The following is a description of the more likely residual effects per species, considering appropriate application of design features (Appendix B). Surveys would be conducted during treatment layout to assess presence or absence (FSSP-2A, Appendix B).

Park Milkvetch

Potential for direct impacts to park milkvetch under Alternative 2 include direct injury, or mortality of individuals. This would occur if the population was growing in a “sub-riparian swale” or other mesic site not identified for protections based on design features protecting wetlands and meadows. However, surveys should detect populations prior to project implementation and flag and avoidance

measures could be followed to protect individuals and populations. This species is rhizomatous which could allow for reestablishment to pre-disturbance levels if only individuals were damaged.

Park milkvetch could be adversely indirectly impacted by any action that resulted in changes to hydrology or sedimentation from above, affecting the suitability of its microsite conditions. Park milkvetch could also be adversely indirectly impacted by the introduction and spread of invasive species resulting in increased competition. Park milkvetch could also be adversely indirectly impacted if browsing were to increase due to increases in aspen sprouting in the vicinity of a population. All these indirect effects could result in reduced vigor of the population, reduced habitat for the species and the potential mortality of individuals.

Peculiar Moonwort

Peculiar moonwort can remain dormant underground for many years, and it has even been shown that the below-ground to above-ground ratio can be very high (Johnson-Groh and others 2002). This would make individuals undetectable during field surveys and so design features would not be implemented. This could result in individuals or populations being burned under piles, removed and killed during road construction or desiccated during overstory removal, resulting in the loss of either individuals or entire populations. These same impacts could also result in decreases in individual or population vigor, though it has been observed that the above ground portions are fairly resilient to light disturbance.

The greatest adverse indirect impact to peculiar moonwort could be impacts to the mycorrhizal symbiont. The greatest impacts to mycorrhizal are likely to occur with actions that intensely affect soil and microbial structure and communities. These actions include burn piles, road construction, use of heavy machinery, and skid trails. Another factor of concern is removal of protective canopy for these individuals (*Botrychium* are sometimes only 20-30 cm tall) by timber harvest or revegetation activities. The magnitude of impacts to peculiar moonwort depends on the magnitude of the impacts to the mycorrhizal symbiont. There are design criteria that prevent more than 15 percent of the soil in a treatment area from being severely burned, compacted, eroded and displaced (WQSP-5A, Appendix B). This would likely reduce the severity of impact, though may not fully mitigate all potential negative effects and therefore some reduced vigor in individuals or populations could occur. Peculiar moonwort could also be adversely indirectly impacted by the introduction and spread of invasive species resulting in increased competition, and could also experience indirect effects from toxicity, especially if they are in the gametophytic underground phase, and dust abatement or herbicide were applied directly or in the near vicinity. This could result in reduced vigor or mortality in some individuals or populations. Indirect effects could arise from changes in canopy cover of associated vegetation due to removal of overstory trees. A decrease in canopy cover may temporarily create habitat for peculiar moonwort and Colorado tansy-aster by increasing sunlight. Creation of temporary habitat could be beneficial to individuals, but transient habitat seems marginally beneficial on a population level.

Lesser Panicled Sedge, Round Leaf Sundew, Chammiso's Cottongrass, Slender Cottongrass, Sageleaf Willow, Sphagnum Moss, and Lesser Bladderwort

Design features for this project protect these species from direct effects, all known to occur in fens and occasionally other wetlands, unless personnel were to walk out into a fen or wetland and crush an individual.

Indirect impacts to lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss and lesser bladderwort would result from impacts to their habitat. The primary impacts would include sedimentation and alterations to hydrology of the fens or wetlands. Design features have been included to limit the effects of these impacts, but there is still the potential to some degree that fens could experience some sedimentation and alteration of hydrology. These effects may be minor, short term influences to fen function, but could result in long term effects that alter to some extent the vigor of these species populations.

Colorado Tansy Aster

There could be direct effects to Colorado tansy aster from road reconstruction and hauling. Road reconstruction could include widening the road prism, vegetation clearing, installing drainage structures and suitable water crossings, and applying road surfacing. Scraping and reconstructing these roads would directly impact Colorado tansy aster plants growing in road beds. Individual plants could also be adversely impacted by being repeatedly driven on or parked on. The result would likely be loss of the plants growing in road beds subject to improvement, and a few plants would have reduced vigor or mortality in parking areas. There is also the potential for mortality caused by piles being constructed and burned on a population.

Road activities could result in indirect impacts to Colorado tansy aster from dust, dust abatement, and invasive plant spread. Dust could reduce the photosynthetic capacity of individuals or parts of populations. Dust abatement could result in mortality of individuals, though a design feature that limits application of the harmful dust abatement compounds within 500 feet of known populations greatly reduce the potential for this impact (FSSP-2C, Appendix B). Invasive species may spread due to project-related activities resulting in increased competition. This indirect impact is not anticipated to be great with project implementation.

Alternative 2 – Cumulative Effects

Park Milkvetch

Increased recreational use of the national forests, especially increased off-road vehicle use, is likely to impact park milkvetch. Other factors include ongoing grazing on and off federal lands and invasive species. Park milkvetch is known to exist in habitats (lower elevation riparian) where both

these impacts occur. The effects from the SBEADMR project are not likely to affect much of the known range and suitable habitat for this species, but there may be long-term adverse impacts that could act synergistically with the cumulative effects resulting in some decline for this species.

Peculiar Moonwort

There is only one population of peculiar moonwort known in the planning area. Peculiar moonwort is thought to be sensitive to extirpation through this part of its range (Farrar and Popovich 2012). This influences the sensitivity of this species to any and all impacts to populations in the planning area to a loss of viability. There are no known threats to the known populations at this time, but one population of peculiar moonwort is known from a ski resort.

Lesser Panicled Sedge, Round Leaf Sundew, Chammiso's Cottongrass, Slender Cottongrass, Sageleaf Willow, Sphagnum Moss, and Lesser Bladderwort

These fen and wetland species may be affected by climate change, especially warming of their fen and wetland habitats and less consistent patterns of precipitation. These species have specific hydrologic habitat requirements and could be indirectly impacted by changes to hydrological processes resulting from roadwork done by the county. This was not found to be a substantial impact in the GMUG fen inventory and assessment (Johnston and others 2012), but because there are 2,591 acres of potential fens in the vicinity of roads there is the potential for road use, improvement and maintenance contributing synergistically to cumulative impacts to the hydrologic function of fens. Many of these species are thought to be Pleistocene relics disjunct from cooler habitats already at the edge of their range, so climate change may be a substantial effect that is influencing the viability of these species.

Colorado Tansy Aster

County road maintenance was identified as a potential cumulative effect for Colorado tansy aster. County road maintenance could result in additional impacts to individuals such as crushing, or removal from road maintenance equipment. Livestock grazing is another ongoing activity in Colorado tansy aster habitat. The effects of grazing on Colorado tansy aster are probably minimal because it is apparently unpalatable to livestock and prefers habitats that are sparsely vegetated and rocky, which are not preferred for grazing (Beatty et al. 2004). Colorado tansy aster may also be cumulatively impacted by invasive plants and recreational activities (trail use, road use). This would act synergistically with the proposed action to add to the potential for decreased vigor and mortality of individuals, but is not anticipated to extirpate any of the populations as they are dispersed both along the road where impacts could occur, and adjacent to the road where fewer impacts are anticipated.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

All activities within Alternative 3 are also included in Alternative 2. This alternative has the potential for the greatest concentration of effects as it has the highest potential for treatment per area ratio. This would mean higher concentrations of temporary roads, road reconstruction activities, mechanical treatments, and other ground disturbing activities. This could result in the greatest magnitude of impacts associated with the proposed action, though the actual effects could be lower than with the other action alternative as there is the least amount of suitable habitat for all species considered in this alternative.

Alternative 3 has the greatest overlap and potential treatment intensity with known invasive plant populations and with already altered baseline habitat. This means that there is the greatest probability of invasive plant spread, but there may be fewer impacts to sensitive species and their habitat associated with the increases in invasive species due to their already being present, and the suitable habitat for sensitive species already being potentially in compromised condition due to human activities associated with the WUI. Project Design Features (Appendix B) and the Pre-Treatment Checklist (Appendix C) would be followed in order to assure that the implementation of projects stays in compliance with and consistent with the Forest Plan.

The residual effects from this alternative are within the range of alternatives described in the direct, indirect, and cumulative effects under effects common to all alternatives.

Sensitive Species within Alternative 3 Area

One of the ten sensitive species, (*Botrychium paradoxum*), has potential to be present or its habitat within lightly disturbed microsites (old roads and road cuts) within or close to mesic coniferous stands above 10,500 ft. in elevation. Potential habitat for *B. paradoxum* could be found within aspen, spruce-fir, lodgepole and cool-moist mixed conifer cover types in alpine and subalpine zones. Eighty-eight percent of the potential affected area for Alternative 3 occurs above 8,500 ft. in elevation. Of that, 57 percent occurs on west, northwest, north, northeast, and east-facing slopes and tends to be more mesic.

Seven of the ten sensitive species (*Carex diandra, Drosera rotundifolia, Eriophorum chamissonis, Eriophorum gracile, Salix candida, Sphagnum angustifolium, Utricularia minor*), have the potential to be present or their habitat may be present within wetland/fen areas. One of the ten sensitive species (*Astragalus leptaleus*) is most likely to occur in moist swales and riparian meadows. Most of these areas occur within riparian areas. The total acres within the potential affected area of Alternative 3 that spatially overlap fen, wetland, riparian, or waterbodies is 3,575 (<1 percent of the total potential affected areas). Of those acres, 1 percent have a fen component, wetland 1 percent, riparian 95 percent, and waterbodies 3 percent. There are 293 acres of aquatic habitat features that overlap Potential Treatment Areas of which 77 percent occurs within non-commercial burn and mechanical treatment locations (Table 162).

Hazard Tree Treatments

There will be 634 acres (18 percent) of hazard tree treatment outside of PTAs that are within aquatic habitat features (Table 162). Design features have been established to minimize the impacts and hence decrease the residual effects of project associated activities within and adjacent to riparian habitat (Appendix B).

New Road Construction

There will be fewer acres of new and reconstructed roads outside PTAs in Alternative 3 (169 acres) in comparison to Alternative 2 (213 acres). Within the 20 ft. buffered areas on either side of new roads (outside PTA's), there is approximately four acres of aquatic habitat features (Table 162) that spatially overlap areas proposed for new road construction. For new roads inside the PTA's, aquatic habitat features were lumped into treatment areas.

Table 162. Areas within the Proposed Action where Design Features FSSP-4, FSSP-5, FSSP-6, FSSP-7, FSSP-8, FSSP-9, WQSP-2, and WQSP-6 will be Applied (Appendix B). Units are in acres.

		Potential Affected Areas							
		Priority Treatment Areas							
		Commercial Treatment			Non-commercial Treatment				
Geographic Area	**Category**	**Resiliency**	**Salvage**	**Combination Resiliency/Salvage**	**Burn and Mechanical**	**Mechanical Only**	**Hazard Trees (Resiliency/Salvage)**	**New Roads Outside PTA's**	**Total Acres**
Grand Mesa	Fen	2		9			2		**13**
	Riparian	91	0	47	326	45	53	1	**562**
	Water	14	0	16	14	1	2	0	**46**
	Wetland	1	0	1	1		0		**3**
Gunnison Basin North	Fen						0		**0**
	Riparian	92	6	16	924		200	2	**1240**
	Water	1			14		1		**16**
	Wetland				2		1		**2**
Gunnison Basin South	Fen						0		**0**
	Ripaian	17	3	14	260		145	0	**440**
	Water			0	1		1		**1**
	Wetland			0	11		2		**13**
North Fork Valley	Riparian	102		16	215	10	118	1	**461**
	Water	3		1	6	0	1		**10**
	Wetland	2					0		**2**
San Juans	Fen	8		1			1	1	**10**
	Ripaian	13		28	2		35		**78**
	Water		0	1			0		**1**
	Wetland	6		3			0		**9**
Uncompahgre Plateau	Fen						1		**1**
	Riparian	39	1	65	446		69		**620**
	Water	2		1	31		5		**39**
	Wetland			1	9				**10**
Grand Total Acres		**391**	**11**	**220**	**2259**	**55**	**634**	**4**	**3575**

Effects to Sensitive Species

The following is a description of the more likely residual effects per species, considering appropriate application of design features (Appendix B). Surveys would be conducted during treatment layout to assess presence or absence (FSSP-2A, Appendix B).

Park Milkvetch

Direct effects are anticipated to be within the range of those discussed in Alternative 2.

Indirect effects are anticipated to be within the range of those discussed in Alternative 2.

Peculiar Moonwort

Direct effects are anticipated to be less than those discussed in Alternative 2. The lower number of temporary roads and road reconstruction miles will likely reduce the potential for adverse direct impacts to individuals and populations.

Indirect effects are anticipated to be less than those discussed in Alternative 2. The lower number of temporary roads will likely reduce the potential for adverse indirect impacts to individuals and populations.

Lesser Panicled Sedge, Round Leaf Sundew, Chammiso's Cottongrass, Slender Cottongrass, Sageleaf Willow, Sphagnum Moss, and Lesser Bladderwort

Direct effects are anticipated to be within the range of those discussed in Alternative 2.

Indirect effects to lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss and lesser bladderwort may be slightly lower with Alternative 3, though the densities of activities—if restricted to the WUI – will only impact slightly fewer potential fens and potential fen acres. The increases in concentrations of these activities may lead to greater levels of sedimentation and hydrologic alteration, though adherence to design features (Appendix B) will reduce the potential for substantial long term impacts to the viability of these species.

Colorado Tansy Aster

Direct effects are anticipated to be less than those discussed in Alternative 2. The lower number of temporary roads will likely reduce the potential for adverse direct impacts to individuals and populations.

Indirect effects are anticipated to be less than those discussed in Alternative 2. The lower number of temporary roads will likely reduce the potential for adverse indirect impacts to individuals and populations.

Alternative 3 – Cumulative Effects

Park Milkvetch

Cumulative effects are anticipated to be within the range of those discussed in Alternative 2.

Peculiar Moonwort

Cumulative effects are anticipated to be less than those discussed in Alternative 2. The lower number of constructed and reconstructed road miles will likely reduce the potential for adverse cumulative impacts to individuals and populations.

Lesser Panicled Sedge, Round Leaf Sundew, , Chammiso's Cottongrass, Slender Cottongrass, Sageleaf Willow, Sphagnum Moss, and Lesser Bladderwort

Cumulative effects are anticipated to be slightly less than those discussed in Alternative 2.

Colorado Tansy Aster

Cumulative effects are anticipated to be in the range, though less than those discussed in Alternative 2. The lower number of constructed and reconstructed road miles will likely reduce the potential for adverse cumulative impacts to individuals and populations.

Determinations of Effect and Rationale by Alternative

All alternatives are in compliance with the Endangered Species Act (ESA). There are no impacts or effects to Threatened and Endangered Plant Species and all proposed alternatives occur outside of the known distributional and/or elevation ranges for any listed or proposed plant species associated with these habitats. A Biological Assessment and Biological Evaluation have been conducted and are available in the project record.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

There are no proposed management activities under Alternative 1. There is the potential for indirect effects resulting from natural processes. There will be no direct effects on *lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort, park milkvetch, Colorado tansy aster* and *peculiar moonwort* from the implementation of the No Action Alternative. Alternative 1 complies with Regional policy on sensitive species as there is no effect.

Alternative 1 (No Action Alternative) – Cumulative Effects

There is no action associated with Alternative 1. Though there is the potential for passive indirect effects, there is no action so it is determined that Alternative 1 will have **no cumulative effect** on *lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort, park milkvetch, Colorado tansy aster* and *peculiar moonwort.* Alternative 1 complies with Regional policy on sensitive species as there is no effect.

Alternative 2 (Agency Preferred Action) –Direct and Indirect Effects

Alternative 2 complies with Regional policy (FSM 2670.32) as pre-implementation surveys will be conducted and design features have been designed to reduce and minimize the potential effect to the viability of these species and their habitat, to the extent possible consistent with project goals.

There is a potential for direct and indirect impacts to sensitive plants that grow in fens and riparian areas, including the *lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort,* and *park milkvetch.* Habitat altering prescriptions that will occur in the proximity of fens could result in altered habitat conditions or damage to individual(s) or populations. While this potential exists, the detailed design criteria that protect their habitat (wetlands and fens) mitigate much of the risk to these species (Appendix B). Thus, the determination for these species is that the action alternatives **may affect individuals, but is not likely to result in a trend toward Federal listing or loss of viability** of affected species.

There is the potential for direct and indirect impacts for *peculiar moonwort* due to the potential for widespread impacts to undetectable individuals and their suitable habitat that cannot be mitigated through design features. However, because implementation will avoid populations when they are detected, we have made the determination that Alternative 2 **may affect individuals, but is not likely to result in a trend toward Federal listing or loss of viability** of *peculiar moonwort*.

There is the potential for direct and indirect impacts for *Colorado tansy aster,* based on the species occurring on road systems and adjacent to areas that could be impacted. Design features have been included that reduce the impacts from road use and destruction of populations due to staging areas and pile burning. Thus, we have made the determination that implementing Alternative 2 **may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability** of *Colorado tansy aster*.

Adapted/Potential Future Treatment Type

The above effect determination considers current stand condition and proposed actions within SBEADMR activity areas. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. If this occurs, the extent of potential direct and indirect effects to suitable habitat and potentially occupied suitable habitat for sensitive species will be greater.

Implementation must adhere strictly to the proposed design features and policy standards discussed in this document to reduce adverse impacts and minimize or reduce direct and indirect impacts (Appendix B). Following the design features and policy standards, changes in treatment type should not change the effect determination. Allowing for adequate time to survey, flag, and apply appropriate design features will be critical.

Protection provided within the design criteria (Appendix B) and standards should allow the effect determination to remain unchanged for any sensitive species. We have made the determination that implementing the adapted action for Alternative 2 **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability.** Following Design Criteria and adhering to policy standards will prevent individuals to trend toward Federal listing or loss of viability.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

Alternative 3 complies with Regional policy (FSM 2670.32) as pre implementation surveys will be required and design features have been designed to reduce and minimize the potential effect to the viability of these species and their habitat, to the extent possible consistent with project goals.

There is a potential for direct and indirect impacts to all sensitive plants analyzed in this document including *lesser panicled sedge, round leaf sundew, Chammiso's cottongrass, slender cottongrass, sageleaf willow, sphagnum moss, lesser bladderwort, park milkvetch, Colorado tansy aster* and *peculiar moonwort.* Design features are included in the project design to mitigate the impacts to all sensitive plants. Alternative 3 has a smaller footprint of where impacts would occur, and hence potentially affects a smaller portion of the range for all sensitive plants. Thus, it is determined that implementing Alternative 3 **may adversely impact individuals, but is not likely to result in a trend toward Federal listing or loss of viability**.

Adapted/Potential Future Treatment Type

The above effect determination considers current stand condition and proposed actions within SBEADMR activity areas. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention treatments have the potential to shift towards salvage treatment. If this occurs, the extent of potential direct and indirect effects to suitable habitat and potentially occupied suitable habitat for sensitive species will be greater.

Implementation of projects in future must adhere strictly to the proposed design features and policy standards discussed in this document to reduce adverse impacts and minimize or reduce direct and indirect impacts (Appendix B). Following the design features and policy standards, changes in treatment type should not change the effect determination. Allowing for adequate time to survey, flag, and apply appropriate design features during pre-treatment design will be critical.

Protection provided within the design criteria (Appendix B) and standards should allow the effect determination to remain unchanged for any sensitive species. We have made the determination that implementing adapted action for Alternative 3 **may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss**

of species viability. Following Design Criteria's and adhering to policy standards will prevent individuals to trend toward Federal listing or loss of viability.

Cumulative Effects Common to All Action Alternatives

The indirect effects of natural processes in combination with past, ongoing, and future activities could result in cumulative effects on the species listed in the Direct and Indirect Effects analyses for each of the action alternatives.

Noxious and Invasive Weeds

The GMUG utilizes the Colorado state noxious weed list to guide management on invasive plants, and additionally manage for invasive species of local concern. The State of Colorado Department of Agriculture ranks invasive plant species by their priority for treatment (CDA 2013).

Existing information on the GMUG for invasive species shows them primarily concentrated along roadways, in campgrounds, along power lines, and other areas with high levels of existing disturbance factors. It was found that these areas also correspond with existing infestations of priority management species. In the analysis conducted for this report, comparison factors found in the literature to be closely associated with invasive species spread (canopy cover, ground disturbance and propagules pressure) are used as a proxy for increased risk of spread associated with project activities. There is a measure of uncertainty in precisely how invasive species will continue to expand and invade the existing environment given the complex interactions and factors that influence densities and distribution, so projections are qualitative instead of quantitative.

Compliance with Regulatory Direction

Federal Laws and Regulations

The principal statutes governing or supporting the management of aquatic and terrestrial invasive species on the National Forest System include but are not limited to, the following statutes. Except where specifically stated, these statutes apply to the entire National Forest System.

- Organic Administration Act of 1897 (16 U.S.C. §§473 *et seq*.).
- Bankhead-Jones Farm Tenant Act of 1937 (7 U.S.C. §§1010 *et seq*.) Title III of the Act.
- Anderson-Mansfield Reforestation and Revegetation Act of October 11, 1949 (16 U.S.C. 581j (note), 581j, 581k).
- Sikes Act (Fish and Wildlife Conservation) of September 15, 1960 (16 U.S.C. 670g-670l, 670o, P.L. 86-797), as amended. Section 201.
- Appropriations Resolution, 2003. Section 323 of the Act, codified at 16 U.S.C. 2104.

- The Plant Protection Act of 2000 (7 U.S.C. 7701 et seq) as amended by the Noxious Invasive Plant Control and Eradication Act of 2004 (P.L. 108-412).
- Wyden Amendment (P.L. 109-54, Section 434).
- Clean Water Act of 1977 (33 U.S.C. 1251, 1254, 1323, 1324, 1329, 1342, 1344; 91 Stat. 1566).
- National Environmental Policy Act of 1969 (16 U.S.C. 4321).
- Executive Order 13112 (Clinton 1999), Section 2.

State Laws and Regulations

Following national Forest Service policy, (Forest Service Manual 2903 p15-16) many programs and projects involving invasive plants on the GMUG are done in cooperation with the state of Colorado or one or more of its counties. Plant species on the state of Colorado's noxious weed list are shown in Appendix A of the Invasive Plant Risk Assessment Report in the Project Record.

In this report, the term *invasive plant species* will be used to describe non-native plants that meet the definition of *invasive species* in Executive Order 13112 (Clinton 1999).

Forest Service Policy and Direction

Forest Service policy states, "Management activities for aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens) will be based upon an integrated pest management approach on all areas within the National Forest System, … prioritizing prevention and early detection and rapid response actions as necessary" (USDA Forest Service 2011d) and goes on to define five objectives:

- Prevention
- Early Detection and Rapid Response (EDRR).
- Control and Management
- Restoration
- Organizational Collaboration

Additional policy statements on invasive plants can be found in Forest Service Manual 2900, Invasive Species Management (USDA Forest Service 2011d), the National Strategy and Implementation Plan for Invasive Species Management (2004), and the USFS Guide to Noxious Invasive Plant Prevention Practices (2001).

Finally, the GMUG Forest Plan (1991 revision), includes the following goals:

- Manage vegetation in a manner to provide and maintain a healthy and vigorous ecosystem resistant to insects, diseases, and other natural and human causes.

- Increase or improve wildlife habitat diversity.
- Improve fisheries habitat.
- Protect the water quality in streams, lakes, riparian areas, and other water bodies.
- Conserve soil resources.
- Maintain long-term land productivity.

The Range Resource Management section of the 1991 Forest Plan sets a priority for treatment of noxious weeds. In the Soil Resource Management section, it sets a goal to "Maintain soil productivity, minimize man-caused soil erosion, and maintain the integrity of associated ecosystems;" and also states:

"Revegetate all areas, capable of supporting vegetation, disturbed during road construction and/or reconstruction to stabilize the area and reduce soil erosion. Use less palatable plant species on cuts, fills, and other areas subject to trampling damage by domestic livestock and big game to discourage grazing by herbivores."

All alternatives are in compliance with policy as set forth in Executive Order 13112 and FSM 2900 through the use of design features that help prevent the introduction of invasive plants and provide a mechanism for monitoring and control.

Analysis Methodology

There are several factors that are identified as increasing the risk of spread of invasive plants, including the presence or absence of an invasive plant, the type of invasive plant, inherent vulnerability of existing habitat, existing vectors facilitating invasive plant spread, and project dependent increases in these vectors and the alteration of the habitat. These factors are divided into two categories for analysis purposes; those independent of project activities, and those that are dependent on project activities.

These factors work synergistically to facilitate invasion of invasive plants. The degree of risk is qualitatively described as low, moderate or high. *Low risk* means that there is a small or negligible chance that an invasive species will spread and infest new areas or increase the size of existing infestations. *Moderate risk* means that it is likely that invasive species infestations will increase significantly in size or number of infestations, possibly up to a 50 percent increase with localized effects. *High risk* means that it is very likely that invasive species infestations will undergo substantial increases, and result in landscape scale effects.

Assumptions

- There is a risk of invasive species spread by vehicles, equipment and people associated with project implementation. Risk will be minimized by design features to wash and clean vehicles and remove seed from clothing; despite best intentions to remove all seed and

propagules, some probability of seed and propagule spread remains due to ongoing recreation use, animal migrations, the prevalence of invasive species impacts in the proposed treatment areas, and the presence of dispersal vectors.

- Decreasing tree canopy and soil disturbing activities associated with the use of heavy equipment are key environmental factors in invasive plant species increases.
- Design features will reduce the potential introduction, spread, and establishment of invasive plants that could occur as a result of treatments.
- Individual design features may, or may not be effective at reducing the potential for introduction and spread of invasive plants. Pre-treatment planning will establish which features are necessary for treatment-specific conditions and activity types, and may require multiple features to be effective.
- The action alternatives include areas common to all; where these alternatives overlap, the impacts and effects will be similar.
- Effects will be dependent on the locations where the treatments occur, and whether there are invasive plants present.

Methods Used to Determine Factors Independent of Treatment Implementation

This portion of the analysis considers three components to risk that help define the condition of the affected environment:

1. The invasibility of each nonnative plant species and their management priority;
2. The invasibility of the landscape; and
3. The existing potential for spread (vector potential).

The methodology used to establish the baseline conditions include: invasive plants on the GMUG and their management priority; habitat vulnerability; and vector potential.

Treatment-dependent vectors: The treatment-dependent vectors considered in this analysis include all people, machines and vehicles that are used in or near the affected area for treatment planning and implementation.

Treatment-dependent habitat alterations: Treatment-dependent factors may include: changes to tall canopy cover, soil disturbance, changes in soil cover, changes in soil characteristics, changes to ground water, changes to surface water, removal or rearrangement of features storing carbon, and changes to site microclimates.

Affected Environment

Effects caused by invasive plants include altered fire patterns and intensity and resulting ecosystem changes, soil erosion and changes in nearby aquatic habitat (Lacey et al. 1989, Carpenter et al. 2000). Many non-native plant species provide poorer habitat for wildlife species and livestock than their displaced native counterparts, and some species like St. Johnswort, Russian knapweed and leafy spurge are toxic to livestock.

Invasive species impact native plant communities and biodiversity in several ways, including changes in plant community structure that result in changes in native species richness and abundance. Some mechanisms for changes in communities include:

- Changes in soil chemistry, such as salt accumulation, changes in nitrogen cycling, or allelopathy[18]
- Changes in soil biota
- Changes in soil moisture
- Changes in habitat and nutrition quality and quantity for producers (green plants) or consumers (wildlife)
- Changes in competition patterns for resources such as light and nutrients
- Changes in ecosystem processes, such as hydrologic regimes, decomposition rates or natural fire frequencies

Invasive plant species can impact soil biota and nutrient cycling in several ways. They can increase or decrease available nitrogen as has been observed in areas invaded with annual grasses (Levine et al. 2003). Some invasive species, such as annual grasses, have shallower root systems than species native to a site, which can result in increased soil erosion (Bossard et al. 2000). Increased biomass inputs to the litter layer may also occur, altering resource cycling. Changes to soil microbes, including fungi, bacteria, and invertebrates, can impact native communities by altering important symbiotic relationships and changing nutrient cycling.

Invasive species can impact hydrologic regimes by altering sedimentation rates, changing transpiration timing and rates, and altering erosion rates. This results in changes in flooding patterns and riparian community structure (Levine and others 2003, Bossard and others 2000).

[18] "A biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial or detrimental effects" (en.wikipedia.org).

From 1998-2013, the GMUG had inventoried or treated 34 non-native invasive plant species. The priority species for the GMUG are calculated in Appendix A of the Invasive Plant Risk Assessment Report located in the project record and summarized in Table 163.

Table 163. Priority Invasive Plant Species for the Grand Mesa-Uncompahgre-Gunnison National Forests.

Priority Class	Code	Name	Common Name
I	CIAR4	*Cirsium arvense*	Canada thistle
	CANU4	*Carduus nutans*	musk thistle
	PORE5	*Potentilla recta*	sulfur cinquefoil
	LIVU2	*Linaria vulgaris*	yellow toadflax
	LEVU	*Leucanthemum vulgare*	oxeye daisy
	CIVU	*Cirsium vulgare*	bull thistle
	CEST8	*Centaurea stoebe*	spotted knapweed
	ACRE3	*Acroptilon repens*	Russian knapweed
	CYOF	*Cynoglossum officinale*	hounds-tongue
II	CADR	*Cardaria draba*	whitetop
	ANAR6	*Anthemis arvensis*	corn chamomile
	COAR4	*Convolvulus arvensis*	field bindweed
	CEDI3	*Centaurea diffusa*	diffuse knapweed
	HYNI	*Hyoscyamus niger*	black henbane
	VETH	*Verbascum thapsus*	common mullein
	CAAC	*Carduus acanthoides*	spiny plumeless thistle
	ARMI2	*Arctium minus*	common burdock
	ARAB3	*Artemisia absinthium*	absinthe wormwood
	SATR12	*Salsola tragus*	prickly Russian thistle
	CIIN	*Cichorium intybus*	Chicory
	TRPE21	*Tripleurospermum perforatum*	scentless chamomile
III	CESO	*Centaurea solstitialis*	yellow star-thistle
	BRTE	*Bromus tectorum*	Cheatgrass
	ONAC	*Onopordum acanthium*	Scotch thistle
	LIDA	*Linaria dalmatica*	Dalmatian toadflax
	TAVU	*Tanacetum vulgare*	common tansy
	TARA	*Tamarix ramosissima*	salt cedar
	LELA2	*Lepidium latifolium*	perennial pepperweed
	EUESU	*Euphorbia esula var. uralensis*	Russian leafy spurge
	ELAN	*Elaeagnus angustifolia*	Russian-olive
IV	DIFU2	*Dipsacus fullonum*	common teasel
	CACA19	*Carum carvi*	wild caraway
	ANCO2	*Anthemis cotula*	Mayweed chamomile
	SEJA	*Senecio jacobaea*	tansy ragwort

Comprehensive Evaluation Report compiled for the GMUG in 2006 showed an increase in invasive species, with “knapweed and thistle moving upward in elevation along forest roads” (USDA Forest Service, 2006d). The report cited ornamental species on NFS lands, presumably originating from private lands and communities located within forest boundaries, as well as an increase in cheatgrass, which was found to have moved into areas disturbed by fire on the Uncompahgre Plateau (USDA Forest Service 2006d, pp. 42-43.)

The distribution of mapped invasive plants has been modeled across the GMUG based on the priority of management, the invasibility of the individual species, and the area of occupied infestation. This is displayed in Figure 25. The lower weighted cells (represented by white and greens) have none to few known infestations that are of management priority. The higher weighted cells (represented by red) identify areas where there are heavier infestations of invasive plants of management priority.

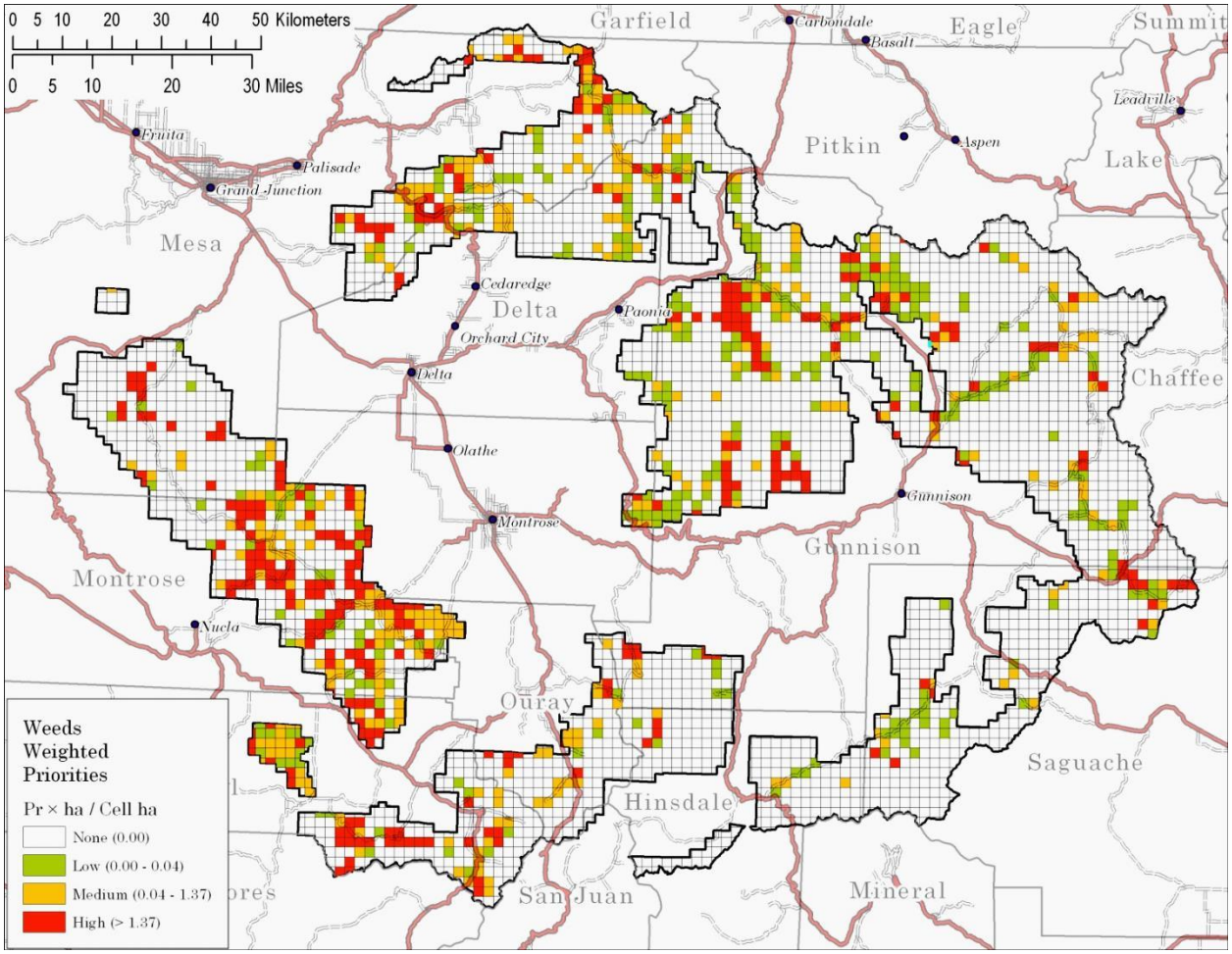

Figure 25. Distribution and concentration of management priority invasive plants on the GMUG, based on the invasive inventory and priorities.

Habitat Vulnerability and Vectors

Habitat vulnerability is controlled by both biotic and abiotic factors of the environment that influence the success of propagules of nonnative species to occupy a site (D'Antonio et al., 2001). Abiotic factors that influence habitat vulnerability include climate (macroclimate and microclimate), water availability and soil nutrients and toxicity. Invasive plants can alter these abiotic processes once established. Some of the known biotic factors that influence habitat vulnerability include the

competitive capacity of other species in the plant community, the presence of required mutualists for the invader, herbivore pressures, and in some cases species diversity (D'Antonio et al., 2001).

Characteristics that increase the probability of a community's invasibility include a frequent disturbance regime, (Bossard and others 2000, MacDougall et al, 2005), overstory canopy cover and litter and duff cover (Merriam et al., 2006, Keeley 2006). Biodiversity has sometimes been linked with resistance of native communities to invasibility (Kennedy and others 2002) with the hypothesis that the more native species inhabit niches (localized environmental conditions), the less opportunity for invasive species to colonize. (Meiners et al., 2004, Robinson et al., 1995, D'Antonio et al., 2001).

The SBEADMR project area is composed of a variety of vegetation types, including coniferous forest, aspen stands, mountain shrublands, mountain grasslands, roadsides and openings within the forest. The Grand Mesa, Uncompahgre and Gunnison Proposed Land Management Plan (USDA 2006a) assessed the risk of invasibility of vegetation cover types. In general, vulnerability in wildlands is low in desert and semi-desert elevations, (mostly below forest), then increases to high at medium elevations, declining to very low at high elevations (colder with short growing seasons, mainly in wilderness areas). Vegetation along major drainages and more open vegetation types were observed to have higher vulnerability. Spruce-fir, high elevation lodgepole pine and cold, windswept alpine cover types have a very low risk of invasion. Lodgepole pine, spruce-fir and aspen at moderately high elevations have a low risk. Grasslands, lodgepole pine, and spruce-fir at moderate elevations have a moderate risk. Grasslands, sagebrush and willow at lower elevations have a high vulnerability rating. Grass lands and bare ground at lower elevations have a very high vulnerability, though this may be reduced by various abiotic conditions (e. g., precipitation, nutrient availability). The very lowest elevations on the GMUG are usually cold semi-desert sites, with a moderate vulnerability because of the high evaporation and evapotranspiration rates compared with precipitation.

Riparian zones are known to be more vulnerable to infestation by invasive plants than adjacent upland sites (Stohlgren and Chong 2002). Stohlgren and Chong (2002) found that mixed conifer forests with sparse understory vegetation tend to be less invaded than adjacent canopy gaps, aspen stands, and montane meadows. However, they found no difference in vulnerability between grazed and ungrazed sites. Any site is vulnerable to invasion if light, water and nitrogen are made available (Stohlgren and Chong 2002).

Future potential non-project conditions that could increase habitat vulnerability would include:

- Openings or soil fertility changes resulting from severe wildfire
- Openings or loss of cover from insect or disease epidemics in trees and shrubs,
- Disturbed habitat from road maintenance or construction causing loss of soil and native vegetation.
- Climate warming, increasing vulnerability in areas formerly too cold for invasions

- Exposed soil from increased off-road vehicle use
- Exposed soil or reduced cover from over-use by big game animals, especially in their winter ranges
- Increased exposure to invasive plant propagules carried by increased levels of people recreating, pack animal use, and off-road vehicle use.

Parts of the analysis area are remote and topographically rugged. The main vectors for spread in these areas would be recreation, wildlife, wind and water. Though all species have the potential to become established with a single introduction, a few, like cheatgrass, potentially have a higher probability of successful introduction into remote areas. In addition to wildlife, livestock, such as cattle and sheep, carry invasive plant propagules (Ferguson et al., 2003); humans are also a major vector for propagation and spread of invasive plants.

Important pathways applicable in the treatment area include roads, water course ways, private property, water inputs (nearby dam and boat launches), and hiking trails. Roads are thought to promote invasive plant distribution and abundance due to two important mechanisms: the creation of suitable habitat (road maintenance disturbance and reduced competition from native plants) and the increase in vectors (e.g. vehicles, animals) (Ferguson and others 2003). These pathways are often the sites of greatest invasion, as they often combine continuous disturbance and higher frequencies of vectors. Roads are the most important habitat to consider when evaluating invasive plants because they create areas of localized habitat that is maintained at an early successional stage, which results in high vulnerability to invasive species. Similarly, other highly disturbed or early successional habitat such as construction sites, trails, campgrounds or landings have a high vulnerability. The SBEADMR analysis area has an extensive existing road and trail system, which increases its inherent vulnerability.

Among recommended management practices for invasive species management, there are several of great importance (Catford and others 2009):

- Strict quarantine and screening measures
- Increase health of indigenous species
- Control/eradicate non-indigenous facilitators
- Concentrate weed control in dispersal corridors
- Time weed control efforts so it is concentrated post-disturbance
- Concentrate weed control at propagule source
- Minimize disturbance in uninvaded areas

Habitat vulnerability is a combination of many factors. These factors interact with vectors synergistically to create areas with greater vulnerability and risk for invasion. Figure 26 displays the weighted risk.

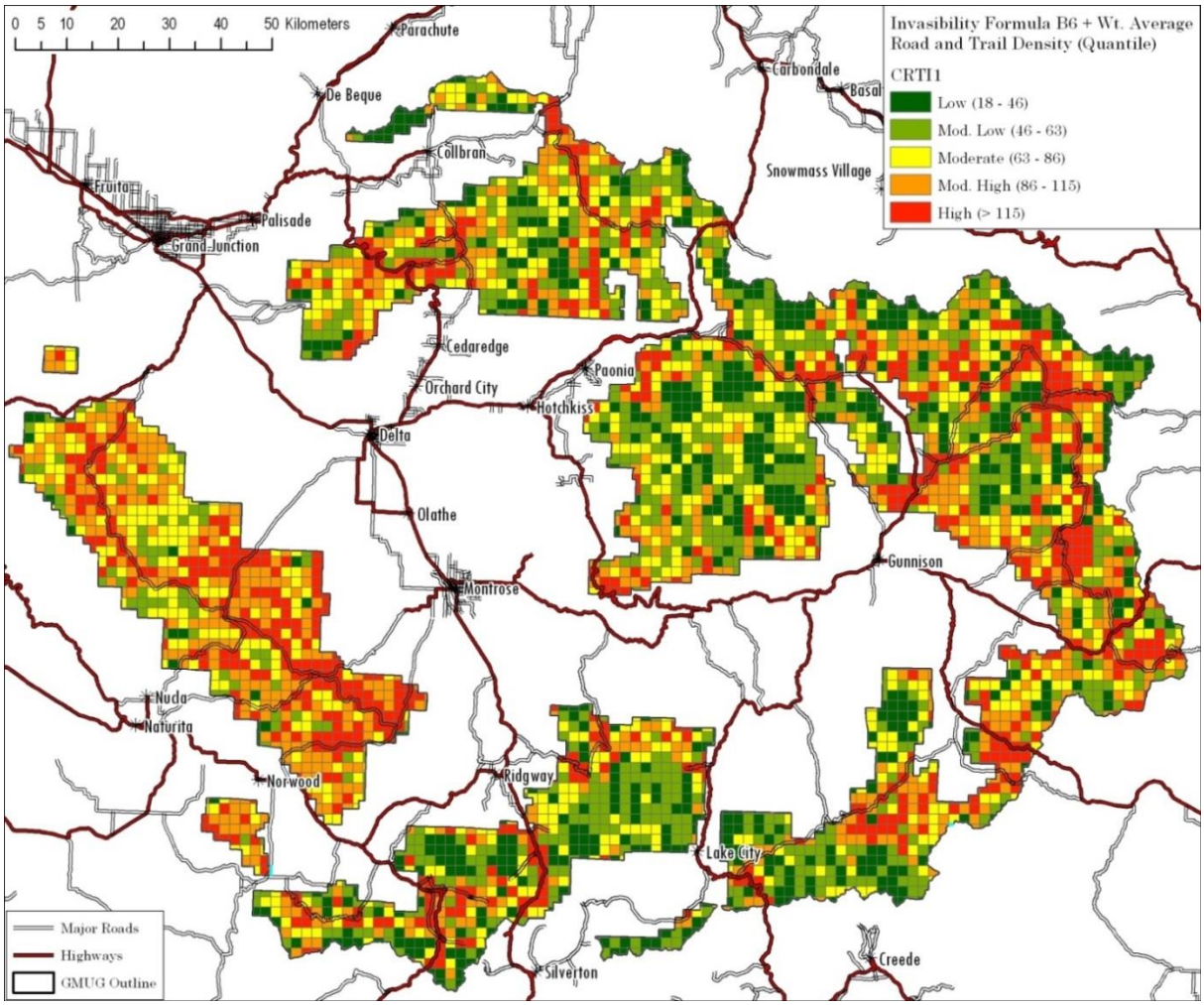

Figure 26. Predicted habitat vulnerability based on aspect, elevation, vegetation, precipitation, slope, and road and trail densities.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

The No Action Alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. Under the No Action alternative, current management plans would continue to guide management of the project area, and related, ongoing treatments would continue to occur. The environmental effects of treatments not associated with SBEADMR are documented in separate environmental documents. The result of less active vegetation management is difficult to predict, as there are numerous successional pathways of invasive species that depend on many factors, including climate change and wildfire.

The general trend with an absence of disturbance will be that some of the invasive species will become less abundant as native overstory canopy increases, decreasing available light. However, areas lacking overstory, possibly due to beetle kill or aspen decline, would likely have increases in

densities of invasive plant species. Species with low canopy cover requirements and high ecological amplitudes such as cheatgrass have the potential to spread into all habitats with lower cover values, though the right combination of factors would need to exist.

Alternative 1 (No Action Alternative) Cumulative Effects

Cumulative effects that result in ongoing ground disturbance and have high vector movement (i.e. recreation, wildfire, roads, trails), are known to introduce and spread invasive species; these activities would continue in the No Action Alternative. Current invasive species management would continue to be implemented.

Activities Common to Both Action Alternatives

Treatment Design Features

Risk of invasive plant infestations will be minimized by design features to wash and clean vehicles and remove seed from clothing; despite best intentions to remove all seed and propagules, some probability of seed and propagule spread remains due to ongoing recreation use, animal migrations, the prevalence of invasive species impacts in the proposed treatment areas, and the presence of dispersal vectors.

Individual design features may or may not be effective and reducing the potential for introduction and spread of invasive plants; pre-treatment planning will establish which features are necessary for treatment-specific conditions and activity types.

The following are design features that are included for all action alternatives. The design features are established in response to the effects described in this section, and are intended to focus efforts on planning, prevention, control and monitoring, thereby reducing the effects of increased proliferation of invasive plants associated with treatment actions. The design features do not address activities or factors not associated with treatment activities.

Table 164. Design Features for Invasive Plants.

Design Feature	Trigger for Use	Description	Effect
IW-1, 5	Any treatment	Practices - Design treatments to avoid new introductions or spread of existing infestations. (IW-1) Consider excluding areas from prescribed burning where there are infestations of fire-proliferating species (example, cheatgrass).	Minimize or prevent the spread of new or existing weeds

Design Feature	Trigger for Use	Description	Effect
		(IW-5) Within high risk areas for invasive plant species, complete inventories to identify invasive plant populations. Treat and document at least 80% efficacy rate prior to treatment and/or road-building. (A decision-making trigger for adaptive management identified in Chapter 2).	
IW-2	Movement of contaminated vehicles, equipment, personnel, or materials into a treatment area	Practices - Prevent the accidental spread of invasive species carried by contaminated vehicles, equipment, personnel, or materials. A - Establish and implement standards and requirements for vehicle and equipment cleaning to prevent the accidental spread of aquatic and terrestrial invasive species on the project area. Use standard timber sale contract provision WO-CT 6.36 to ensure appropriate equipment cleaning. Equipment cleaning should be conducted after working in areas with known infestations, and prior to bringing equipment onto the National Forest. B - Locate and use weed- free project staging areas. Avoid or minimize all types of travel through weed- infested areas, or restrict to those periods when spread of seed or propagules are least likely. C - All imported materials (erosion control materials, soil, gravel, etc.) should be from a “weed-free” source or area. D - Monitoring will occur where imported materials have been placed to ensure no new infestations have been established.	Minimize or prevent the spread of new or existing weeds
IW-3	Actions that disturb native vegetation and soil	Practices - Retain native vegetation to the extent possible to prevent weed germination and establishment, in and around activity area and keep soil disturbance to a minimum. A - Timber purchasers and contractors will re-seed disturbed areas (as designated by the Forest Service) with an appropriate certified weed-free native seed mix (USDA Forest Service 2008) to avoid introduction of nonnative invasive plants and promote re-vegetation of native species. B - Throughout the implementation period of the proposed action, the Forest Service should maintain flexibility to defer cut units or stands within priority areas from treatment due to the discovery of significant new invasive plant populations with potential to disrupt the functioning of native plant communities. C - Where fuel reduction, timber harvest and other resource objectives necessitate ground disturbance and soil exposure, or substantial ground cover and canopy removal, include appropriate re-vegetation or invasive plant management strategies in the fuel treatment plan. Where necessary, rehabilitate/restore or treat disturbed areas after management activities and conduct follow up monitoring on these areas susceptible to invasive plant spread. D - Rehabilitate/restore or treat disturbed areas after fuel management activities and conduct follow up monitoring on these areas susceptible to invasive plant spread. E - Cover and reduce exposure of bare ground. Use on-site chipping or treated fuels from mastication to cover bare soil to prevent seed	Retain native vegetation and minimize soil disturbance

Design Feature	Trigger for Use	Description	Effect
		establishment where appropriate. See SV-4 concerning areas where mineral soil exposure would be needed to assist with natural regeneration. F- Slash and burn piles will be located away from known invasive plant populations and will be assessed for restoration and revegetation needs.	
IW-4	Actions in areas of existing infestations	Practices - Control and treat existing infestations to prevent treatment-associated spread and proliferation. A - Coordinate project activities with any nearby herbicide application to maximize cost effectiveness of nonnative invasive plant treatments. B - Treatment of noxious weeds will follow Forest Service policy regarding certification of applicators and reporting of data to Forest Service data bases. C - Treatments of noxious weeds will follow the District Noxious Weed Treatment Decision Notice. D - Populations of noxious weeds should be aggressively treated with the appropriate management tools. This may include treatment with herbicides, grazing, cultural, and biological methods, consistent with the GMUG district decision notices.	Minimize the spread of existing weeds
IW-6	Any treatment	Practices - Monitor treatment area for new infestations and to assess efficacy of treatments. A - Inspect and document all limited term ground-disturbing operations in infested areas for at least three growing seasons following completion of the project. For on-going projects, continue to monitor until reasonable certainty is obtained that no new infestations have occurred. Provide for follow-up treatments based on inspection results. B - Consider modifying design feature implementation for future project implementation based on considerations such as efficacy, cost, and other unforeseen impacts. C - Consider including other design criteria for treatment-specific considerations.	Minimize or prevent the spread of new or existing weeds

These design features as individually listed may or may not be effective in preventing invasive plant introduction and spread, and in many situations will only be effective if combined. This list of design features should be evaluated when implementing each treatment, in order to choose the features most appropriate to the individual site. Prevention is the first objective and the most effective strategy with invasive plant management (USDA Forest Service 2001).

Effects Common to All Action Alternatives

Direct and Indirect Impacts

Direct impacts associated with the action alternatives increasing risk of the spread of all invasive plants include movement of propagules on machinery, vehicles, clothing, and equipment between and within treatment units. Washing equipment will reduce the risk of spread on mechanized equipment between treatment sites. Between washings, there is a high risk that propagules will be spread within the areas treated. Direct impacts also include short term decreases in invasive cover as all treatment methods will remove or reduce above ground portions of the plant. In the long term there will be no net decrease as all of the invasive plants will regenerate from underground vegetative parts (perennials) or establish from seed. There is the potential that prescribed fire treatments will kill the seeds of some portion of the seed bank of weeds or standing seed heads, which will be a beneficial short term impact, but if the weed seed bank is partially killed, then so will the seeds of natives on which the revegetation may depend.

There are six main factors to consider when considering the indirect impact of the action alternatives in facilitating increases of nonnative invasive species:

1. Any disturbance decreases the environmental resistance to invasive nonnative plant species, especially disturbance that increases bare soil.
2. Long distance dispersal species have the capacity to quickly move into treatment areas near infestations (e. g., knapweeds, bull thistle, yellow star-thistle, see Appendix A in the Invasive Plants report located in the project record).
3. Changes in vegetation structure, canopy closure, and soil cover are important factors affecting habitat that create suitable habitat for invasive plants.
4. Seed banks for nonnative invasive plants could be present before treatment, and be germinated by treatment implementation.
5. All ground disturbing activity within invasive species occurrences will result in increases in abundance and distribution of invasive species in the absence of additional management, such as weed eradication and control treatments immediately post-disturbance, and implementation of other appropriate design features.
6. Increases in abundance and distribution of invasives are variable based on variable biotic and abiotic factors such as weather patterns, soil types, wind patterns (airborne seeds), etc.

All invasive species are able to migrate into new areas, so when suitable habitat is created close to existing occurrences there is a high risk for population expansion. The treatment dependent factors that influence invasive plants' potential mobility to new sites depend on the six factors listed above, especially when referring to the creation of suitable habitat. Mobility also depends on non-treatment dependent factors such as an existing seed bank.

The action alternatives will result in alterations to vegetation structure and species composition. Structural changes to vegetation are the direct impact of the action alternatives and include changes to understory and overstory vertical and horizontal spatial composition through vegetation removal to meet the project's forest health and diversity objectives. Compositional changes in species are an indirect effect of the action alternatives caused by the present species assemblage and the successional pathway that results from the particular treatment applied.

All actions associated with treatment implementation have the potential to increase invasive nonnative plant species abundance and distribution. Creation of suitable habitat for nonnative invasive plant species is the primary adverse indirect impact to vegetation associated with the action alternatives. The factor that has been the most strongly correlated with invasive plant species richness and abundance in sites where vegetation management has occurred is removal of overstory canopy, litter and duff cover (Merriam et al., 2006). Reducing overstory canopy cover allows light to penetrate to the soil layer; combined with reduced water and nutrient competition, this can allow for invasive nonnatives to increase in extent and abundance. Disturbance, litter and duff removal reduce a plant community's resistance to invasion (D'Antonio et al., 2001).

Overstory canopy reduction is associated with the proposed treatments, which include timber harvest, mastication, prescribed fire and hand thinning, and combinations of these treatments. There is an inversely proportional relationship between overstory canopy cover and invasive species cover, meaning that as overstory canopy decreases, invasive plant cover increases (Coulter et al., 2010, Keeley and McGinnis 2007, Merriam et al., 2006, Gibson 2002). The magnitude of the impacts from the resulting condition depends on the amount of overstory canopy reduction. The effect of overstory canopy reduction, combined with prescribed fire, would not be a uniform reduction across the landscape, but would occur as a mosaic with localized areas of overstory canopy loss, and areas with no net change. More uniform patterns of overstory canopy removal could result from spruce salvage treatments, aspen coppice treatments and road construction. Any of these treatments (with or without prescribed fire) could result in further decreases or greater variability in canopy cover.

The action alternatives may result in alterations to current successional pathways. A successional pathway is the sequence of communities that has occurred (or could occur) on a site over time. There are several factors associated with the action alternatives that impact successional pathways and changes in vegetation composition. These factors include types of disturbance, frequency of disturbance, and the vegetation response to the types and frequencies of disturbance. For the project area, fire was likely the dominant historic disturbance regime that was the primary force in shaping successional pathways. The introduction of invasive plants can result in altered successional pathways as they are very efficient at exploiting initial, early successional resources (e.g. lighter nutrients).

A review of the literature found that the majority of vegetation treatments proposed for the action alternatives would result in increases of non-native species ranging from slight increases to substantial increases (Thysall and Carey 2001, McGlone et al., 2009). The range of results is likely a function of the presence of invasive species prior to treatments. Response of invasives post-fire is most pronounced when invasives were present before fire treatments were initiated. (Zouhar et al., 2008). There is also variability in the measured differences in increase between treatment types.

The following is a brief discussion of activities associated with treatment implementation and the factors associated with each of their impacts to the environment.

Roads

In wildlands, roads often have the highest concentrations of invasive plants. Road construction and maintenance create prime habitat for invasion as most invasive species are early successional that prefer highly disturbed sites (Ferguson and others 2003). Roads create the combination of factors associated with invasive plant establishment (creation of suitable habitat and vectors that transport and introduce seed or propagules) (Ferguson et al., 2003). Roads have also been found to have a greater impact on the distribution and abundance of invasive plants than the associated vegetation management treatments (Birdsall et al., 2012). There is high risk of invasion associated with all road activities, though implementation of design features would reduce the amount of disturbance, thereby reducing the likelihood of spreading existing invasive populations.

Timber Harvest

A review of studies conducted in 2010 looking at the response of the understory to timber harvest treatments found there was an increase in the frequency, richness and cover of invasive plants after harvest. This study found that these factors were increased with increasing entries and combinations of treatment types (Sutherland and Nelson 2010). This means that if a timber harvest was followed with prescribed fire, there was a corresponding increase in invasive plants. This review also found that these factors are compounded by propagule pressure (Jeschke 2014), though introductions did account for increases in many of the studies. Where silvicultural prescriptions require bare soil (20-40 percent) for natural regeneration (design feature SV-4 in Appendix B) the risk for invasive species to establish will increase.

Table 165. Location, Forest Type, Treatment Types, Response Variables, Direction of Response, and Authorship of Investigations of the Effects of Multiple Silvicultural Treatments on Nonnative Plants. (Reproduced from Sutherland and Nelson 2010.)

Location	Forest type	Metric	Harvest effect	Intensity effect	Harvest + burn versus harvest	Nonnative species	Change cover or frequency	Noxious species	Author
Arizona	PP	Frequency	Increase	Increase		3	1–14	3	Abella and Covington 2004
Oregon	S/WH	Frequency	Decrease			1			Alaback and Herman 1988
Minnesota	A	Richness	Increase			1		1	Alban et al. 1994
Washington	DF	Richness	Increase	Increase		3–20			Aukema and Carey 2008
Oregon	DF/WH	Cover	Increase				<1		Bailey et al. 1998
		Frequency	Increase				<1		
		Richness	Increase			4–10		5	
California	Mixed conifer	Cover	Increase	Increase		1–7	3	1	Battles et al. 2001
		Richness	Increase	Increase					
Virginia	Hardwood	Density	Increase			1	0.3		Carter and Fredericksen 2007
California	Mixed conifer	Cover	Increase		Increase	2	1	2	Collins et al. 2007
		Richness	Increase		Increase		<1		
Washington	WH/DF, S/WH	Cover	Increase				<1–18		DeFerrari and Naiman 1994
		Density	Increase				<1–4		
		Richness	Increase			1–27		13	
Montana	PP	Cover	Increase	Increase	Increase		<1–2		Dodson and Fiedler 2006
		Richness	Increase		Increase	1–10		8	
Washington	PP/DF	Cover	Increase		Increase		<1		Dodson et al. 2008
		Richness	Increase		Increase	0–7		1	
Oregon	DF	Cover	Increase		Increase	0–6	0–8	1	Dyrness 1973
		Frequency	Increase		Increase				
		Richness	Increase		Increase				
West	Conifers	Cover	Increase				0–7		Freeman et al. 2007
		Richness	Increase			0–4			
Arizona	PP	Cover			Increase				Fulé et al. 2005
		Richness			Increase			2	
Oregon	Various	Cover	Increase	Increase			<1–5		Gray 2005
		Frequency	Increase	Increase		8	<1–14	2	
Arizona	PP	Forb cover	Decrease		Increase		<6		Griffis et al. 2001
		Forb richness	Increase		Increase	2	<3	1	
		Gram cover	Increase		Increase		<5		
		Gram rich	Increase		Increase	2	<2	1	
Oregon, Washington	DF	Cover	Increase				11–17		Halpern and Spies 1995
		Richness	Increase			1	<10		
Arizona	PP	Seeds	Increase					1	Korb et al. 2005
British Columbia	LP	Richness	Increase	Increase		3			Lindgren et al. 2006
Montana	PP/DF	Cover	Increase		Increase		<3		Metlen and Fiedler 2006
		Richness	Increase		Increase		1–10	2	
Oregon	J	Biomass	Increase					1	Miller et al. 2005
Arizona	PP	Biomass	Increase		Increase	1		1	Moore et al. 2006
Arizona	PP	Abundance	Increase		Increase		<3	2	Neary et al. 2002
Washington	DF	Cover	Increase				<1		Nelson and Halpern 2005
		Frequency	Increase			5	2–31	2	
Washington	PP	Cover	Increase	Increase	Increase		<1		Nelson et al. 2008
		Richness	Increase	Increase	Increase	42	2–6	11	
Oregon, Washington	WH	Frequency	Increase			8	1–88	3	North et al. 1996
British Columbia	DF	Cover	Increase					1	Page et al. 2005
Oregon	Chaparral, oak	An grasses cover	Increase						Perchemlides et al. 2008
		An forb cover	Decrease						
Michigan, Wisconsin	Northern hardwood	Cover	Increase	Increase		1	0–5		Scheller and Mladenoff 2002
		Frequency	Increase	Increase			2–34		
Washington	Mixed conifer	Cover	Increase		Increase	13	<6	4	Scherer et al. 2000
Oregon	WH/DF	Cover	Increase			5	0–3	3	Schoonmaker and McKee 1988
Wyoming	LP, SF	Presence	Increase			7	<1	2	Selmants and Knight 2003
Massachusetts	Mesic forest	Frequency	Increase						Silveri et al. 2001
Idaho, Montana	Various conifers		Increase					2	Stickney and Campbell 2000
Washington	DF	Cover	Increase	Increase		3	<1%		Thomas et al. 199
		Frequency	Increase						
South Dakota	PP	Biomass	No exotics						Thompson and Gartner 1971
Washington	DF	Cover	Increase				<1		Thysell and Carey 2000
		Richness	Increase					3	
South Dakota	PP	Biomass	Increase	Increase					Uresk and Severson 1998
		Richness	Increase					3	
Oregon	J	Biomass	Increase					1	Vaitkus and Eddleman 1987
California	Mixed conifer	Frequency	No exotics						Wayman and North 2007
South Dakota	PP	Biomass	Increase	Increase	Increase			1	Wienk et al. 2004
Oregon	PP/DF	Cover	Increase		Increase		<3	1	Youngblood et al. 2006
		Frequency	Increase		Increase				
		Richness	Increase		Same				

A = aspen, *Populus tremuloides*; DF = Douglas-fir, *Pseudotsuga menziesii*; J = western juniper, *Juniperus occidentalis*; LP = lodgepole pine, *Pinus contorta*; PP = ponderosa pine, *Pinus ponderosa*; S = spruce, *Picea* spp.; SF = spruce-fir, *Picea* sp. and *Abies* sp.; WH = western hemlock, *Tsuga heterophylla*.

Mastication (including chipping treatments)

Vegetation debris is spread out by machinery during mastication. Some mastication methods leave areas of bare soil that have a moderate to high potential of being colonized by nonnative invasive plants, and some areas where the residual material suppresses nonnative establishment (Wolk and Roca 2008). Other mastication methods distribute woody debris more evenly across all areas, reducing erosion and the risk of invasion. Recent studies (Potts and Stephen 2009) have concluded that mastication may provide fuels management with an effective means of reducing fuel loading over a longer period of time but with an increase in nonnative invasive plants. Areas where mastication was applied showed much higher plant richness and abundance for both native and nonnative species in comparison to prescribed fire, including the highest proportion of nonnative plants (Potts and Stephens 2009). Other studies (Knapp et al., 2007) in conifer dominated vegetation types found mastication had significantly higher nonnative response compared to prescribed fire, though when mastication was *combined* with prescribed fire, there was the highest nonnative invasive response (Kane et al., 2010, Coulter et al., 2010).

Piling and Pile Burning

Studies have found that the footprints where slash pile burning has occurred have the greatest distribution and abundance of invasive plants (Keeley 2006, Jimenez Esquilin et al., 2006), inherently giving these areas a high risk for invasion. Depending on the size of the pile and its residence time, the soils below may become sterile, reducing native seed banks. This could reduce competition for invasive nonnative plant species. Another potential factor increasing risk with this action is the release of nutrients through the burning of organic materials, which could encourage invasive nonnative species growth, though conversely, this same release could provide nutrient resources for native species. These impacts are likely to be greatly reduced when pile construction is conducted by hand (and thus more dispersed and less concentrated), when compared to machine piling.

Broadcast Burning

In forested stands, fire severity has been found to be directly proportional to the abundance and species richness of invasive nonnative plant species (Griffis et al., 2001, Erickson and White 2007) meaning that the higher the fire severity, the higher the invasive plant response. In situations where more detailed history is available, it is apparent that sites experiencing increases in invasives are closely tied to pre-fire infestations, presence of corridors, and weeds introduced during the fire. Areas with no pre-fire weeds and without human or vehicle vectors are usually weed-free after the fire (Johnston 2012). Studies (Bradley et al., 2006, Collins et al., 2006) have found broadcast burning to have the lowest nonnative plant response when compared to mastication and hand treatment areas in vegetation types with high shrub components. Broadcast burning can result in

amplified invasive plant response when combined with other treatment types (Table 165, Sutherland and Nelson 2010), especially with low intensity fires (Harrod and Reichard 2002).

Fire Lines and Staging Areas

Constructed fire lines and use of staging areas can act as pathways for invasion of roadside invasive nonnative plants into other areas and adjacent wild lands. Fire line construction will establish dispersal vectors and foot travel on constructed fire lines will result in naturalized nonnative invasive plant species seed and propagule dispersal in treatment units. Where invasive species are present prior to fire line construction, spread to nearby and adjacent uninfested areas are likely, though treatment design features including pretreatment of invasive plants will reduce this risk. Native vegetation recovery on fire lines will be slower than in adjacent treated areas because fire lines are cleared of organic matter that greatly aids native plant establishment in the short-term, and construction of fire lines typically results in soil compaction that restricts rapid root expansion and plant available water. Rehabilitation of fire lines immediately following the application of prescribed fire would minimize the increase of invasive species distribution and abundance in proposed treatment units; however the threat of greater distribution and abundance remains likely due to the highly disturbed conditions and slow native recovery of fire lines.

Summary of Impacts to Abundance and Distribution of Invasive Plant Species

All activities have the potential to increase invasive plants, but there is a range in the potential magnitude of invasive plants response. The treatment-dependent factors that will affect the risk of response will be the level of soil disturbance, the degree of change in canopy coverage, introduction of new infestations, where the activities occur, and which activities are involved. The greatest invasive plant response will likely be where road activities and mechanically-constructed pile burning activities occur, especially if there is an existing infestation nearby. The greatest potential vector for introduction of new infestations would be associated with vehicles utilized for treatment activities.

The non-treatment dependent factors that will influence invasive plant abundance and distribution will include; the location of the proposed treatment site, the site characteristics that result in high to low risk for infestation, whether infestations are known to occur at and nearby the site, and the current risk of spread and introduction by existing non-treatment dependent vectors.

Integration of the design features that inventory and treat occurrences before activities commence, maintain soil and canopy coverage, prevent the accidental introduction and spread of infestations, restore or rehabilitate highly disturbed areas, and monitor and treat new infestations will greatly reduce the risk of invasive species establishing and persisting with treatment activities. However, with the level of treatment proposed and probable resulting ground disturbance, invasive plants are likely to appear in new areas.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

Alternative 2, the Agency Preferred Action, addresses the effects of the spruce beetle epidemic and sudden aspen decline by implementing vegetation management activities in five geographic areas.

The effects from Alternative 2 are within the range of alternatives described in the direct, indirect, and cumulative effects under Effects Common to all Action Alternatives listed above. Overlaying the Priority Treatment Areas (PTA) with the habitat vulnerability modeling shows that project wide, there is a moderate-high to high risk for the spread of invasive plants (Table 166). Active treatments in these areas pose a high risk for the spread of invasive plants, but this risk is minimized by the implementation of the design features associated with all action alternatives.

Table 166. Percent of Priority Treatment Areas for Alternative 2 by Invasibility Risk Class and Geographic Area.

Invasibility Risk	Grand Mesa	Gunnison Basin North	Gunnison Basin South	North Fork Valley	San Juan's	Uncompahgre Plateau	Totals	Project wide
Low	321	849	1,281	89	922	0	3,462	1%
Moderate Low	5,387	5,429	3,406	3,493	1,309	4,145	23,169	8%
Moderate	10,762	13,263	8,565	4,738	4,102	9,289	50,719	18%
Moderate High	11,332	21,257	15,811	6,002	4,392	17,654	76,448	28%
High	12,051	26,687	21,990	10,016	3,937	46,648	121,329	44%

Alternative 3 (WUI Focus) – Direct and Indirect Effects

The effects from this alternative are within the range of alternatives described in the direct, indirect, and cumulative effects under Effects Common to all Action Alternatives described above. Overlaying the Priority Treatment Areas (PTA) with the habitat vulnerability modeling shows that project wide, there is a moderate-high to high risk for the spread of invasive plants. (Table 167). Active treatments in these areas pose a high risk for the spread of invasive plants, but this risk is minimized by the implementation of the design features associated with all action alternatives.

Table 167. Percent of Priority Treatment Areas for Alternative 3 by Invasibility Risk Class and Geographic Area.

Invasibility Risk	Grand Mesa	Gunnison Basin North	Gunnison Basin South	North Fork Valley	San Juan's	Uncompahgre Plateau	Totals	Project Wide
Low	269	346	254	45	618	0	1,532	1%
Moderate Low	4,525	3,633	1,129	3,045	1,172	3,767	17,271	10%
Moderate	7,541	8,131	3,733	4,230	1,182	5,569	30,386	17%
Moderate High	6,430	15,825	3,537	3,732	1,996	11,706	43,226	24%
High	10,734	17,872	9,934	8,256	2,835	34,406	84,037	48%

Comparison of Action Alternatives

Between action alternatives, Alternative 2 has the larger area (acres) with a moderate-high to high risk for the spread of invasive plants.

Table 168. Comparison of Invasibility Risk by Action Alternative (acres for all Geographic Areas).

Invasibility Risk	Alternative 2	Alternative 3
Hazard Tree Removal		
Low	105	107
Moderate Low	740	852
Moderate	3,145	4,065
Moderate High	5,989	7,943
High	7,395	11,714
New Roads		
Low	2	1
Moderate Low	8	11
Moderate	50	35
Moderate High	69	50
High	85	70
Commercial Treatments		
Low	2,842	1,226
Moderate Low	6,556	3,734
Moderate	15,866	5,750
Moderate High	30,290	9,411
High	57,139	25,780
Noncommercial Treatments		
Low	513	199
Moderate Low	15,865	12,671
Moderate	31,660	20,538
Moderate High	40,101	25,821
High	56,712	46,473
Invasibility Risk Percentages - All Treatments		
Low	1%	1%
Moderate Low	8%	10%
Moderate	18%	17%
Moderate High	28%	24%
High	44%	48%

The findings of this analysis show that there is an increased risk in the rate of spread of priority invasive species and the creation of suitable habitat with implementation of both action alternatives. This risk will be largely mitigated through implementation of design features. Invasive nonnative plant species known from the proposed project area are recognized to have adverse ecological

impacts such as changes in the soil chemistry (changes in nitrogen cycling, allelopathy), changes in the soil biota, changes in soil moisture; changes in site and food quality and quantity for other trophic levels; increased competition for resources such as light and nutrients; and changes in ecosystem processes, such as hydrologic regimes or fire regimes.

Cumulative Effects Common to both Action Alternatives

Characteristics that increase the probability of a plant community's invasibility has been hypothesized extensively (Bossard and others 2000, MacDougall and others 2005, Catford and others 2009), but consistently include a frequent disturbance regime of either natural or anthropogenic origin. Areas that have multiple or prolonged disturbances have higher susceptibility to invasion. This implies that where there are overlapping treatments there is the potential for greater adverse and longer term impacts where invasive nonnative species are present.

The following table displays the foreseeable future actions that are likely to contribute cumulatively to the spread and introduction of invasive plants and whether the impacts are anticipated to be similar to those described above in the effects analysis. These foreseeable actions are detailed further in Chapter 3, Cumulative Impacts – Actions Considered & Analysis Approach.

Table 169. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area

Agency	District	Foreseeable Future Project	Impacts within the range of those described in direct and indirect impact (Yes/No) and effects analysis and additional comments.
USDA Forest Service, USDI Bureau of Land Management, Counties	Forestwide	Ongoing Grazing Activities	No, see below
	Forestwide	Fuels & Timber Projects	Yes, Design Features included to mitigate invasive plants impacts.
USDA Forest Service, USDI Bureau of Land Management, Counties	Forestwide	Road maintenance	Yes
	Forestwide, multiple locations	Trail Management	Yes, similar to impacts from roads although much lower.
	Forestwide, multiple locations	Minerals activities	Yes
Private landowners	N/A	Grazing	No
Public	Forestwide	Increased development, creating new WUI, increased nitrogen deposition from associated air quality changes	No
Utility companies and water providers	Forestwide, multiple locations	Construction and maintenance of above- and below-ground utility corridors, ditches, and reservoirs.	No

The following is a brief summary of the potential range of impacts anticipated from the activities mentioned in the above table. These descriptions summarize the general potential indirect impacts through the pathway of changes to environmental conditions (e.g. increases in invasive species in the cumulative impacts analysis area, climate change, etc.).

Vegetation Management and Fuels Reduction Projects

The vegetation and fuels reduction projects involve vegetation treatment similar to those proposed in the action alternatives for this project, and thus direct and indirect impacts on site are similar to those assessed in this report. Conducting many projects across the landscape in close temporal and geographic proximity is likely to result in greater cumulative impacts.

Grazing

Livestock grazing management can be beneficial in invasive plant management through the cooperation of grazing permittees and cooperating agencies; but livestock grazing but can also assist in the spread and proliferation of invasive plants. Grazing occurs both on the GMUG and in areas adjacent to the forest. In areas where the action alternatives create soil disturbance where cattle or other grazing animals are used, introductions of invasive plants could occur if propagules are brought in on the animals. Grazers can also create disturbed soils that could result in areas where introductions caused by vectors associated with project activities could occur. Wild animals such as elk, mule deer, and moose can also be vectors for introduction and spread of invasive plants.

Invasive Plant Management

There are ongoing invasive plant treatments throughout the GMUG (please see Appendix A of the Invasive Plants Specialist Report for list of acres treated). These treatments help to reduce the source of propagules that could move into areas where treatment activities occur and reduce the impacts of invasive plants on a landscape scale.

Road Maintenance

There is ongoing road maintenance in and near the analysis area. These projects may result in some increase in localized invasive abundance. This will contribute to adverse impacts as nonnative invasive plants may become established and could invade the project area.

Recreational Use

The analysis area currently has high levels of recreation, and recreation is expected to increase – motorized, mechanized, and non-motorized. Areas with high concentrations of recreation usage are vulnerable to high disturbance levels, and many of these areas are in or near spruce-fir or aspen forests. These are also sites where introductions of invasive species could occur, due to increased vehicular and foot traffic carrying seeds or vegetative propagules. The overall trend in these areas would create a higher risk for the introduction and spread of invasive plants.

Construction and Maintenance of Power Line and Pipeline Corridors

There are a number of overhead power lines crossing the forest, often through spruce-fir or aspen stands. Forest management is already actively involved in detecting and treating invasive plants in these corridors; it is expected that these efforts will intensify.

There are several pipelines that cross the forest, and maintenance of these (including weed control) is usually done cooperatively between the Forest Service and the companies owning the pipelines.

There may be more pipeline applications in future; maintenance is likely to intensify. Many of these are below the spruce and aspen zones, but there are several that cross through spruce-fir or aspen stands. The overall trend for these areas would be increased risk for introduction and spread of invasive plants.

Increased Demand for Mine and Drill Facilities

Demand for mine and drill facilities continue to increase, although only a few of these are near spruce-fir or aspen stands. These are usually areas where intense soil disturbance occurs for a few years, followed by long-term recovery and rehabilitation. Increasing demand is expected, especially on the Paonia District and the eastern part of the Grand Valley District. There will likely be increased focus put on better rehabilitation of mine sites and drill pads, especially for invasives. The overall trend for these areas would be increased risk for introduction and spread of invasive plants.

Increased Development, Creating New WUI

Every year there is more development near or adjacent to the Forest Boundary, creating more wildland-urban interface (WUI). This will increase the area to be disturbed under all action alternatives. Increased WUI will result in greater potential for introduction of invasives onto the forest due to increases in disturbance, increased vector activity, and potentially the escape of planted ornamentals (e.g., ivy) into the forest wildlands. The overall trend for these areas would be increased risk for introduction and spread of invasive plants.

Water Facilities (Ditches, Reservoirs) Construction and Maintenance

As demand for water continues to increase (for both agricultural and domestic uses), demand for new water management facilities, and more active management of existing ones, on the national forests will also increase. This will likely result in more disturbances around existing reservoirs and ditches, many of which are in spruce-fir or aspen stands. This concern is Forest-wide, though there is a great concentration of such facilities on the Grand Mesa. The overall trend for these areas would be increased risk for introduction and spread of invasive plants.

Construction and Maintenance of Ski Facilities, Including Weed Control

Most of the ski areas on the forests have expansion plans, big or small. There will also be ongoing maintenance of existing ski facilities, including new construction within existing permit boundaries, and weed treatments. Most of these ski areas are in the spruce-fir zone. The overall trend for these areas would be increased risk for introduction and spread of invasive plants.

Deteriorating Air Quality Due to Increased Population

For the last few decades, there has been a trend towards greater population numbers in and near these forests, especially around spruce-fir and aspen stands. This trend will likely continue and perhaps accelerate, resulting in more fossil fuel use and more wood-burning, which will deteriorate the air quality on and around the forests. This would result in increased nitrogen deposition which has been found to increase the success of invasive plants (Dukes and others, 2011).

Range

Affected Environment

SBEADMR is proposing vegetation treatments across the Grand Mesa, Uncompahgre, and Gunnison National Forests' five Ranger Districts. Priority treatment areas occur across the same 144 grazing allotments under Alternatives 2 and 3; 125 active, 12 vacant and 7 closed. An active allotment is one in which a grazing permit has been issued and regular use occurs. Vacant allotments have no grazing permit associated with them; however, they may be used by existing grazing permit holders in specific circumstances for example, when needed during or following fire on an active allotment. Closed allotments have no grazing permit associated with them. The list of allotments for each of the action alternatives is available in the project record.

Table 170. Grazing Allotments, Status, and Acreages for Alternatives 2 and 3.

Allotment Status	Number	Alternative 2 Acres by Status	Alternative 3 Acres by Status
Active	125	251,397	159,693
Vacant	12	10,032	7,164
Closed	7	8,538	4,868
Total	**144**	**269,967**	**171,725**

NEPA analysis for the active grazing allotments has been completed and these are currently being managed through a combination of Allotment Management Plans (AMPs) and Annual Operating Instructions (AOIs) as well as through grazing permit administration. Acres currently classified as unsuitable or incapable for grazing are not being proposed for conversion to suitable or capable.

Alternative 1 (No Action) –Direct, Indirect and Cumulative Effects

Activities that result in ongoing ground disturbance and have high vector movement (i.e. recreation, wildfire, roads, trails), are known to introduce and spread invasive species, which can impact the quality and quantity of forage. These activities would continue under the No Action Alternative. Current invasive species management would continue to be implemented.

Activities Common to Both Action Alternatives

Design features for range are noted below. Additional design features to specifically address the need for reseeding in treated areas and minimizing potential spread of noxious and invasive weeds are discussed in the Noxious and Invasive Weeds section and Appendix B.

Table 171. Design Features for Range.

	Trigger	Design Feature	Impact
RG-1	All treatments	Coordinate with District Rangeland Management Specialists prior to developing sale and/or service contracts and/or burn plans to identify and mitigate any potential direct conflicts during implementation. Range personnel will be responsible for incorporating mitigation measures into grazing permittees' Annual Operating Instructions (i.e., a pasture needs to be grazed earlier/later to avoid direct temporal overlap with timber sale activities).	Eliminate or mitigate direct conflicts between implementation activities and range activities.
RG-2	All treatments	Coordinate with District Rangeland Management Specialists prior to treatment to determine whether or not grazing deferment or pasture rest is needed, when deferment or rest is needed (prior to or following treatment), and for how long.	Enhance effectiveness of treatments to meet established objectives

Direct and Indirect Effects Common to All Action Alternatives

As specified in the Pre-Treatment Checklist (Appendix C), and in compliance with the GMUG LRMP, all range improvements including fences, cattle guards, corrals, water developments, pipelines, troughs, stock trails and stock driveways would be identified in the timber sale, service contract, or burn plan as protected improvements. Range transects and witness trees/posts would likewise be identified and protected. As such, impacts to existing range improvements and management features should be avoided.

Timber and fire staff will work closely with range management personnel to avoid direct conflict from overlapping activities (Table 171 Design Feature RG-1). In order to improve the ecological benefit of a treatment, there may be short-term changes in grazing rotations in advance of treatments or after treatments (Design Feature RG-2). For example, a pasture may need to be deferred or rested from livestock grazing prior to a prescribed burn to ensure there is fuel to carry a fire. Likewise, a pasture may need to be deferred or rested following a vegetation treatment to ensure adequate recovery before livestock grazing returns. There would be no standard timeframe for any such deferment or rest. The District Range Staff would determine whether or not deferment or rest is

needed, when deferment or rest is needed (prior to or following treatment), and for how long; they would coordinate with the affected permittee accordingly.

Vegetation treatments proposed in this EIS would generally open up the canopy and encourage growth of the understory, which could increase the forage resources available. Soil compaction from heavy equipment may have localized impacts to forage productivity. Prescribed burns may result in areas of soil impact that could impact forage productivity in localized areas, though design features will be implemented to minimize such impacts; see Soil section and *Appendix B*. While there may be temporary increases or, in certain locations, decreases in forage resources following vegetation treatments, no changes to livestock numbers are being considered, nor are any allotments being considered for closing.

Cumulative Effects Common to Both Action Alternatives

Management actions that facilitate the introduction and/or spread of noxious and invasive plants cumulatively impact the quality and quantity of forage for grazing; a more thorough discussion of cumulative impacts on invasives from past, present, and foreseeable actions are noted in the Noxious & Invasive Weeds section. Proposed SBEADMR activities, in combination with other foreseeable vegetation management (primarily noncommercial fuels treatments), will change forage conditions and can concentrate livestock use or affect livestock distribution patterns. Furthermore, ongoing and increased recreation use can influence the distribution of wild ungulates, as well as domestic livestock, on the landscape.

Silviculture

Changes Between Draft and Final

- The Draft discussed the effects of each prescription qualitatively, while the final shows the actual shift in structural stages in 6 geographic areas for each alternative and compares the results to the desired conditions. A more in-depth discussion on reforestation was added with references to local data regarding regeneration rates.
- Between the draft and final EIS the inter-disciplinary team worked in conjunction with Rocky Mountain Research station and Colorado State University to identify a maximum of approximately 110,000 acres of priority treatment areas for commercial harvest. See Chapter 2 and Appendix F for more detail.

Compliance with Regulatory Direction

Forest Service direction guiding this project includes the GMUG National Forest Land and Resource Management Plan (Forest Plan) and amendments, the National Forest Management Act of 1976, the Multiple Use, Sustained Yield Act of 1960, and the Forest Service Handbook (FSH)

2409.26 and FSH 3409.11. The FSH 2409.26 details silvicultural activities permitted on government-owned lands within the National Forest System. The FSH 3409.11 is the Forest Pest Management Handbook. This project also follows direction established in the Southern Rockies Lynx Amendment.

Openings from mechanical treatments in affected stands may exceed 40 acres. Per the 1991 GMUG Amended Forest Plan, the maximum size of openings creating by the application of even-aged silviculture is 40 acres (p. III-43); however, larger openings are permitted when they are the result of natural catastrophic conditions, such as insect or disease attack. Per the National Forest Management Act, Forest Plan maximum size for openings to be cut in one harvest operation shall not apply to the size of openings harvested as a result of natural catastrophic conditions such as fire, insect and disease attack, or windstorm (16 U.S.C. 1604(g)(3)(F)(iv)).

Analysis Methodology

- Analysis will occur at multiple scales: treatment unit, LAUs, Geographic Areas, and the Grand Mesa, Uncompahgre, and Gunnison National Forests
- All silviculture prescriptions would follow the applicable Design Features
- Direct and Indirect Effects are assessed in a 1 to 5-year time frame; however activities are expected to be implemented over an 8-12 year timeframe.
- Vegetation management activities under the action alternative were developed using the following assumptions:
    1. For Alternative 2, likely mechanical vegetation treatments would be within 1 mile of existing operational maintenance level 3-5 NFS roads.
    2. For Alternative 3, likely mechanical vegetation treatments would be within ¼ mile of existing operational maintenance level 3-5 NFS roads.
    3. Reforestation activities, including residual stocking, would comply with the Forest Plan.

Affected Environment

Increased beetle population and changed climate and weather patterns has resulted in increased susceptibility in individual spruce trees and across large landscapes and geographic regions of the spruce cover type (See Chapter 1).

SAD is changing aspen on a landscape as well as at the stand level, but its effects are more constrained; clonal response varies based on various factors, with moisture stress as an underlying and contributing factor. Moisture deficits have been noted in recent years. SAD has led to loss of aspen cover, and future warm, dry growing seasons are theorized to lead to future occurrences of SAD (Worall et al 2010).

There is likely a linkage between global climate change and the existing condition of vegetation across the GMUG, and within the Priority Treatment Areas. Bark beetle populations have increased in response to warmer temperatures and drought conditions (Hebertson and Jenkins 2008). Climate strongly influences productivity, species composition and the frequency and magnitude of forest disturbances (Hauser et al 2009). Recent research indicates SAD occurrence and incidence is changed due to changed climate, specifically changed moisture regime (Worall et al 2010).

Geographic Area Assessment

Geographic Area Assessment on the GMUG is an additional way of portraying the link between the broad-scale forest assessment and this project-level analysis. The geographic areas describe current vegetation conditions, wildlife structural stages, potential natural vegetation and how the proposed actions influence these factors. There are six geographic areas that will be used to analyze the effects of the action alternatives: Grand Mesa, Gunnison North, Gunnison South, North Fork Valley, San Juans, and Uncompahgre Plateau (See Chapter 1, Figure 7).

Habitat Structural Stage

Habitat structural stage (HSS) is a field-verified structural stage that exists as an attribute in a GIS spatial layer. The HSS describes vegetation by type, size and crown cover. The HSS assists in understanding the overall stage of development, as well as size and cover from above and can be useful in determining the overall landscape condition of vegetation.

Table 172. Description of Habitat Structural Stage across the GMUG National Forests.

HSS Code	Description	Approximate Tree Size	Crown Cover
1M*	Grass/Forb, natural meadow	Nonstocked	Not applicable
1T*	Grass/Forb, previously trees	Nonstocked	Not applicable
2S*	Shrub-Seedling; not previously trees	Nonstocked	Not applicable
2T	Shrub-Seedling, previously trees	Less than 1" DBH	Not applicable
3A	Sapling-Pole	1" to 9" DBH	Less than 40%
3B	Sapling-Pole	1" to 9" DBH	40-69%
3C	Sapling-Pole	1" to 9" DBH	70-100%
4A	Mature tree	Greater than 9" DBH	Less than 40%
4B	Mature tree	Greater than 9" DBH	40-69%
4C	Mature tree	Greater than 9" DBH	70-100%

*Did not fall within the Priority Treatment Areas

The habitat structural stage can be directly linked to the successional stages by potential natural vegetation (PNV) types discussed in Chapter 1 in order to create a comparison between the existing condition based on habitat structural stage and the desired condition based on PNV successional stages. The following table represents the desired condition by PNV model with a crosswalk between HSS and PNV successional stage.

Table 173. Desired Conditions as per Potential Natural Variation: Crosswalk between Habitat Structural Stage and Successional Stages.

PNV	Early Seral	Early-Mid Seral	Late-Mid Seral	Late Seral
PNV/HSS Crosswalk	2T	3A, 3B, 3C	4A, 4B, 4C	
Spruce-Fir	27-32%	20-24%	12-13%	31-40%
Spruce-Fir-Aspen	13-19%	22-29%	13-16%	35-49%
Aspen	8-14%	23-26%	17-24%	23-43%

Per the LRMP, desired conditions for vegetation are to sustain all PNV types that exist on the GMUG through balancing habitat structural stages through active forest vegetative management.

The HSS figures are not restricted to the vegetation types that would be affected under the alternatives and considers all vegetation types across all acres of each geographic area. The HSS analysis of the Geographic Areas shows a lack of early and mid-seral vegetation. Mid and late seral

forest conditions provide ample habitat for spruce beetle. In the case of SAD, lack of early seral aspen has created conditions that perpetuate aspen decline, as the aspen across the landscape are generally mid-seral. Added environmental stressors, such as lack of moisture, changed weather patterns, and overall climate shifts affect larger areas since the age, size, and maturity of aspen across the landscape is generally similar.

The distribution of size and density is skewed toward larger trees with higher amounts of canopy cover across all vegetation types, meaning that most of the stands on the GMUG are comprised of older trees, which are generally larger. Large acreages of vegetation in this condition are at risk from disturbance events, including insects and disease.

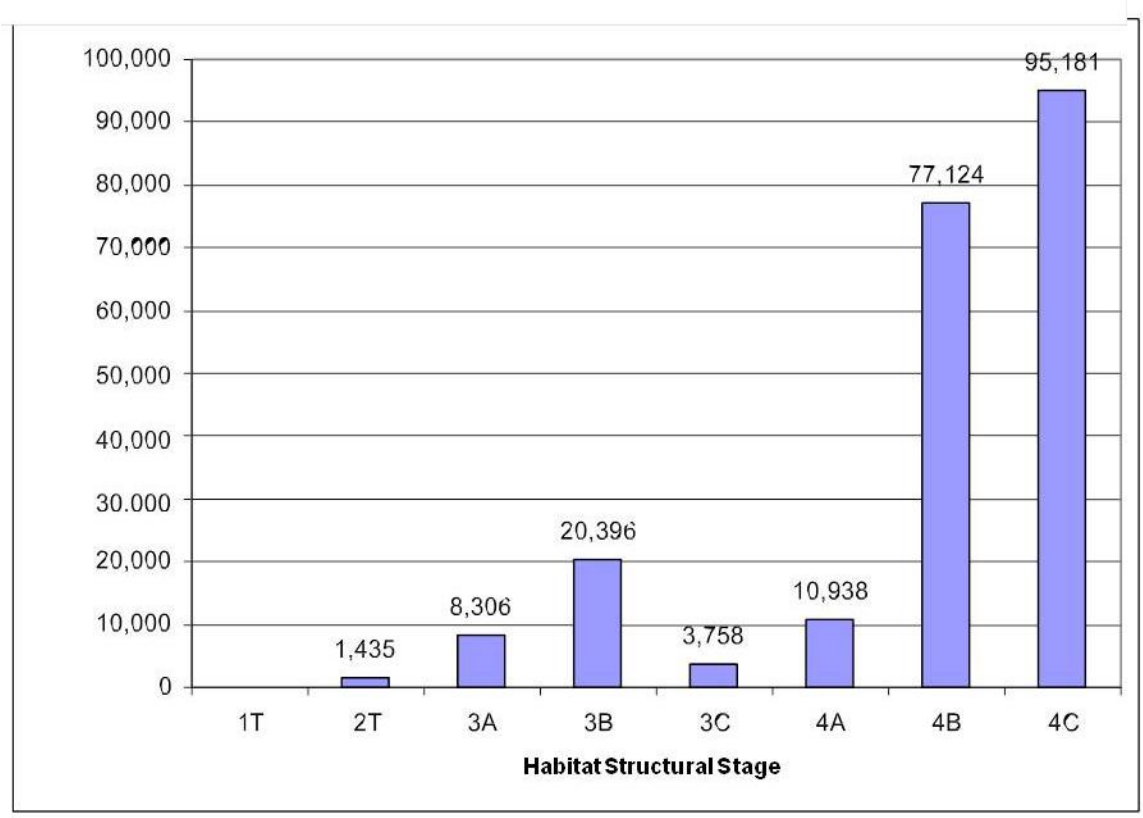

Figure 27. Habitat structural stage distribution of forest and woodland cover types, Grand Mesa Geographic Area.

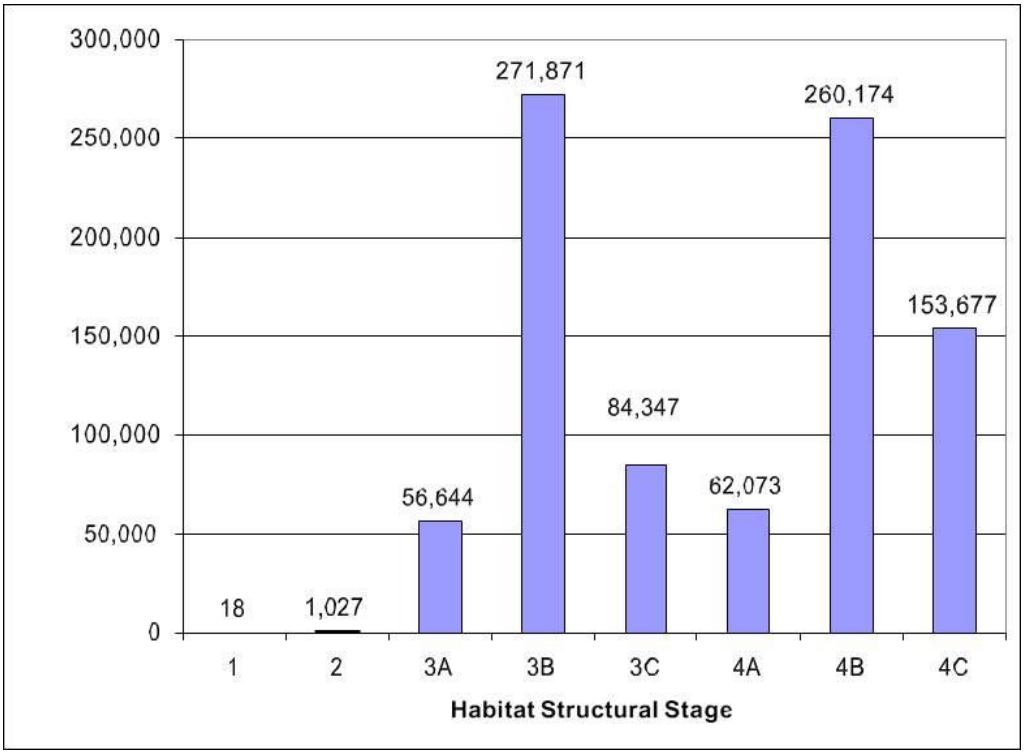

Figure 28. Habitat structural stage distribution of forest and woodland cover types, Gunnison Basin Geographic Area.

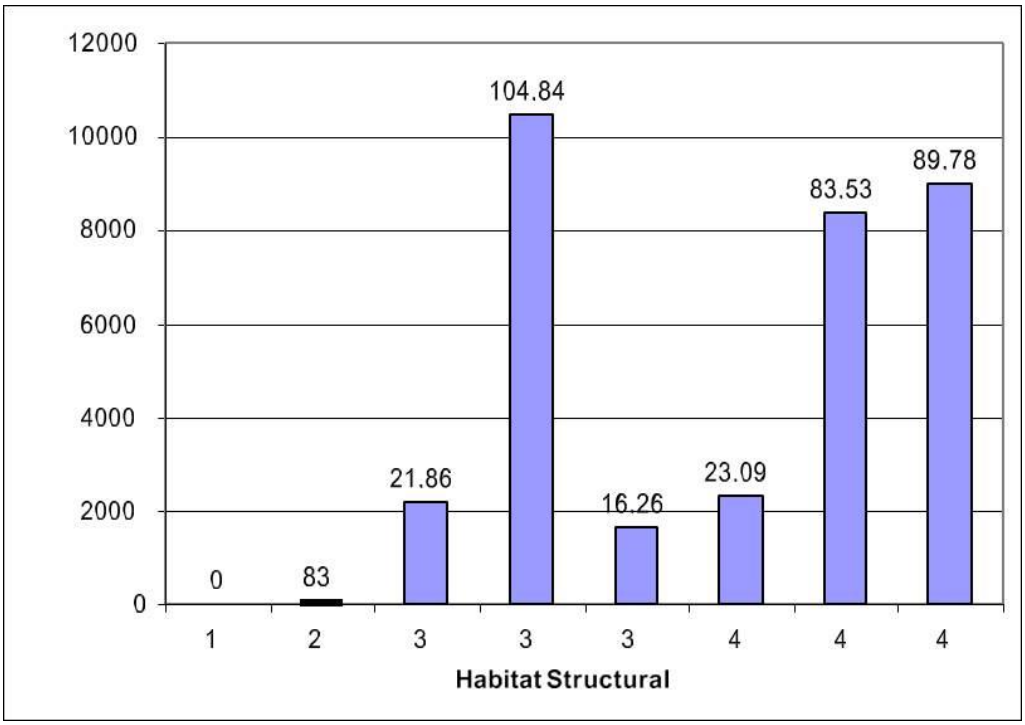

Figure 29. Habitat Structural Stage distribution of forest and woodland cover types, North Fork Valley Geographic Area.

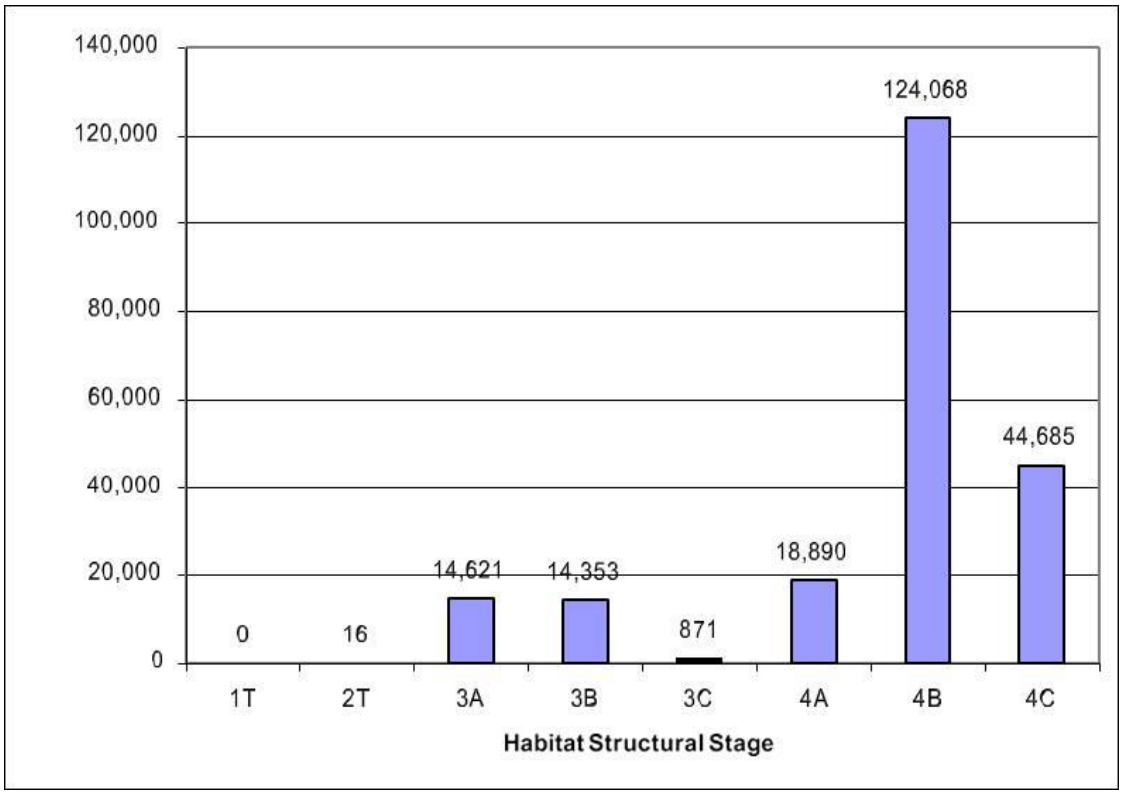

Figure 30. Habitat Structural Stage distribution of forest and woodland cover types, San Juans Geographic Area.

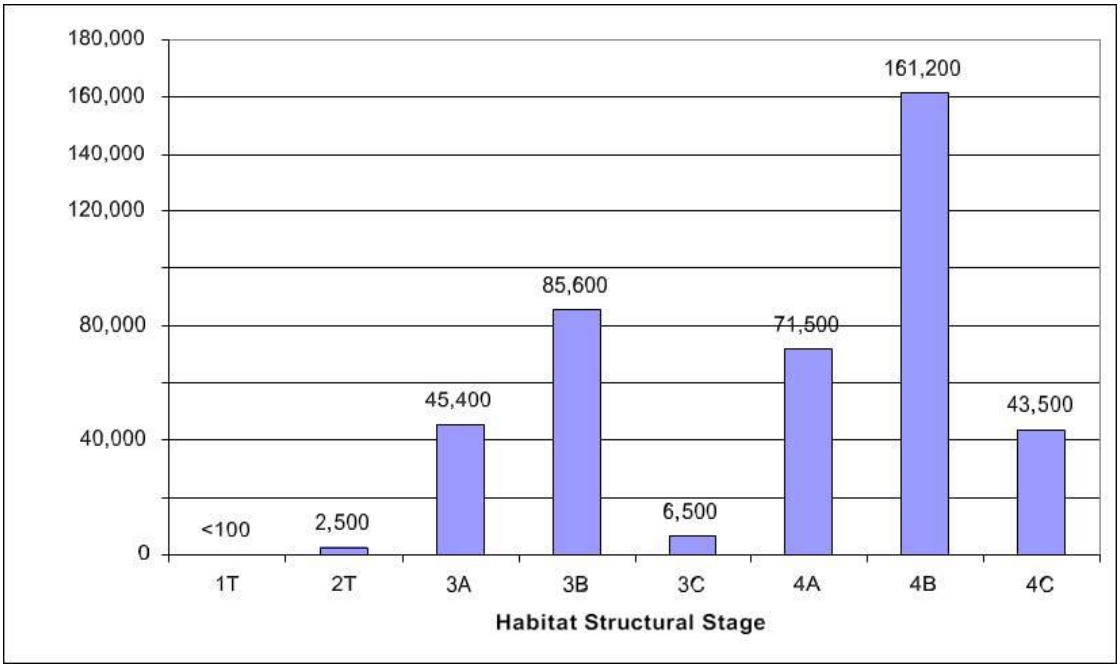

Figure 31. Habitat Structural Stage distribution of forest and woodland cover types Uncompahgre geographic area.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

There would be no additional vegetation treatments to address safety, recovery or resiliency objectives from the No Action Alternative. Currently authorized activities and other reasonably foreseeable related actions would continue to occur.

Dense spruce stands would likely continue to be affected by spruce beetles. The spruce stands with higher densities are generally at higher risk, and this risk would continue in the No Action alternative. Due to the unprecedented nature of the current attack, all stands have the potential to succumb to mortality. The spruce beetle attack would likely continue due to the population that currently exists. The numbers of beetles are high enough that they will likely perpetuate the current attack until the spruce tree that they use for habitat is no longer available.

Over time, standing trees would fall to the ground. Large amounts of downed trees would cover soils. Natural regeneration may be less predictable in the absence of bare mineral soils; such soils provide a seedbed and germination. Increased fuel loading may lead to increased fire hazard. If a fire were to occur, live spruce trees that are not affected may be susceptible to mortality from fire, as spruce is a fire sensitive species (Uchtyil 1991). Canopy cover would continue to decrease as both aspen and spruce trees die.

The number of dead trees would continue to increase in the short term. Over time, snags would fall to the ground and downed woody debris would increase. Windthrow risk may increase as stand structures change and individual trees become less windfirm. Species composition may shift as natural succession occurs. Engelmann spruce is considered a climax species in sub-alpine forests of this region (Uchytil 1991).

Natural succession processes in spruce dominated stands may result in colonization of the site by other tree or shrub species that are present. Shade intolerant species are likely to increase due to loss of mature trees. Over time, stands in high mortality areas would begin the stand initiation phase, provided adequate seedling establishment. Over time, there would be an overall increase in age class diversity across the affected landscape. Spruce fir stands with a significant component of fir may have a greater composition of fir over the long term (Schmid and Frye 1974).

Aspen forest types can be either early seral or stable aspen communities. Seral aspen communities often have a significant component of conifers present, suggesting that conifers will eventually overtake the aspen and the stand type will become conifer dominated. Stable aspen communities may have occasional conifers present, but the aspen community will persist over time (Debyle and Winokur 1986). Under the No Action alternative, SAD-affected stands that continue to decline in previously stable aspen communities could be replaced by other vegetation, including shrubs, and conifer would likely succeed and dominate the formerly mid-seral aspen stands.

Alternative 1 – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no change to silviculture would result from the implementation of the No Action Alternative. The direct and indirect effects of past, ongoing, and future activities could result in cumulative effects to silviculture that are similar to those identified in the cumulative effects for the action alternatives, albeit to a lesser extent. Very few other reasonably foreseeable timber activities are planned. Current and future vegetation management activities authorized by other decisions and that are reasonably likely to occur are noted in Chapter 3, Cumulative Impacts – Actions Considered & Analysis Approach.

Activities Common to Both Action Alternatives

Design Features

Design features would be incorporated into the implementation of the action alternatives as a means to comply with applicable laws, regulation, policy and other guidance. Silviculture design features are noted in Table 174. Design features for silviculture are intended to: enhance and increase effects to the vegetation resource and consider the long term productivity and maintenance of the forest; recover a live tree component in stands heavily affected by spruce beetle and SAD; and keep forest areas forested in the near future as well as through time.

Table 174. Design Features Related to Silviculture

Number	Design Feature	Citation
SV-1	All regeneration cutting will meet stocking standards as defined in the Forest Plan.	1991 Forest Plan
SV-2	All vegetation treatments, including prescribed fire, will be prescribed by a U.S. Forest Service, Region 2, Certified Silviculturist in accordance with applicable guidance from other resource specialists.	FSH 2409.17 Silvicultural Practices Handbook
SV-3	To the greatest degree practicable given site fuels conditions, jackpot and pile burning would be used as acceptable methods to assist with natural regeneration strategies. Burning could be prescribed to create mineral soil seedbeds for natural regeneration. Harvested areas would be evaluated for stocking.	R-2 FSH 2409.17 Silvicultural Practices Handbook

Number	Design Feature	Citation
SV-4	During site preparation or piling activities, mineral soil exposure will be less than 40% of these treated areas. Soil cover should be retained when practicable. To assist natural regeneration, conduct vegetation and fuels management activities to average 20 - 40% mineral soil exposure in post-harvest, as prescribed in the stand management prescription. On south slopes, mineral soil exposure would be less so that site moisture can better be retained If the area has been identified as being high risk for invasive plants, or is known to have existing infestations, reduce soil exposure and consider artificial regeneration practices (planting).	Alexander 1987
SV-5	In order to reduce the risk of spruce beetles being drawn to uninfected trees, in stands with a component of live spruce which are not beetle-infected, felled spruce shall be removed from the sale area by no later than October 31 of the year following felling. Unutilized spruce material (in excess of the 10-20 tons/acre required by the Forest Plan) that is cut during operations and greater than 6" diameter at the small end could be removed from the stand and taken to the landing. This will be considered yarding of un-merchantable material (YUM). When removal of non-merchantable material (YUM) is operationally infeasible, material would be debarked in stands, chipped or otherwise treated within the stand to reduce the likelihood of the material being utilized as brood material. Treatment of non-merchantable material will be prescribed by a certified silviculturist, with the overall goal to reduce brood material.	Professional judgment of Forest silviculturists and Forest Health Protection Staff.
SV-6	During any types of harvest in spruce-fir, pockets or areas of advanced regeneration will be avoided to the greatest degree practicable to protect advanced regeneration.	Southern Rockies Lynx Amendment, Professional judgment and standard operating procedure.
SV-7	Broadcast burning for regeneration of spruce-fir stands should be limited to salvage operations in single-story stands with almost total spruce mortality; such stands have limited/no advanced regeneration. Targets for broadcast burning for regeneration in salvage-harvested, single-story spruce-fir stands would be creating patches of exposed mineral soil in up to 40% of the area to allow for spruce seed establishment mixed with some large residual material to provide shade to seedlings and seed sources within 300 feet of a majority of the unit. If the area has been identified as being high risk for invasive plants, or is known to have existing infestations, reduce bare mineral soil exposure and consider artificial regeneration practices (planting).	Professional judgment of Forest silviculturists, Fire Effects Information System, Kilgore and Curtis 1987.
SV-8	In stands managed for aspen regeneration: a. Treatment units > 20 acres are preferred, to lessen effects of big game and livestock browsing. Treatments may exceed 40 acres. b. Minimize soil compaction by heavy equipment and haul trucks. c. Confine aspen treatments to suitable soils as much as possible. d. Use clear-felling (with fire as appropriate) to regenerate aspen stands for increased landscape resilience. e. Choose timing of treatments, appropriate to recent extreme weather events.	Johnston 2001, Worrall 2013, Worrall et al. 2013

Direct and Indirect Effects Common to Both Action Alternatives

The following analysis is based upon professional knowledge and the best available science. As the main difference between the alternatives is the spatial area that they could occur, a comparison of Priority Treatment Areas, hazard tree treatments, and new roads that are outside PTAs (all three activities together will be referred to as "potential affected areas") will be a proxy for magnitude of impacts.

Treatment types have been identified along with estimated acres associated with each action in each PTA. Based on the current stand conditions and the alternative, we expect that 7-15 percent of treatments will be salvage, 47-49 percent will be variable retention regeneration (combination), and 38-44 percent will be resiliency treatments in spruce. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage. This latter scenario is also analyzed and is referred to as "adapted treatment type".

Hazard Tree Removal

Depending on the level of mortality in an area, there may be a few individual trees removed where there are small amounts of affected trees. For areas where the removal is incidental, there will not be a measurable change to basal area or canopy cover, nor will the overall density of the stand change a measurable amount.

In areas where there is significant mortality, a substantial amount of trees could be removed. These areas would have significant changes to the following: basal area (reduced residual stocking), canopy cover, and stand density. However, overall, the effects of hazard tree removal along roads will have limited to no impact to species composition, structural stage, or seral stage at the LAU, Geographic Area, or Forest scale due to the limited scale to which hazard tree removal will occur.

Non-commercial Treatments

The effects of this type of treatment are discussed in more depth in the fuels section.

Prolific aspen regeneration results from application of fire, as there is a complex hormonal control that exists in aspen, making it almost 'fire dependent' on some sites (Howard 1996). Aspen can also regenerate without fire, and this is entirely dependent on aspen genetics as well as site. The effects of fire burning through heavy fuels on aspen clone roots is not well documented in the literature, but it is suspected that aspen clone roots are generally insulated enough by soil to survive and sucker in fuel loadings as high as light slash.

In clones where fire is prescriptively applied, the anticipated effect of broadcast burning is consumption of surface fuels and mortality of any remaining aspen stems and stems of non-fire-adapted species. This would then result in a flush of new aspen growth, suckering and other stand responses that are desirable and that would perpetuate the clone for a long period into the future. This would also result in a reduction of shade-tolerant, non-fire adapted species in the stand. The effects would trend the landscape towards a desired shift in habitat structural stages and seral stages as well as provide a net benefit to aspen in the immediate and through time.

If stands were burned where some spruce were present, it is likely they would be eliminated from the stand. Spruce is not a fire-adapted species. Spruce is very fire sensitive and is generally killed even by low-intensity fires. Post-fire reestablishment is via wind-dispersed seeds which readily germinate on fire prepared seedbeds (Uchytil 1991). Broadcast burning may also reduce natural spruce regeneration success, depending on the timing and intensity of the fire prescription. For these reasons, design feature SV-7 limits the use of broadcast burning in spruce to salvage operations in single-story stands with almost total spruce mortality; such stands have limited/no advanced regeneration, and the intent of the burn would be to prepare sites for replanting. The effects of broadcast burning some residual slash from spruce salvage in stands where aspen is present or one of the most dominant species, would likely result in some mortality of any still-living aspen stems and prolific suckering of aspen, except under areas of very high slash fuels or slash piles.

Prescription Effects for Indicator Measures

This section outlines the effects of the prescriptions from Appendix A, Silvicultural Prescription Matrix.

The effects analysis of the indictor measures addresses from Lowest to Highest how the indicators change across the spruce fir structural stand conditions. This is how the indicators are ranked:

1. Lowest
2. Lower
3. Low
4. Moderate
5. High
6. Highest

This ranking system defines the spatial complexity of the stands in terms of categorizing the various indicator measures; the spatial complexity of stands is then factored into the larger landscape. Since the spruce beetle epidemic is landscape level and considered ‘catastrophic’ the amount of stands that have moderate to high complexity post treatment will be limited.

Table 175 outlines how the indicator measures compare to each other by stand conditions and prescription across those described in the matrix, Appendix A. In general, multiple canopy layers have the highest complexity on a stand level, with the indicators changing by prescription from highest to lowest. The complexity decreases as the amount of tree cover removed by the prescription increases. Two-storied stands are less complex, with fewer canopy layers, than multiple storied stands, and so the indicator measures change appropriately based on the lower complexity. Single-storied stands are least complex, and so have the lowest overall diversity of the indicator measures.

Table 175. Spruce Prescriptions and Anticipated Effects by Indicator Measure.

Spruce fir structural stand condition	Indicator	Resiliency	Recovery and Resiliency	Recovery
Single storied	Age class	Moderate	Lowest	Lowest
Single storied	Species composition	Moderate	Moderate - Low	Moderate
Single storied	Vertical structure	Lower	Lowest	Lowest
Single storied	Horizontal strucutre	Lower	Lowest	Lowest
Two storied	Age class	Moderate	Moderate-Low	Lowest
Two storied	Species composition	Moderate	Moderate	Moderate
Two storied	Vertical structure	Moderate	Moderate-Low	Lowest
Two storied	Horizontal structure	Moderate	Moderate-Low	Lowest
Multiple canopy layers	Age class	Highest	High-Moderate	Moderate
Multiple canopy layers	Species composition	Highest	Moderate	Low-Moderate
Multiple canopy layers	Vertical structure	Highest	Moderate	Moderate
Multiple canopy layers	Horizontal structure	Highest	High-Moderate	Low

The indicator measures are in context of group selection, matrix and clearcutting that could be applied. The type of treatment as well as amount of acres treated will vary based on the existing condition. When considering the indicator measures at a stand and landscape level, various types of patterns emerge. These patterns are influenced by the scale, size and distribution of disturbance patterns.

Oliver and Larson (1996) capture patterns of species and dominance by categorizing forests by these general terms:

1. *Stand initiation stage.* After a disturbance, new individuals and species continue to appear for several years.
2. *Stem exclusion stage.* After several years, new individuals do not appear and some of the existing ones die. The surviving ones grow larger and express differences in height and diameter; first one species and then another may appear to dominate the stand.
3. *Understory reinitiation stage.* Later, forest floor herbs and shrubs and advance regeneration appear and survive in the understory, although

they grow very little.

4. *Old growth stage*. Much later, overstory trees die in an irregular fashion, and some of the understory trees begin growing into the overstory.

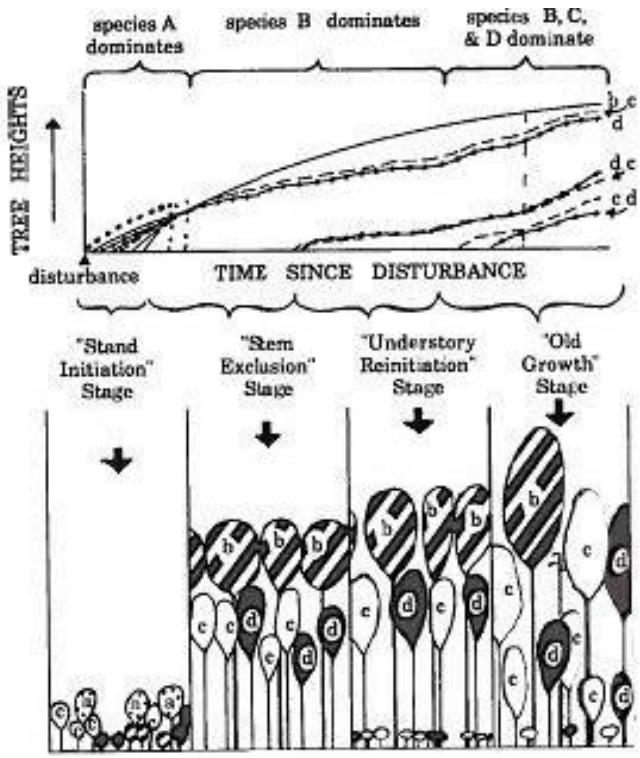

Figure 32. Schematic stages of stand development following major disturbances (Oliver and Larson, 1996).

Using Oliver and Larson's (1996) stages of stand development following major disturbances, Table 176 categorizes the stand structural stages post treatment that would be possible under the various prescriptions from Appendix A, Silvicultural Prescription Matrix. Stand type defines the structural complexity, with single storied stands having the lowest complexity pre-treatment. Post-treatment, the stand complexity remains lowest. Two-storied stands have higher structural complexity, but these areas are still unable to support the 'old growth' stage as defined by Oliver and Larson (1996) due to a lack of structural complexity.

Table 176. Categorization of Stand Structural Stages, Post Treatment, Based on Oliver and Larson (1996).

Spruce fir structural stand condition	Prescription type	Resiliency	Recovery and Resiliency	Recovery
Single storied	Group selection	Understory re-initiation	Stand initiation	Stand initiation
Single storied	Matrix	Understory re-initation	Stand initiation; understory re-initation	Stand initiation
Two storied	Group selection	Understory re-initiation	Stand initiation	Stand initiation
Two storied	Matrix	Understory re-initiation; stem exclusion	Stand initiation; understory re-initiation	Stand initiation
Multiple canopy layers	Group selection	Understory re-initiation	Understory re-initiation	Understory re-initiation; stem
Multiple canopy layers	Matrix	Old growth; understory re-initiation; stem	Understory re-initiation; stem	Understory re-initiation; Stem

The existing condition of the stands before beetle attack has a significant influence on the different stages of development that can exist post-treatment. Single-storied stands, for example, started with less complex vertical and horizontal structure, and post-treatment would remain low.

Timber Harvesting and Regeneration

The most significant impact from harvesting activities is the large open areas that will be created. These openings will average 60 to 90 acres in size, but could be as large 300 acres in some cases. Openings of this size will increase the site exposure to sun and wind and has the potential to alter the dynamics of the snow pack (accumulation, scouring, transpiration, spring melting) to varying degrees. All of these influences combined will affect the ability of forest vegetation to establish and grow. In particular, spruce seedling establishment and survival will be inhibited in open, full sunlight sites, especially if snow scouring has removed some of the site moisture that would otherwise be available. Past experience with regenerating large spruce clearcuts has proven difficult in certain cases (Jacobs, 2004; Ronco, 1970; Schmid & Hinds, 1974; Shepperd et al, 1981).

Due to these concerns, harvest treatments will be designed to maximize the survival rate of tree seedlings by locating units on north to east facing slopes where feasible, and protecting advanced regeneration from logging damage as much as possible. Additionally, mature tree retention pockets will be marked in each cutting unit with a target of retaining at least 3 to 10 percent of the overstory trees on site in salvage units. These pockets will be centered in locations with high quality tree regeneration to help protect these seedlings and saplings from logging damage.

Depending upon the density of existing pre-harvest tree regeneration within the stand, a certain amount of sites will require tree planting to meet agency stocking standards (360 TPA). On sites where alternative species other than spruce are present, natural regeneration may be possible, however it is expected that most mature spruce trees would no longer be a seed source due to mortality. Discussions of the estimated land area in need of planting for each alternative are provided in the corresponding sections below.

Proper tree planting practices will be used to minimize seedling mortality. The use of tree shelters for planting large spruce clearcuts has shown to result in 88 percent seedling survival rate, measured six years after planting (Jacobs, 2004). Furthermore, the use of high quality containerized seedlings produced by modern nursery practices can significantly increase survival rates.

To estimate the proportion of the cutting units that will need tree planting, common stand exam data was used where it was available for stands proposed for treatment. Alexander observed that clearcutting in spruce stands with pre-harvest seedling and sapling density of 600 trees per acre or greater of non-cull trees would result in an acceptable post-harvest level of stocking of 300 trees per acre (Alexander, 1987). This density was applied as a threshold to identify stands that would likely not require tree planting to meet stocking standards after treatment. Additionally, stands where measured inventory plots showed a greater than 10 percent aspen component were assumed to meet post-harvest stocking standards due to the prolific coppice (sprouting) response of aspen. Tree species and stocking levels of planting will be based on stand biophysical attributes. It is estimated that planting will occur on 1700 acres a year in the Gunnison Basin and 750 acres a year outside the Gunnison Basin.

Spruce-Fir Prescriptions

Under the action alternatives, the effects to the indicator measures for spruce are anticipated to have the following effects, by prescription type. Objectives for each type of treatment are identified in Appendix A, Silviculture Prescription Matrix. The effects to the indicators are based on meeting the identified objectives for each prescription type.

Age Class would vary by treatment method across the stand. In the short-term time frame, areas that are group selected would be in the understory re-initiation phase (Oliver and Larson 1996). In the long term time frame, the group selection areas would transition to the sapling and pole stage, with the oldest trees in group selection areas being approximately 20 years old. Group selection areas would be re-forested as required by the 1991 Forest Plan, to appropriate stocking standards. For the group selection treatment type within the short term time frame, trees would be seedlings. In the long term time frame, they would transition to older trees, but would not exceed 20 years of age. Matrix areas that are outside of the group selection areas, but within the larger stand treatment boundary would have small areas that could be in the stand initiation

phase in the short term timeframe. This would occur only if natural regeneration resulted, as matrix thinning would not reduce stocking below 40 percent of present stocking, and so would not require planting. Matrix areas would generally have trees that are in the sapling, pole and sawlog size classes. The matrix areas would have higher age class diversity than group selection areas. Places not affected by spruce beetle may have high age class diversity, with the stem exclusion, understory reinitiation, and old growth stages present. These types of stands would be restricted to areas that have generally not seen spruce beetle activity and would be extremely limited on the landscape due to the magnitude of the current outbreak.

The group selection and matrix areas combined in the larger stand would exhibit the highest level of age class diversity under the resiliency prescription than under recovery and resiliency (combination) or recovery prescriptions. This is because the existing stand, pre-treatment, has had the least overall negative effects from the spruce beetle epidemic; stand level mortality is less pre-treatment than in other scenarios, which provides for greater age class diversity in the short term and long term time frame.

Variable retention regeneration treatments would occur during resiliency/recovery (combination) and recovery treatments. Stands treated with these treatments are required to be certified as fully stocked within five years of harvesting either by natural regeneration or artificial regeneration (replanting). These stands will be considered openings by forest plan standards following harvest till approximately 20 years into the future.

Figure 33. Example of Variable Retention

Species Composition: Species composition is likely to be highest under the resiliency prescription, compared to the recovery and resiliency (combination), and recovery prescription. Since the resiliency prescription would be applied to stands with less than 40 percent overstory mortality, this prescription would be applied to stands that have the highest level of stand-level and local diversity.

Variable retention regeneration treatments would occur during resiliency/recovery and recovery treatments. These stands are geographically located in areas mapped as lost according to Rehfeldt et al. 2015, and therefore represent potential areas where post-treatment succession and/or replanting of more shade-intolerant species would result in increased species diversity across the landscape.

Vertical Structure: Vertical structure would be greatest under the resiliency prescription. Stands that are in a condition to have this prescription applied would have less mortality than other stands.

Multiple canopy layers would have the greatest overall amount of vertical structure, with two storied stands being next. Single storied stands would have low amounts of vertical structure. Considering all of the stands in context, those with resiliency prescriptions applied that are multiple canopy layers would have the greatest amount of vertical structure in all the treatment scenarios. This is likely the highest quality wildlife habitat that would be available across the landscape.

Horizontal Structure: Under the resiliency prescription, stands that are selected for treatment would have greater amounts of horizontal structure than under the recovery and resiliency prescription. The recovery prescription would have the least amount of horizontal structure. The resiliency prescription results in a greater amount of horizontal structure than the other prescriptions, as the stands are in a better condition pre-treatment; this, combined with the combination of group selection and matrix thinning, results in high levels of horizontal structure within the treated stand.

Aspen Prescriptions & Indicator Measures

Coppice cutting is the method of cutting that would be implemented in aspen. Broadcast burning may be utilized to increase suckering potential post treatment. Even-aged management would be implemented in aspen stands. Aspen prescriptions will incorporate recommendations outlined Shepperd 1993 and Johnston 2001. See Appendix A for further detail.

Discussion of Indicator Measures (Aspen)

Age Class: Coppice cuts would remove all the trees, which would create a new age class of trees. In the short-term time frame, areas that are harvested would be in the stand initiation

phase. In the long-term time frame, the harvested areas would transition to the sapling and pole stage, with the oldest tress being approximately 20 years old.

***Species Composition*:** The harvested areas would likely remain as aspen, as they are a clonal species and as such would re-sprout. In areas where the clone is weakened and severely affected by SAD, a different species may colonize the area and would likely be conifer rather than deciduous tree. There is a possibility that species other than conifers could colonize the site if the aspen clone was already beyond the threshold for successful regeneration through treatment (>50% overstory mortality). Wetter areas may see riparian species colonize.

Vertical Structure: Vertical structure would be very low in the short-term time frame, and would increase gradually over the long-term time frame. Even-aged management would remove the standing trees, which would result in virtually no vertical structure within the treated areas.

Over time, these trees would regrow and vertical structure would increase.

Horizontal Structure: In the short-term time frame, horizontal structure within the treated stand would be low, and would remain somewhat low during the long-term time frame.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

Under Alternative 2, resiliency treatments would effectively reduce the amount of standing live trees by use of group selection. Areas that are group selection harvested would then be regenerated and a new cohort of seedlings would be established. Group selection areas would be less than two (2) acres in size. Recovery treatments would remove trees that have been killed or will die within a very short timeframe. This would lead to fewer numbers of standing snags across the landscape, with fewer left in the treated units. Across the landscape there would a significant amount of snags remaining due to the fact that such a small portion of the affected landscape would be treated. There would be a reduction to downed woody debris in the immediate and over the longer term in the treated stands that are either aspen or spruce. The reduced amount of downed wood in the treated stands would likely lead to greater establishment of natural regeneration, provided seeds existed on site.

Dense stands would likely continue to be affected by spruce beetles. Alternative 2 resiliency treatments may change this trajectory, however, due to the current population of spruce beetles it is unknown as to how significant the change could be. Bark beetle activity is not generally curtailed until the population entirely exhausts available live trees. Treated areas would be reforested as needed; this would not occur under the No Action alternative.

Recovery and resiliency treatments are intended to assist with providing the best options for a future forest, not necessarily to stop beetle activity. The epic scale of the outbreak has foreclosed

some options that existed prior to infestation. Recovery and resiliency treatments will be focused on late seral successional stages and tend to balance the landscape across all successional stages by managing the stands through the stand initiation stage into stem exclusion. Within this alternative there are approximately 72,000 acres that have been mapped as areas where species conversion could occur if recovery treatments are identified. Spruce is considered a moderate to good seed producer (Uchytil 1991). Natural regeneration strategies would be used when possible (see Silviculture Design Features). In areas that have been treated, planting desirable species could more readily be accomplished, as the site would be prepared.

Aspen treated by mechanical and/or broadcast burning would facilitate persistence of aspen where it is a stable aspen community. In seral aspen communities, the stand composition may shift to greater conifer presence. Treatment intensity has a significant effect on aspen response as aspen is a clonal species and much of the response to management varies depending on the clonal genetics, location, and other environmental factors. Under Alternative 2 there would be greater age class diversity across the landscape. Management under the Proposed Action would result in younger aspen on the landscape, which may help to perpetuate aspen into the future (Worrall 2013).

Spruce beetles would likely continue to impact spruce trees, as the population of beetles is high enough that they will continue to move into areas that have not been affected in an effort to perpetuate themselves. The resiliency treatments would break up the continuity of the available mature spruce trees, so this would assist developing age class diversity, which may curtail future activity in the relatively small areas where resiliency treatments will occur. Mature ‘old growth’ spruce may not effectively be protected as it is most susceptible to beetle attack. However, resiliency treatments may assist in recruitment of old growth due to the design of the treatment, as the overall intent is to protect some component of the current green stands, so that they can be perpetuated into the future and provide for regeneration and future forests. Recovery treatments would allow stand re-initiation which would indirectly increase the amount early and mid-seral successional stages over the next 20 to 30 years contributing to a balanced range of successional stages across the landscape.

Aspen that is treated by clearfelling would result in suckering, which would establish a new age class of trees. On a landscape scale, this would assist in creating age class diversity. Aspen clones that are not mature have less overall susceptibility to the effects of SAD, and greater resilience to disturbance events.

The effects of the alternatives will be analyzed for each of the six geographic areas.

Grand Mesa

The vegetation on the Grand Mesa GA is characterized by aspen and spruce-fir cover types; these cover types currently occupy 26 percent of the GA. Aspen is also present in 31 percent of

the spruce-fir cover type, making aspen the most common tree species on the Geographic Area. Approximately 84 percent of the forest and woodland cover types are in the mature size class. There is very little early seral condition in any cover type on the Grand Mesa Geographic Area.

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen-dominated forests to conifer-dominated forests is also occurring as a result of successional changes.

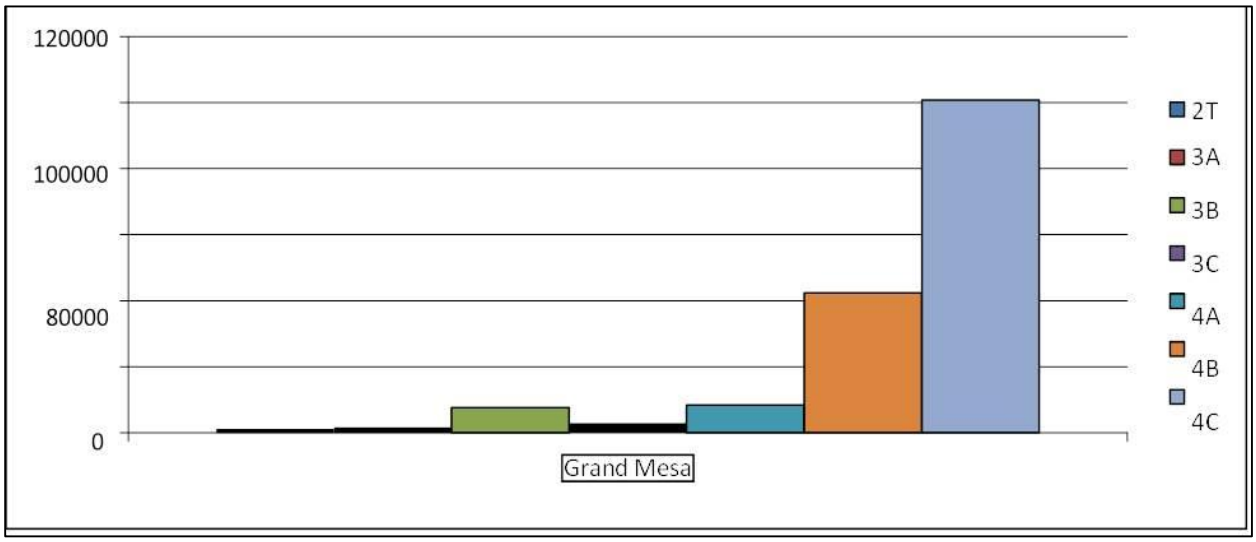

Figure 34. Summary of structural stages in the spruce-fir cover type, Grand Mesa GA.

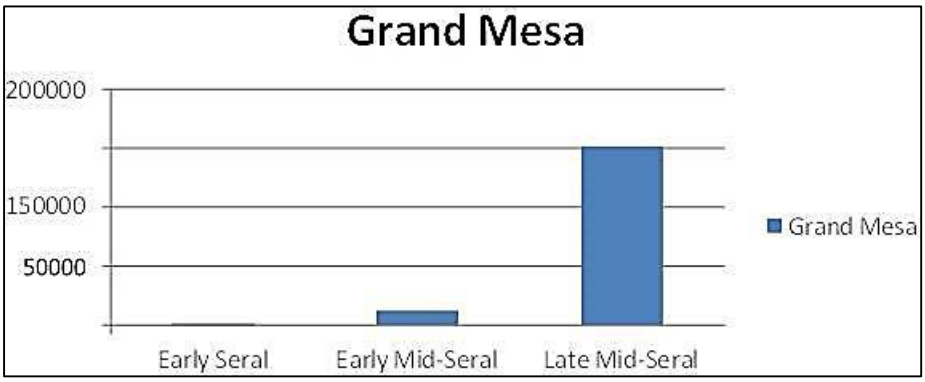

Figure 35. Summary of seral stages in the spruce-fir cover type, Grand Mesa GA.

Table 177. Summary of Commercial Treatments in Spruce-fir, Grand Mesa GA.

GA Name	Combination	Resiliency	Salvage	Total
Grand Mesa	8805	6149	485	15440

Table 178. Summary of Noncommercial Treatments in Aspen, Grand Mesa GA.

	Burn and Mechanical
Grand Mesa	9301

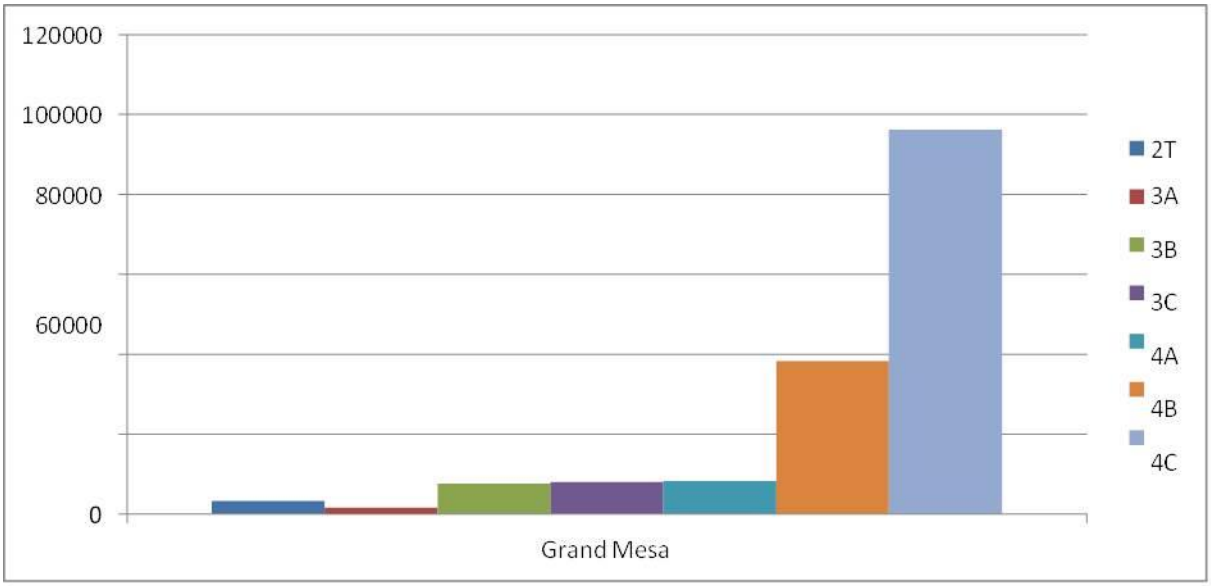

Figure 36. Effects of treatment on habitat structural stages within spruce-fir on the Grand Mesa GA.

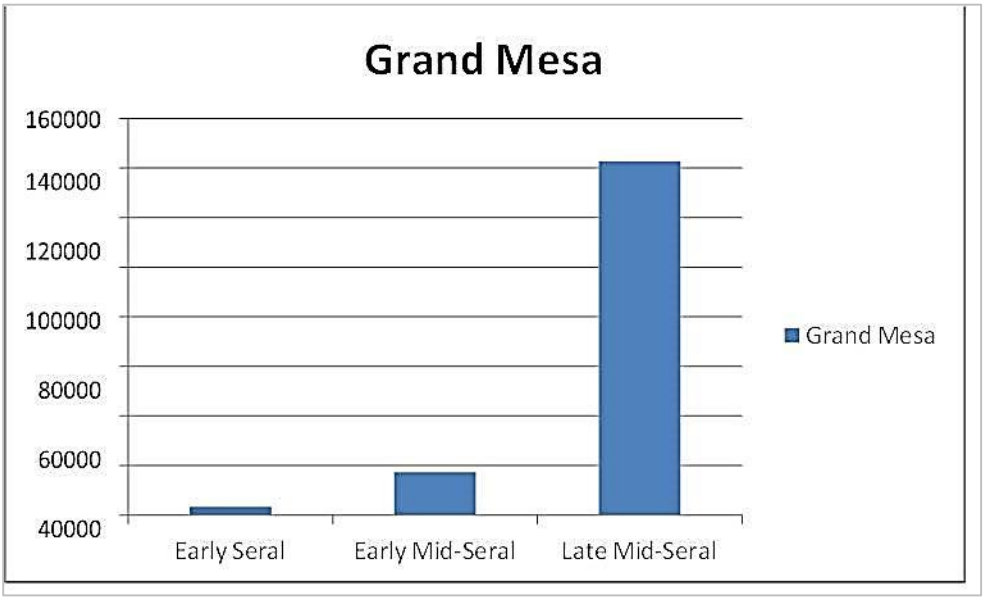

Figure 37. Shift in Seral stages in spruce-fir on the Grand Mesa GA

Table 179. Summary of Effects for Commercial Activities: Succession (Seral Stages) in Spruce-Fir PNV Type, Grand Mesa GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	1%	7%	92% (Limited age data makes it difficult to differentiate between late-mid and late	

	Early	Early-Mid	Late-Mid	Late
Post Treatment Alternative 2	2%	11%	87%	

*Kulakowski and Veblen, Draft 2004

Table 180. Summary of Effects from Non-Commercial Activities: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Grand Mesa GA

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	15%	83% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	12%	14%		74%

*Romme et al. 2003

Gunnison Basin North and South

The current vegetation within the Gunnison Basin Geographic Area can be characterized by approximately 46 percent of forest and woodland cover types in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent in mature size class (mostly in the spruce-fir cover type). As mentioned above, photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists. The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances.

Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

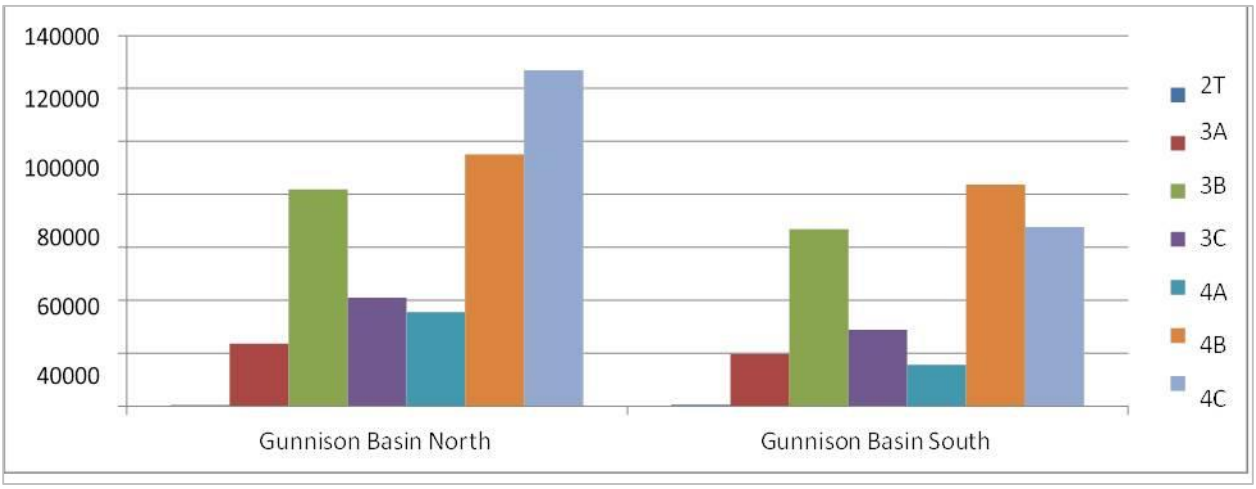

Figure 38. Summary of structural stages in the spruce-fir cover type, Gunnison Basin North & South GAs.

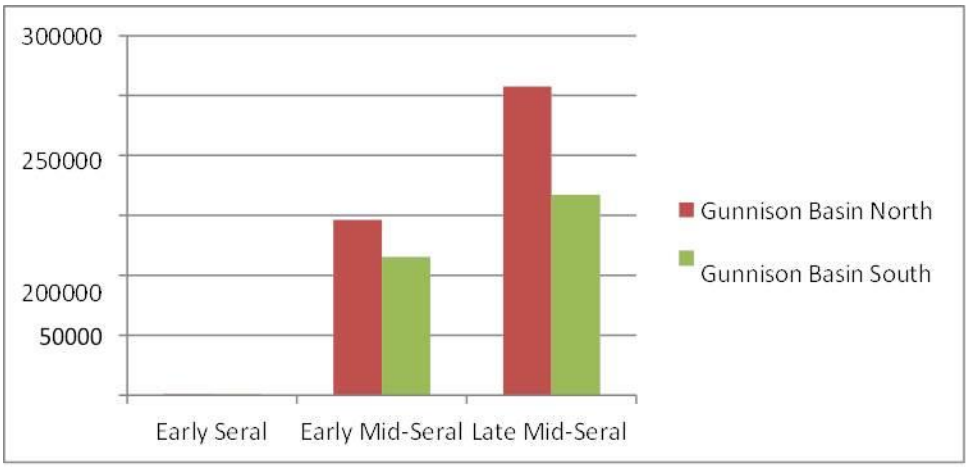

Figure 39. Summary of seral stages in the spruce-fir cover type, Gunnison Basin North & South GAs.

Table 181. Summary of Commercial Treatments in Spruce-fir, Gunnison Basin North & South GAs.

GA Name	Combination	Resiliency	Salvage	Total
Gunnison Basin North	6296	6548	1548	14391
Gunnison Basin South	10430	4254	11085	25768
Total	16725	10802	12632	40160

Table 182. Summary of Noncommercial Treatments in Aspen, Gunnison Basin North & South GAs.

	Burn and Mechanical
Gunnison Basin North	**14384**
Gunnison Basin South	**12414**
Total	**26798**

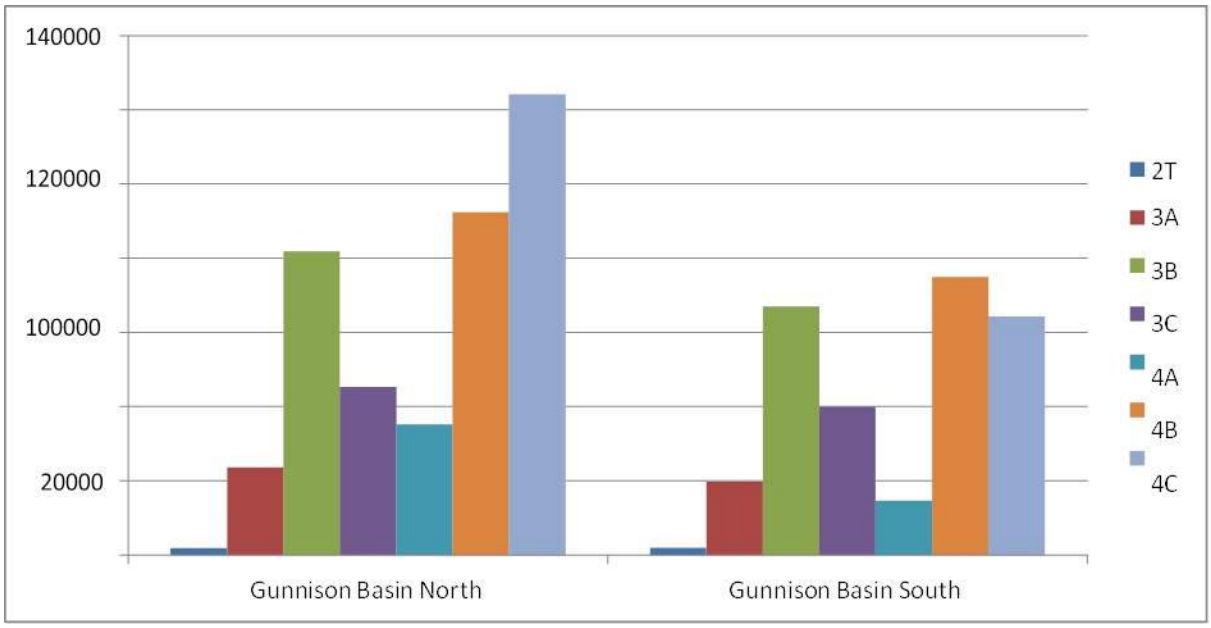

Figure 40. Shift in habitat structural stages in spruce-fir in the Gunnison North & South Geographic Areas.

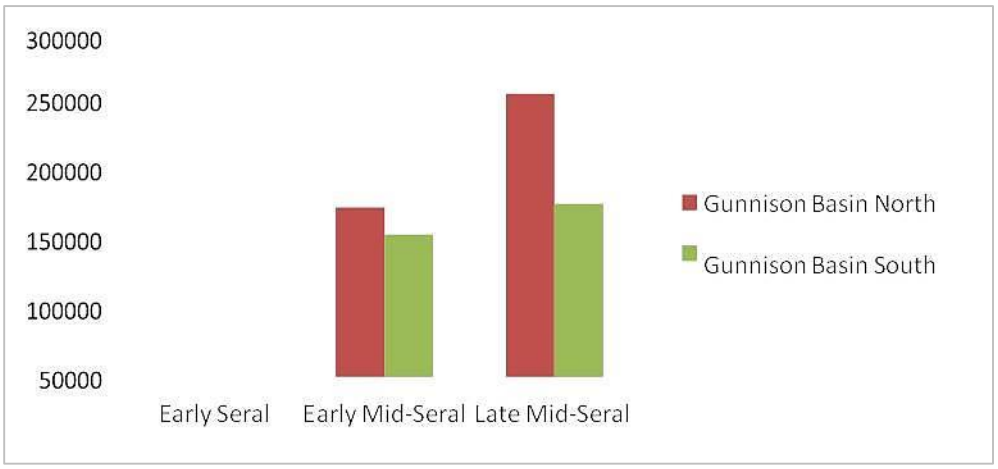

Figure 41. Shift in Seral Stages in spruce-fir for the Gunnison North & South GAs.

Table 183. Summary of Effects of Commercial Activities: Succession (Seral Stages) in Spruce-Fir PNV Type, Gunnison Basin North & South GAs.

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	31%	59% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	1%	45%	54%	

*Romme et al. 2003

Table 184. Summary of Effects for Non-Commercial Activities: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Gunnison Basin North & South GAs.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers , and occasional lodgepole pine with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and occasional lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	52%	47% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	5%	50%	45%	

*Romme et al. 2003

North Fork Valley

The vegetation in the North Fork Valley Geographic Area can be characterized as aspen being currently the dominant tree species, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area.

Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type).

The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

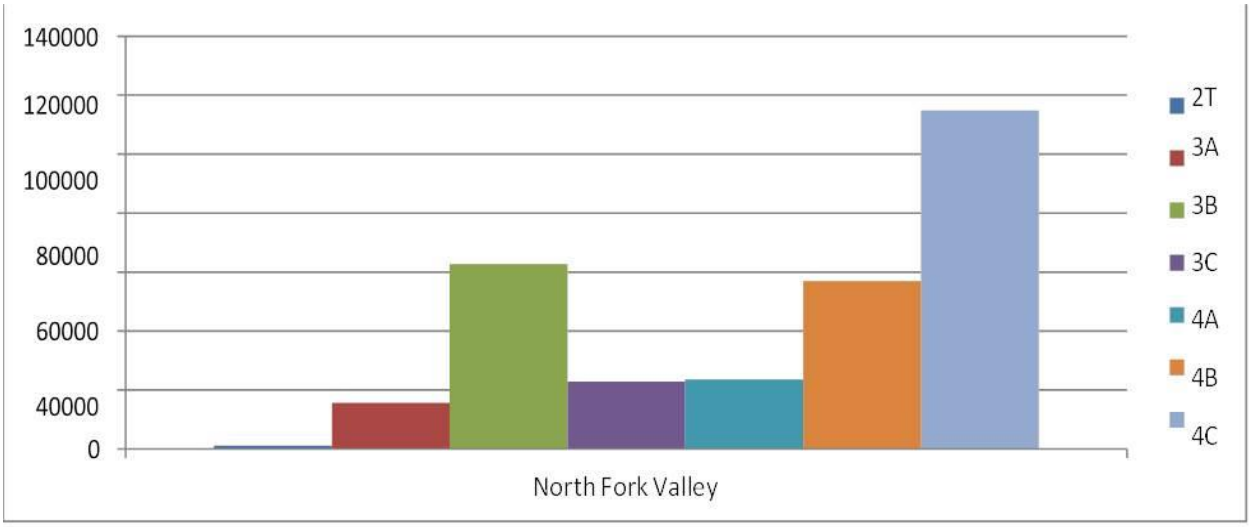

Figure 42. Summary of habitat structural stages in the spruce-fir cover type, North Fork GA.

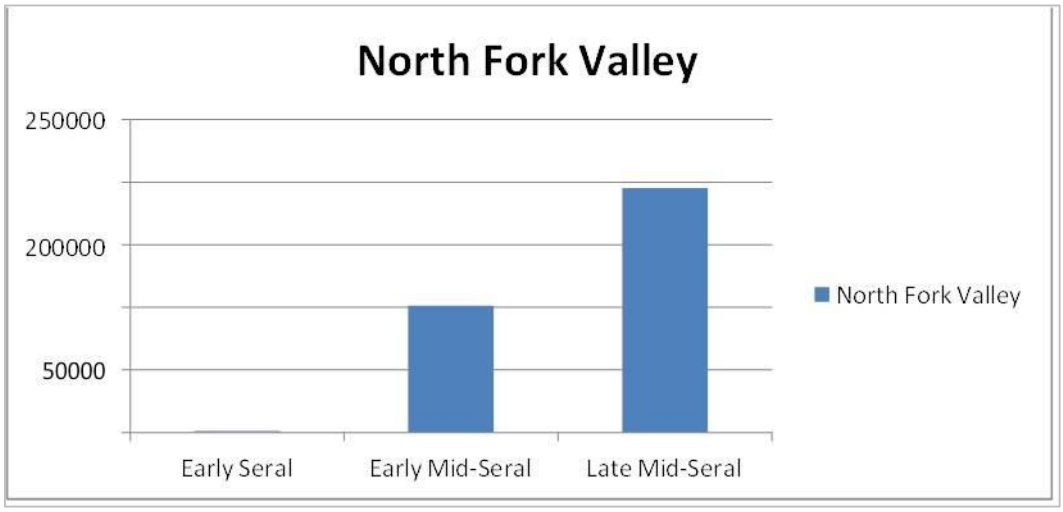

Figure 43. Summary of seral stages in the spruce-fir cover type, North Fork GA.

Table 185. Summary of Commercial Treatments in Spruce-fir, North Fork GA.

GA & LAU Name	Combination	Resiliency	Salvage	Total
North Fork Valley	**3356**	**4941**	**544**	**8842**

Table 186. Summary of Noncommercial Treatments in Aspen, North Fork GA.

	Burn and Mechanical	Mechanical Only	Total
North Fork Valley	**2340**	**198**	**2538**

The full implementation of the identified treatments would result in the following shift in habitat structural stages in spruce-fir in the North Fork Valley Geographic Area.

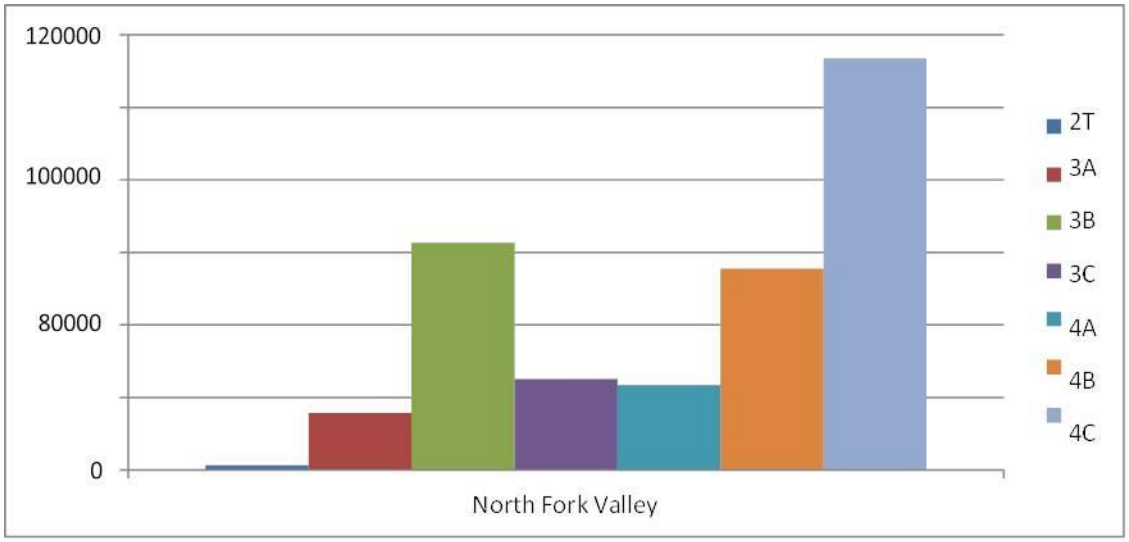

Figure 44. Shift in habitat structural stages in spruce-fir within the North Fork Valley GA.

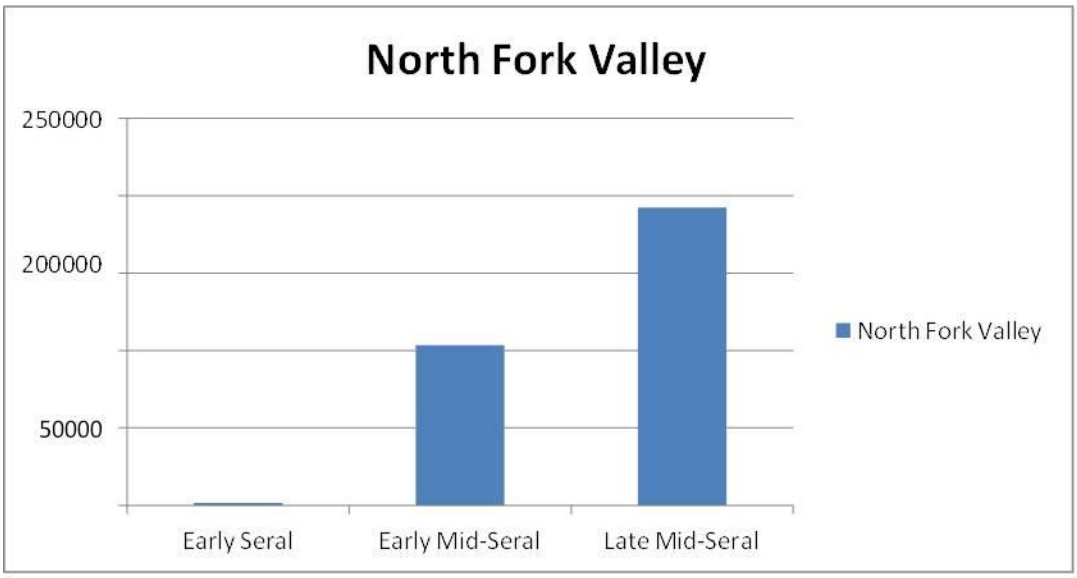

Figure 45. Shift in seral stages in spruce-fir within the North Fork Valley GA.

Table 187. Summary of the effects of Commercial Activity within the North Fork Valley GA. Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	34%	66% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	0%	35%	65%	

*Romme et al. 2003

Table 188. Summary of Effects of the Non-Commercial Activities within the North Fork Valley GA. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	54%	45% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	3%	53%	44%	

*Romme et al. 2003

San Juans

The vegetation in the San Juan Geographic Area can be summarized as having spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juan Geographic Area. The San Juan Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types. Approximately 86 percent of the forest and woodland cover types are in mature size classes. There is very little early seral condition in any cover type on the San Juan Geographic Area.

The trend across all vegetation cover types on the San Juan is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

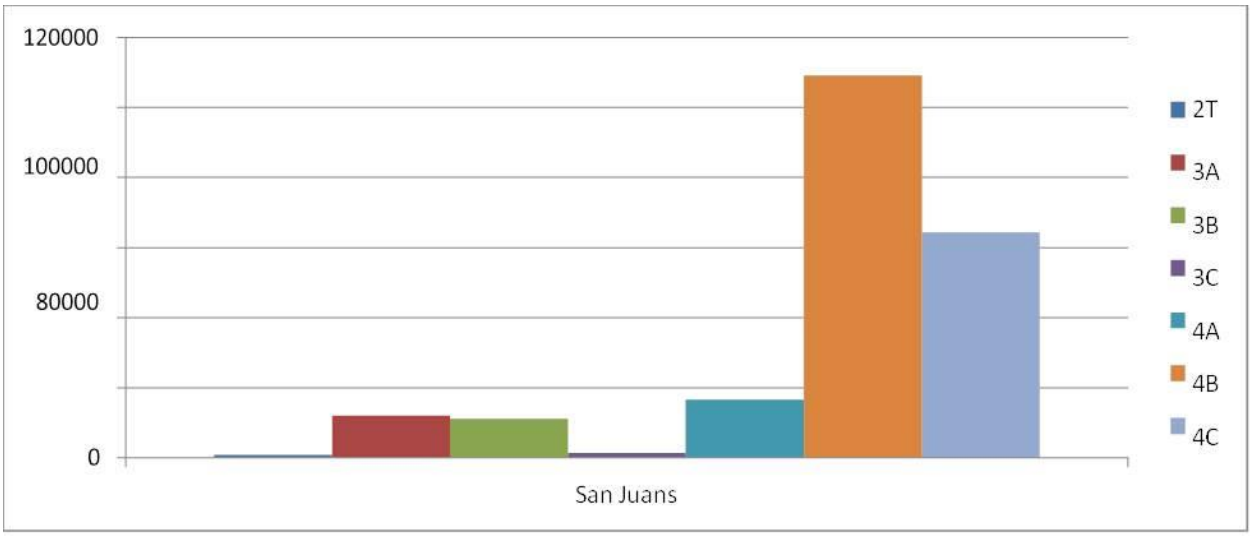

Figure 46. Summary of structural stages in the spruce-fir cover type, San Juan GA.

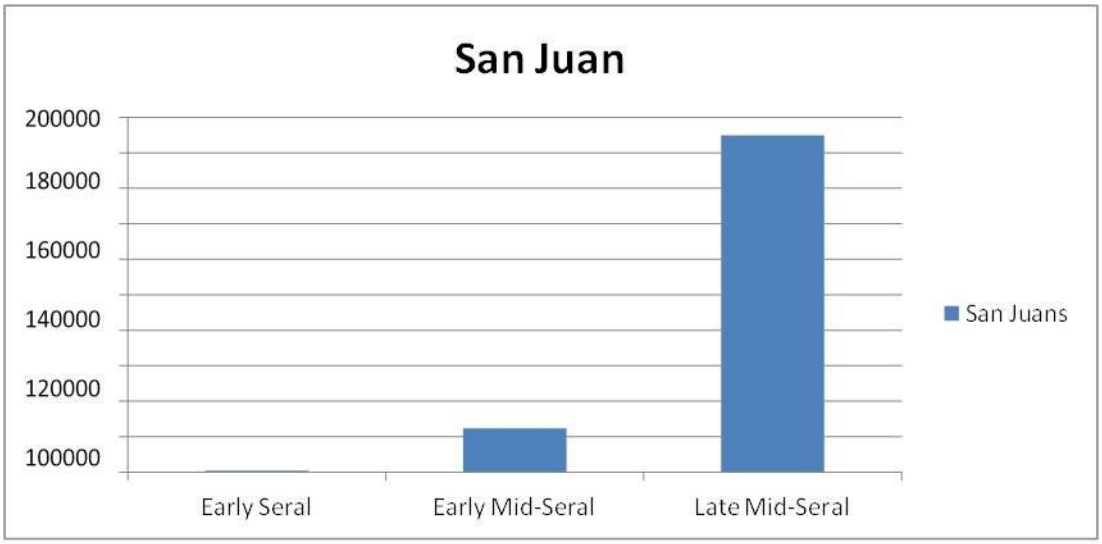

Figure 47. Summary of seral stages in the spruce-fir cover type, San Juan GA.

The following table summarizes the proposed commercial treatments in the San Juans Geographic Area that were identified during the treatment prioritization process.

Table 189. Summary of Commercial Treatments in spruce-fir, San Juan GA.

GA & LAU Name	Combination	Resiliency	Salvage	Total
San Juans	**7772**	**2590**	**1830**	**12193**

Table 190. Summary of noncommercial Treatments in aspen, San Juan GA.

	Burn and Mechanical
San Juans	379

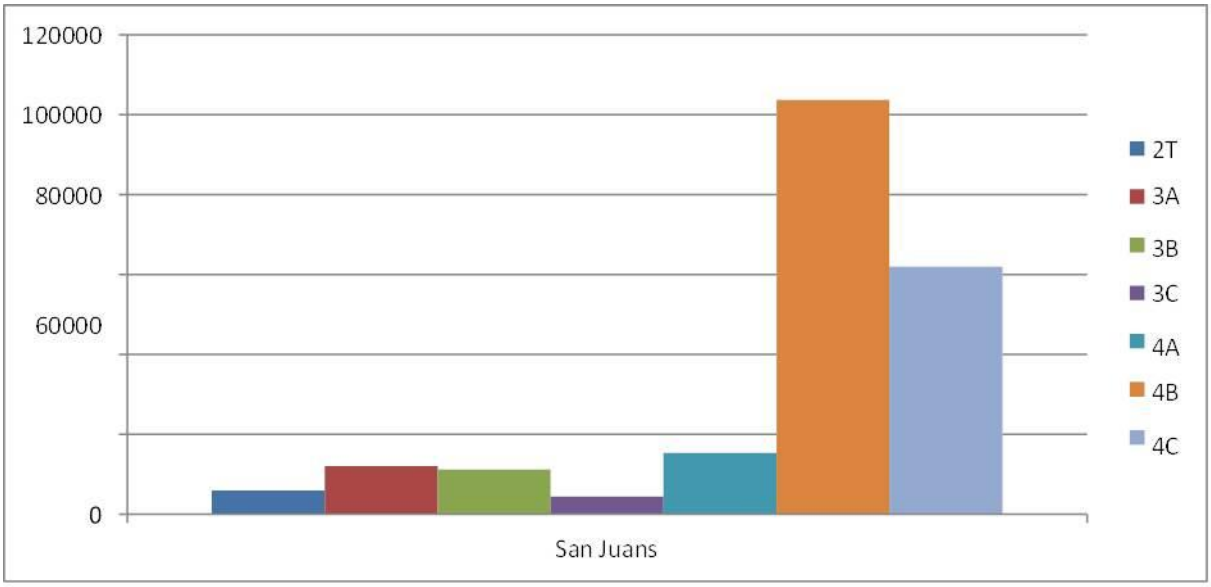

Figure 48. Shift in habitat structural stages in the spruce-fir cover type in the San Juan GA.

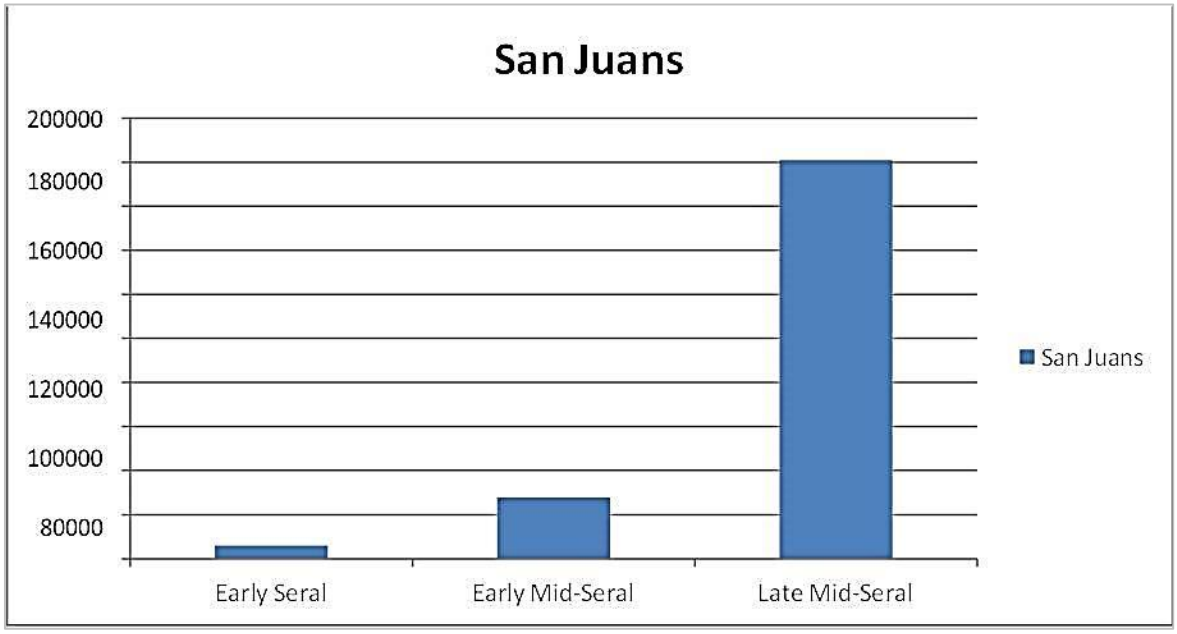

Figure 49. Shift in seral stages in the spruce-fir cover type in the San Juan GA.

Table 191. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	11%	88% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	3%	13%	84%	

*Romme et al. 2003

Table 192. Summary of Effects of Non-Commercial Activities on Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30- 50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%

	Early	Early-Mid	Late-Mid	Late
Current Seral Conditions	0%	22%	78% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	0%	22%	78%	

*Romme et al. 2003

Uncompahgre Plateau

The vegetation within the Uncompahgre Plateau Geographic Area can be characterized as a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66 percent are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).

The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands (Manier et al. Draft 2003). A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

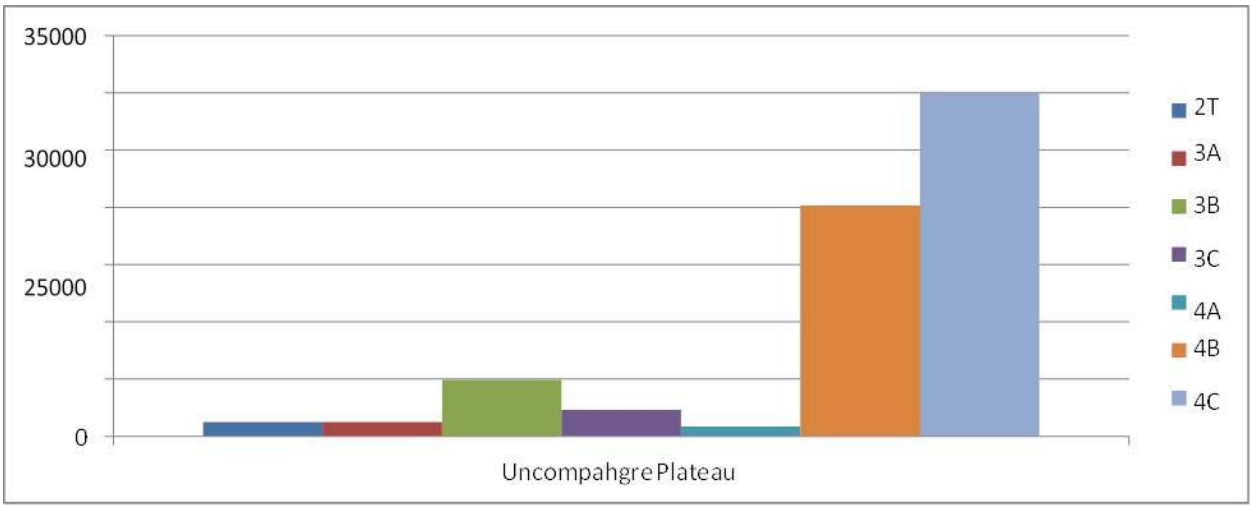

Figure 50. Summary of habitat structural stages in the spruce-fir cover type, Uncompahgre Plateau GA.

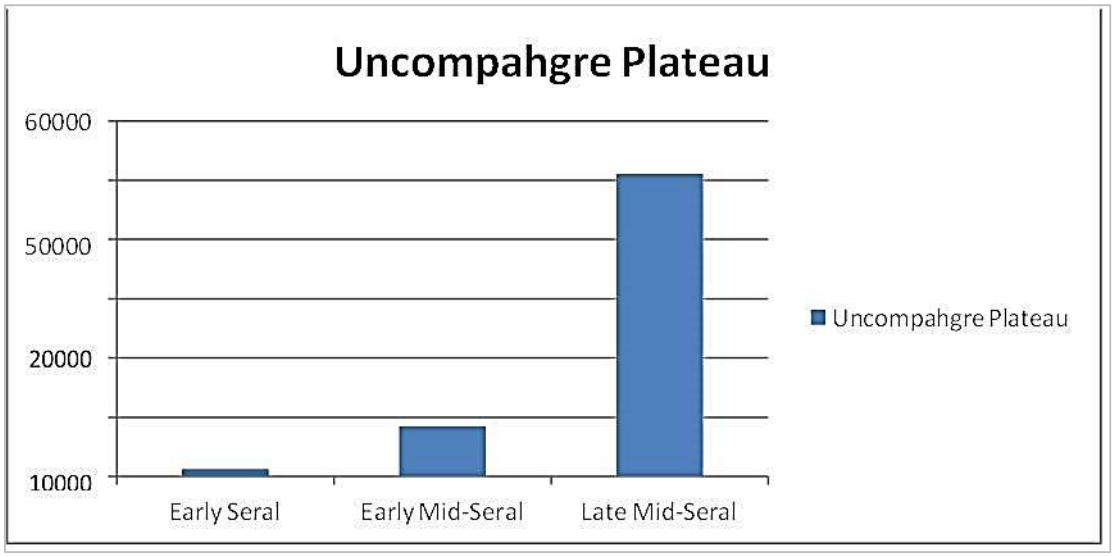

Figure 51. Summary of seral stages in the spruce-fir cover type, Uncompahgre Plateau GA.

Table 193. Summary of Commercial Treatments in Spruce-fir, Uncompahgre Plateau GA.

GA & LAU Name	Combination	Resiliency	Salvage	Total
Uncompahgre Plateau	**13673**	**14159**	**351**	**28183**

Table 194. Summary of Noncommercial Treatments in Aspen, Uncompahgre Plateau GA.

	Burn and Mechanical
Uncompahgre	**3857**

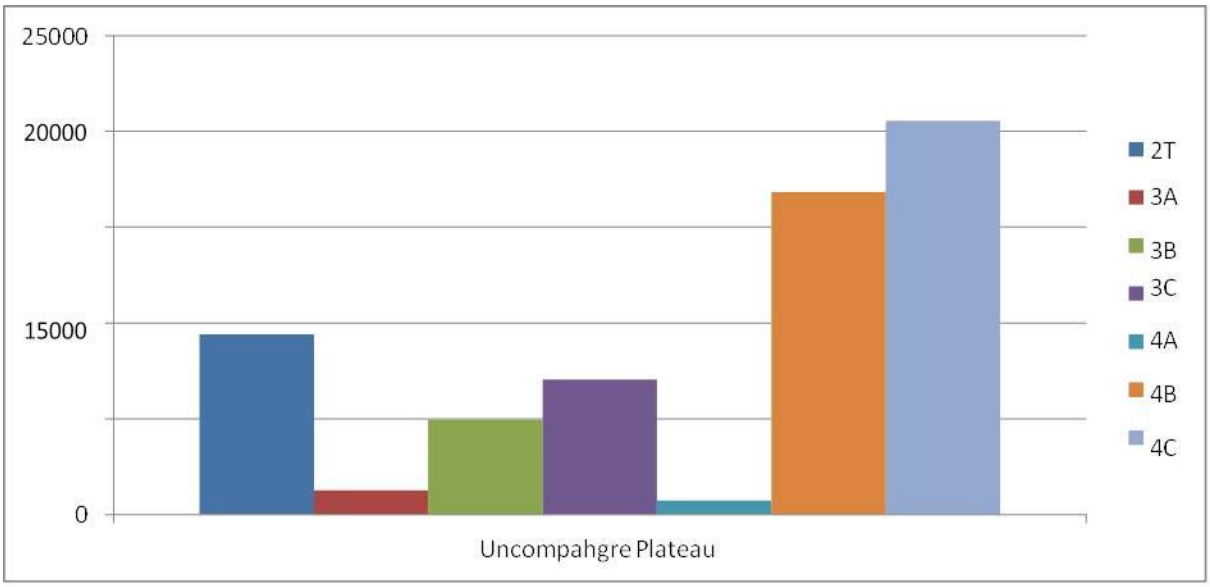

Figure 52. Shift in Habitat Structural Stages within spruce-fir in the Uncompahgre Plateau GA.

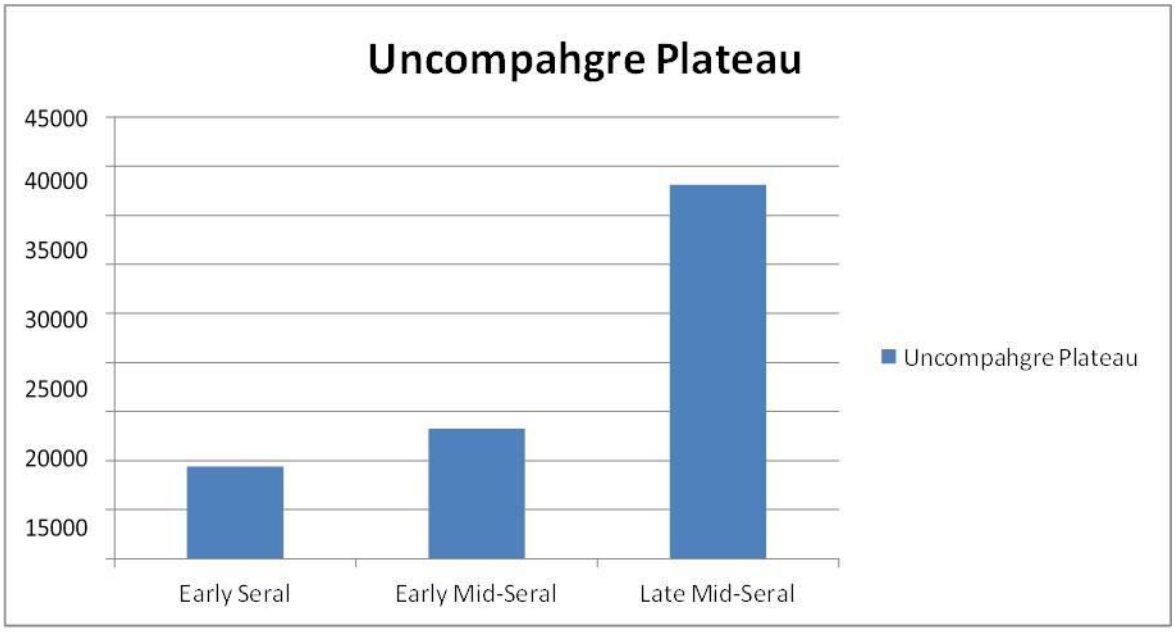

Figure 53. Shift in Seral Stages in spruce-fir in the Uncompahgre Plateau GA.

Table 195. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, Uncompahgre Plateau GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	14%	84% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	15%	22%	63%	

*Romme et al. 2003

Table 196. Summary of the effects of Non-Commercial Activity on Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type, Uncompahgre Plateau GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	1%	37%	62% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	7%	37%	57%	

*Romme et al. 2003

Summary of Alternative 2 Effects

Table 197. Effects to Seral Stage in Spruce-fir from Commercial Activities

	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	1%	2%	7%	11%	92%	87%
Gunnison Basin North	0%	0%	36%	37%	64%	62%
Gunnison Basin South	0%	1%	41%	45%	59%	54%
North Fork Valley	0%	0%	34%	35%	66%	65%
San Juans	0%	3%	11%	13%	88%	84%
Uncompahgre Plateau	2%	15%	14%	22%	84%	63%

Table 198. Effects to Seral Stages in Aspen from Non-Commercial Activities.

	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	2%	12%	15%	14%	83%	74%
Gunnison Basin North	1%	12%	52%	46%	47%	42%
Gunnison Basin South	1%	5%	52%	50%	47%	44%
North Fork Valley	1%	3%	54%	53%	45%	44%
San Juans	0%	0%	22%	22%	78%	78%
Uncompahgre	1%	7%	37%	37%	62%	57%

Adapted/Potential Future Treatment Type

The adapted/potential future treatment is based on a scenario where spruce beetle mortality continues across all the priority treatment areas and the opportunities to implement resiliency treatments are minimized and salvage becomes the primary method to treat spruce. If this were to occur, the following table summarizes the effects to seral stages across the Geographic Areas.

Table 199. Summary of Effects to Seral Stages in Spruce, Adapted Potential Action (All Spruce Salvage).

	Early Seral		Early Mid Seral		Late Mid-Seral	
	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	1%	4%	7%	13%	92%	83%
Gunnison Basin North	0%	1%	36%	38%	64%	61%
Gunnison Basin South	0%	1%	41%	41%	59%	53%
North Fork Valley	0%	1%	34%	35%	66%	64%
San Juans	0%	5%	11%	12%	88%	83%
Uncompahgre Plateau	2%	27%	14%	36%	84%	36%

Alternative 3 (WUI Focus) – Direct and Indirect Effects

Alternative 3 focuses on protection of community infrastructure and public safety. Under Alternative 3, all treatment types and methods would remain the same as in Alternative 2, but would be limited to identified priority treatment areas located in the wildland urban interface. The total Alternative 3 priority treatment acres identified during the prioritization process for commercial treatment is approximately 45,958 acres of spruce-fir in the WUI.

The direct effects to the stands that are treated under this alternative in regards to resilience, resiliency/recovery, and recovery are the same as under Alternative 2. The primary difference is the direct effects would be only related to the WUI and not contribute to the desired conditions at the landscape-scale.

The volume of harvest may be reduced under this alternative, as the focus may shift to areas that do not have as much economic value, or may be expensive to treat. The treated areas would have similar effects as reported under Alternative 2. The untreated area effects would be similar to those reported under effects section of the ‘no action’ alternative.

Grand Mesa

The following table summarizes the proposed commercial treatments within spruce-fir in the Grand Mesa Geographic Area that were identified during the treatment prioritization process.

Table 200. Summary of Commercial Treatments in Spruce-fir, Grand Mesa GA.

	Combination	Resiliency	Salvage	Total
Grand Mesa	**5283**	**3605**	**376**	**9264**

The following table summarizes the proposed noncommercial treatments in aspen.

Table 201. Summary of Noncommercial Treatments in Aspen, Grand Mesa GA.

	Burn and Mechanical
Grand Mesa	**8179**

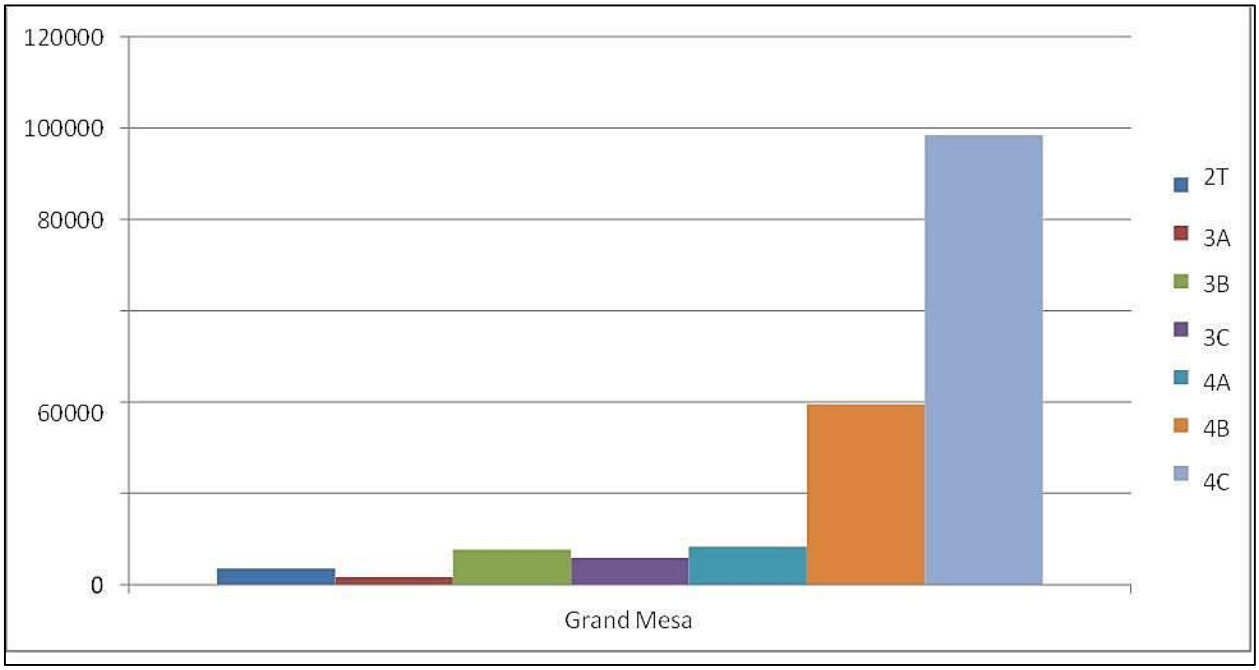

Figure 54. Shift in Habitat Structural Stages in Spruce-fir in the Grand Mesa GA.

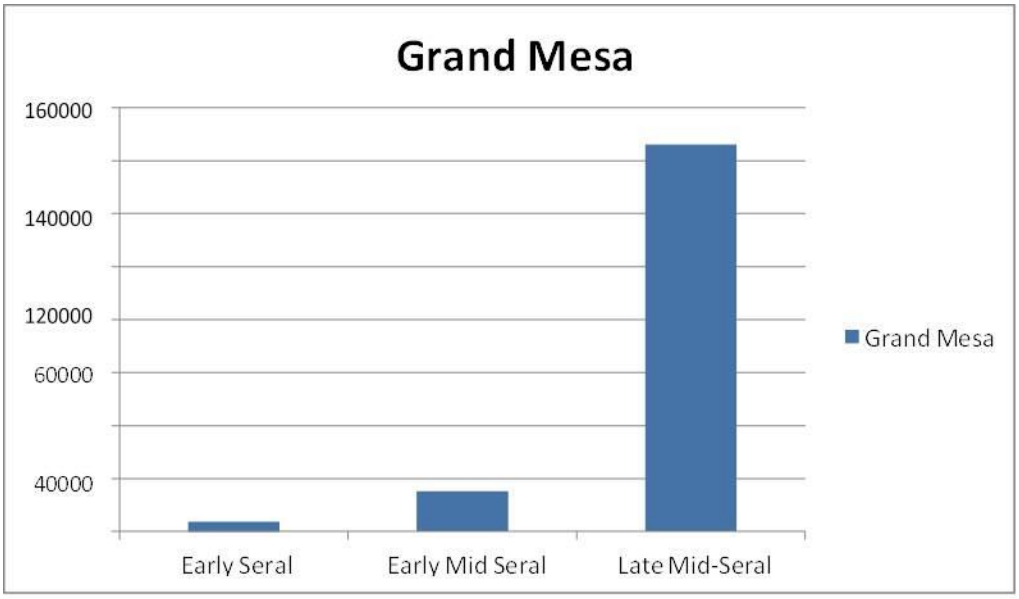

Figure 55. Shift in Seral Stages in Spruce-fir in the Grand Mesa GA.

Table 202. Summary of the Effects of Commercial Activity on Succession (Seral Stages) in Spruce-Fir PNV Type, Grand Mesa GA.

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	1%	7%	92% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	2%	9%	89%	

*Kulakowski and Veblen, Draft 2004

Table 203. Summary of the Effects of Commercial Activity within the Grand Mesa GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	15%	83% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	11%	14%	75%	

*Romme et al. 2003

Gunnison Basin North & South

The following table summarizes the proposed commercial treatments in spruce-fir within the Gunnison Basin North & South Geographic Areas.

Table 204. Summary of Commercial Treatments in Spruce-fir, Gunnison Basin North & South GAs.

	Combination	Resiliency	Salvage	Total
Gunnison Basin North	**1719**	**2183**	**714**	**4616**
Gunnison Basin South	**1632**	**996**	**1259**	**3887**
Total	**3352**	**3179**	**1973**	**8504**

The following table summarizes the proposed noncommercial treatments within aspen located within the Gunnison Basin North & South Geographic Areas.

Table 205. Summary of Noncommercial Treatments in Aspen, Gunnison Basin North & South GAs.

	Burn and Mechanical
Gunnison Basin North	**9819**
Gunnison Basin South	**4271**
Total	**14090**

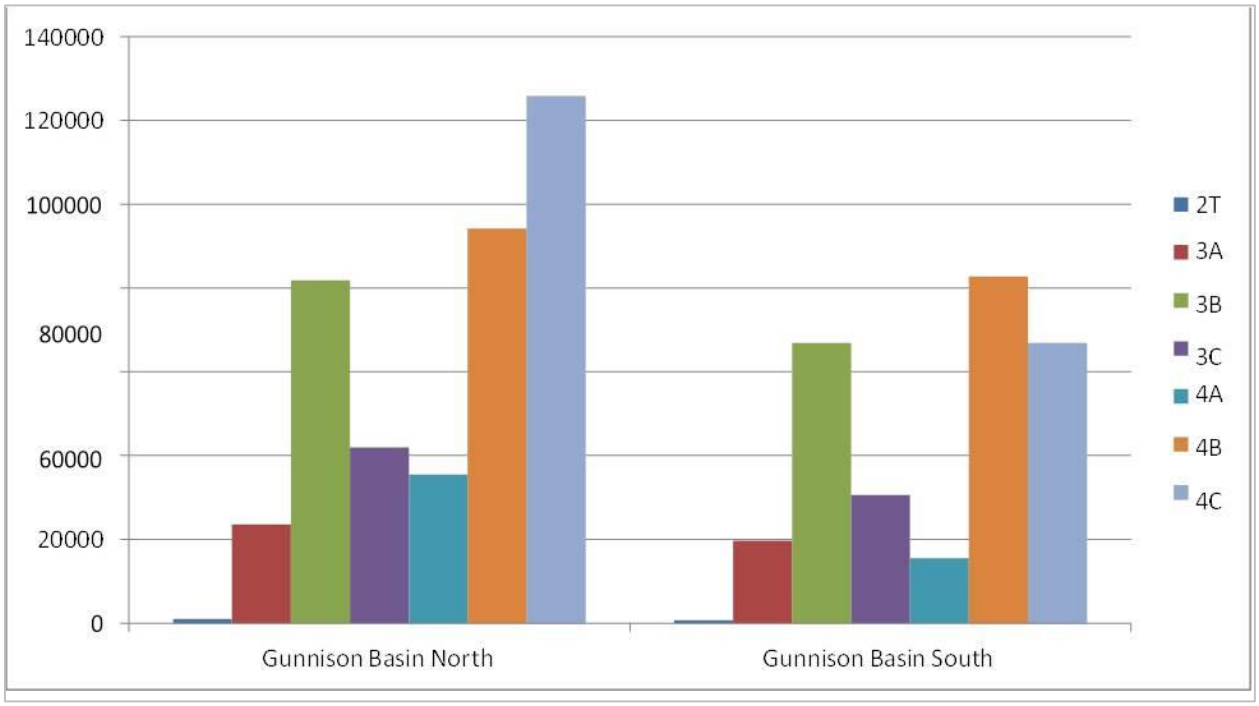

Figure 56. Shift in Habitat Structural Stage within Spruce-fir in the Gunnison Basin North & South GAs

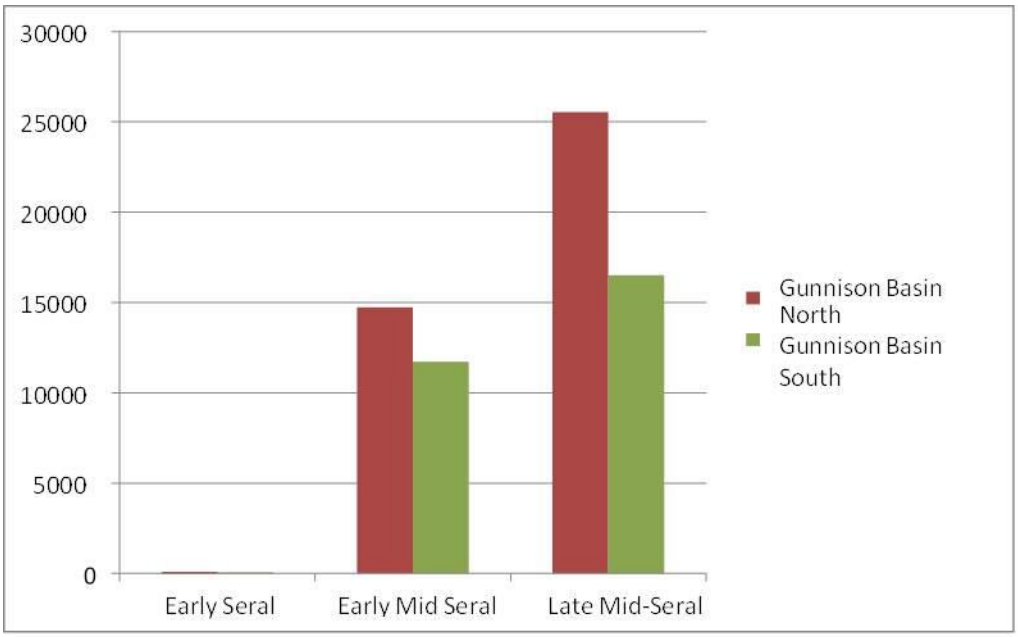

Figure 57. Shift in Seral Stages in Spruce-fir in the Gunnison Basin North & South GAs.

Table 206. Summary of the Effects of Commercial Activity within the Gunnison Basin North & South GAs: Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to 200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	31%	59% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

	Early	Early-Mid	Late-Mid	Late
Post Treatment Alternative 3	1%	41%	58%	

*Romme et al. 2003

Table 207. Summary of the Effects of Non-Commercial Activity within the Gunnison Basin North & South GAs: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers , and occasional lodgepole pine with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and occasional lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	52%	47% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	3%	52%	45%	

*Romme et al. 2003

North Fork Valley

The following table summarizes the proposed commercial treatments in Spruce-fir in the North Fork Valley Geographic Area.

Table 208. Summary of Commercial Treatments in Spruce-fir, North Fork Valley GA.

	Combination	Resiliency	Salvage	Total
North Fork Valley	**1761**	**4223**	**56**	**6040**

The following table summarizes the proposed noncommercial treatments within aspen located within the North Fork Valley Geographic Area.

Table 209. Summary of Noncommercial Treatments in Aspen, North Fork Valley GA.

	Burn and Mechanical	Mechanical Only	Total
North Fork Valley	**1878**	**175**	**2053**

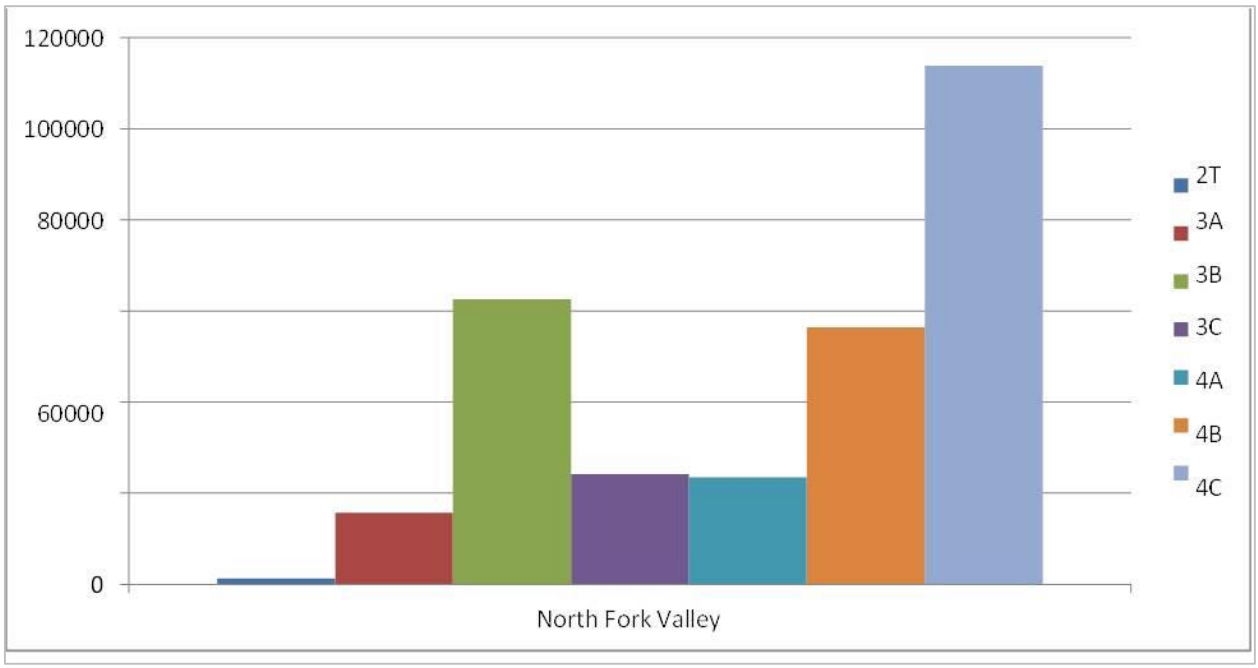

Figure 58. Shift in Habitat Structural Stage within the spruce-fir cover type in North Fork GA.

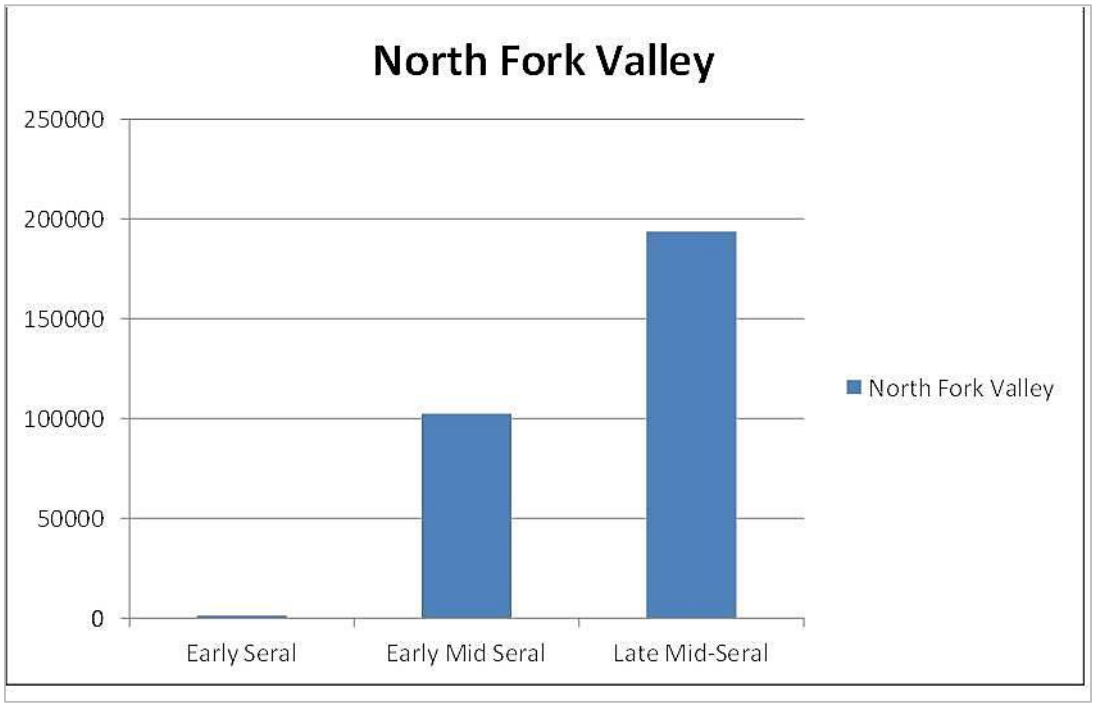

Figure 59. Shift in Seral Stages within the spruce-fir cover type in the North Fork Valley GA.

Table 210. Summary of the Effects of Commercial Activities within the North Fork Valley GA: Succession (Seral Stages) in Spruce-Fir PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	34%	66% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	0%	35%	65%	

*Romme et al. 2003

Table 211. Summary of the Effects of Non-Commercial Activity within the North Fork Valley GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	54%	45% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	3%	53%	44%	

*Romme et al. 2003

San Juans

The following table summarizes the proposed commercial treatments within spruce-fir in the San Juan Geographic Area that were identified during the treatment prioritization process.

Table 212. Summary of Commercial Treatments spruce-fir, San Juan GA.

	Combination	Resiliency	Salvage	Total
San Juans	**3137**	**1074**	**652**	**4863**

The following table summarizes the proposed noncommercial treatments within aspen in the San Juan Geographic Area that were identified during the treatment prioritization process.

Table 213. Summary of Noncommercial Treatments in Aspen, San Juan GA.

	Burn and Mechanical
San Juans	**379**

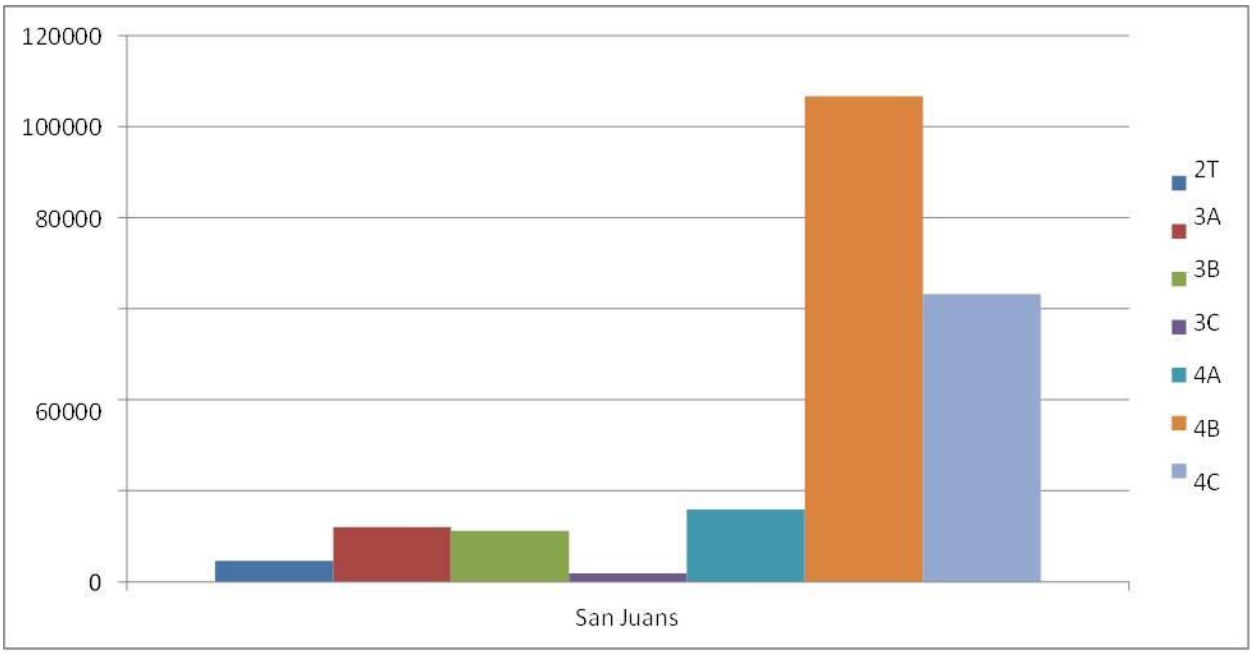

Figure 60. Shift in Habitat Structural Stages in the spruce-fir cover type, San Juan GA.

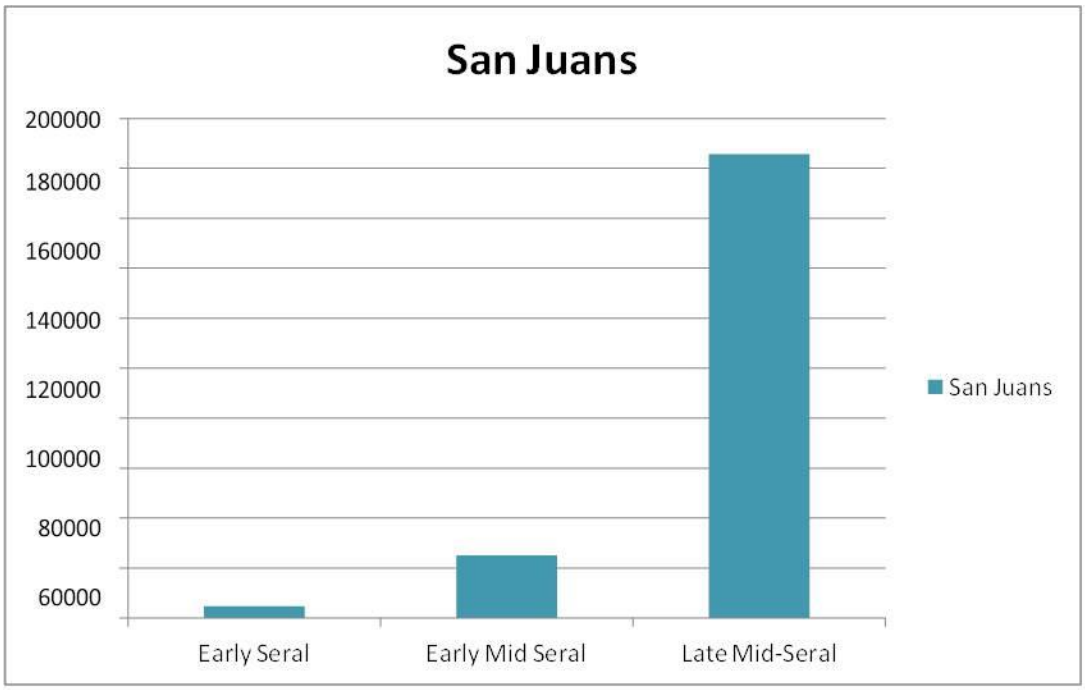

Figure 61. Shift in Seral Stage in the spruce-fir cover type, San Juan GA.

Table 214. Summary of the Effects of Commercial Activity within the San Juan GA: Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	11%	88% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	2%	17%	86%	

Table 215. Summary of the Effects of Non-Commercial Activity within the San Juan GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	0%	22%	78% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	0%	22%	78%	

*Romme et al. 2003

Uncompahgre Plateau

The following table summarizes the proposed commercial treatments in spruce-fir in the Uncompahgre Plateau Geographic Area that were identified during the treatment prioritization process.

Table 216. Summary of Commercial Treatments in spruce-fir, Uncompahgre Plateau GA.

	Combination	Resiliency	Salvage	Total
Uncompahgre Plateau	**8758**	**7685**	**218**	**16660**

The following table summarizes the proposed noncommercial treatments within aspen located within the Uncompahgre Plateau Geographic Area that were identified during the treatment prioritization process.

Table 217. Summary of Noncommercial Treatments in aspen, Uncompahgre Plateau GA.

	Burn and Mechanical
Uncompahgre Plateau	**2469**

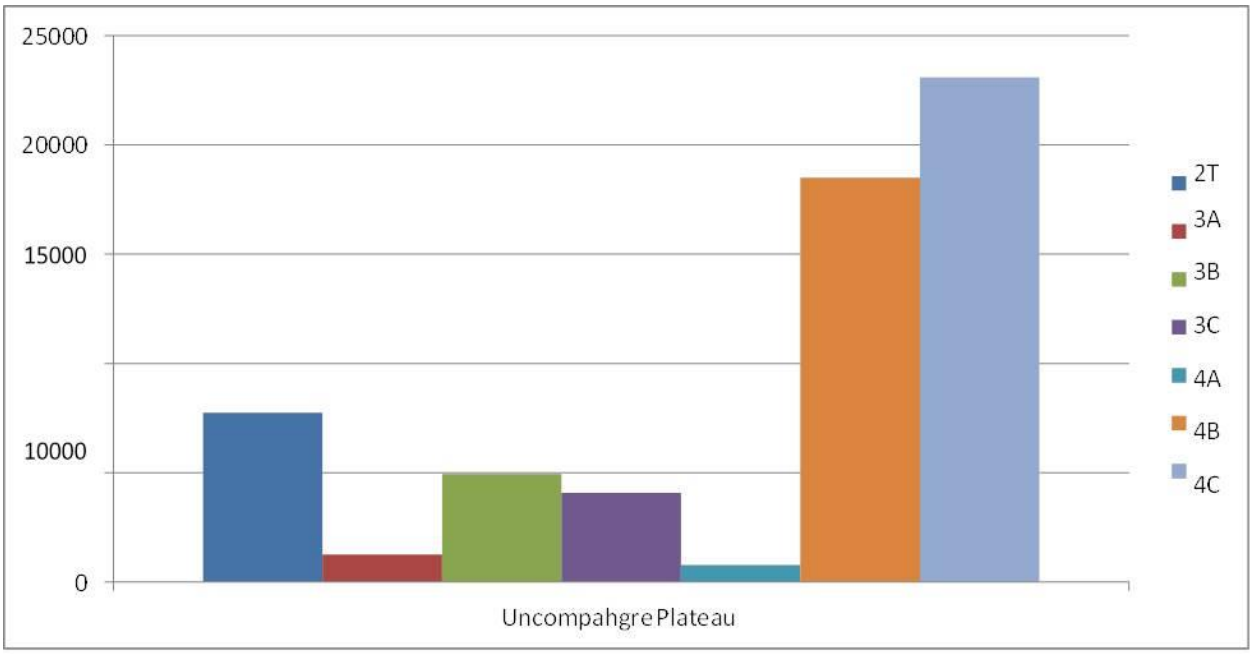

Figure 62. Shift in Habitat Structural Stages in the spruce-fir cover type, Uncompahgre Plateau GA.

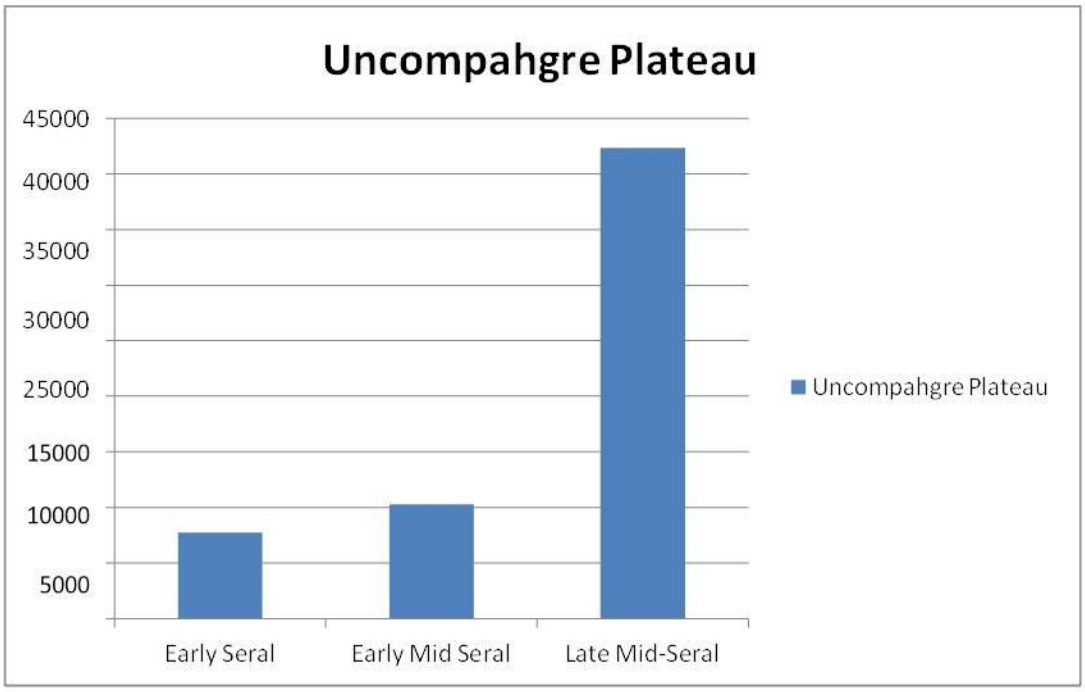

Figure 63. Shift in Seral Stages in the spruce-fir cover type, Uncompahgre Plateau GA.

Table 218. Summary of the Effects of Commercial Activity within the Uncompahgre Plateau GA: Succession (Seral Stages) in Spruce-Fir PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	14%	84% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	13%	17%	70%	

*Romme et al. 2003

Table 219. Summary of the Effects of Non-Commercial Activity within the Uncompahgre Plateau GA: Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	1%	37%	62% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	8%	37%	56%	

Summary of Alternative 3 Effects

Table 220. Effects to Seral Stage in Spruce-fir from Commercial Activities.

	Early Seral		Early Mid Seral		Late Mid-Seral	
	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	1%	2%	7%	9%	92%	89%
Gunnison Basin North	0%	0%	36%	36%	64%	63%
Gunnison Basin South	0%	0%	41%	41%	59%	58%
North Fork Valley	0%	0%	34%	34%	66%	65%
San Juans	0%	2%	11%	12%	88%	86%
Uncompahgre Plateau	2%	13%	14%	17%	84%	70%

Table 221. Effects to Seral Stages in Aspen from Non-Commercial Activities.

	Early Seral		Early Mid Seral		Late Mid-Seral	
	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	2%	11%	15%	14%	83%	75%
Gunnison Basin North	1%	11%	52%	46%	47%	43%
Gunnison Basin South	1%	3%	52%	52%	47%	46%
North Fork Valley	1%	3%	54%	53%	45%	44%
San Juan	0%	0%	22%	22%	78%	78%
Uncompahgre Plateau	1%	8%	37%	37%	62%	56%

Adapted/Potential Future Treatment Type

The adapted/potential future treatment is based on a scenario where spruce beetle mortality continues across all the priority treatment areas and the opportunities to implement resiliency treatments are minimized and salvage becomes the primary method to treat spruce If this were to occur, the following table summarizes the effects to seral stages across the Geographic Areas.

Table 222. Summary of Effects to Seral Stages in Spruce, Adapted Potential Action (All Spruce Salvage).

	Early Seral		Early Mid Seral		Late Mid-Seral	
	Existing	Post-Tx	Existing	Post-Tx	Existing	Post-Tx
Grand Mesa	1%	3%	7%	10%	92%	87%
Gunnison Basin North	0%	1%	36%	37%	64%	63%
Gunnison Basin South	0%	0%	41%	42%	59%	58%
North Fork Valley	0%	1%	34%	35%	66%	65%
San Juans	0%	2%	11%	12%	88%	86%
Uncompahgre Plateau	2%	22%	14%	20%	84%	58%

Cumulative Effects Common to Both Action Alternatives

As under the cumulative effects analysis for the No Action, impacts of past activities on silviculture are reflected in the baseline.

Current and future vegetation management activities authorized by other decisions and/or reasonably foreseeable are noted in Chapter 3, *Cumulative Impacts – Actions Considered & Analysis Approach.*

SBEADMR, in combination with reasonably foreseeable management actions, would facilitate regeneration of spruce-fir and aspen and increase age-class diversity in treated stands.

As noted in the cumulative effects analysis for the No Action, climate change is increasingly accepted as a primary driver of forest cover change in this region (Funk et al 2014; Worrall et al. 2010; Worrall et al. 2008). Proactive strategies such as SBEADMR, designed to anticipate and respond to the impacts of climate change, may increase the capacity of ecosystems to survive (Scholes et al. 2014). Because SBEADMR includes management strategies outlined in Rehfeldt et al. 2015, managers can focus treatments where they are predicted to be most effective over the long term. Recovery and resiliency treatments would be focused on late seral successional stages and tend to balance the landscape across all successional stages by managing the stands through the stand initiation stage into stem exclusion. Specifically, recovery treatments would allow stand re-initiation which would indirectly increase the amount early and mid-seral successional stages over the next 20 to 30 years.

Spruce beetles are likely to continue to impact area spruce trees over the next 5+ years on all ownerships where spruce stands exist in the planning area. With the possible exception of minor amounts of blow-down salvage, no future large-scale, commercial timber harvests are anticipated in the salvage units in the immediate future. Salvage and reforestation can contribute to landscape heterogeneity over time in response to this large-scale disturbance event. Due to current stand structure and conditions created by the spruce beetle; these areas will be either even-aged or two-aged, whether or not management activities are applied.

The most significant effect to forest management within the analysis area is the large-scale mortality of mature spruce trees. The loss of these trees will decrease wood volume growth for many decades into the future. In addition to the loss of growing stock, regeneration will be damaged as trees fall. Schmid and Hinds measured 5 percent to 45 percent seedling damage for spruce and 9 percent to 60 percent for subalpine fir in un-logged spruce stands after a large-scale spruce mortality event in Colorado in the 1940s (Schmid & Hinds, 1974).

The Engelmann spruce forest type within the Rocky Mountain west is highly valued as a producer of saw timber and house log product. The loss of a significant amount of this component on the GMUG NFs and BLM public lands within the planning area, and those adjacent on the Rio Grande National Forest, will impact the regional wood products industry in the mid to long term (50 to 200 years).

In the short term, wood volume will be provided at an increased rate creating a boost to industry and the ability to fund forest improvement projects such as planting, site preparation and slash disposal.

Approximately 7,800 acres of timber projects are identified as reasonably foreseeable within the planning area. These treatments would include forest stand improvement thinning and intermediate and regeneration harvests in the non-spruce-dominated forest types within the landscape (aspen, mixed conifer, lodgepole pine), and house log and firewood harvesting in the spruce-dominated forests. Local markets for these projects are limited, and would not support a large-scale harvesting program.

As funds are available, additional non-treated, under stocked spruce dominated stands created by the beetle epidemic would be planted to promote recovery to a forested condition. It is likely that these activities would be funded with agency appropriations, or reforestation grants. Given the limited availability of these funding sources only a small portion of the planning area outside of harvest units could be planted.

Wildlife

This section presents the analysis and determination of effects of the proposed action on federally listed wildlife species (threatened, endangered and proposed) as well as Regional Forester-designated sensitive species (FSM 2670.3) and critical habitat. Potential effects on Forest Service sensitive species and Management Indicator Species are also evaluated.

Following a general discussion of the affected environment, more specific information regarding wildlife species and associated analyses is included in the following order:

- Threatened, Endangered, and Proposed Species
- Sensitive Species
- Management Indicator Species (MIS)

Compliance with Regulatory Direction

Federal Laws and Regulations

Federal laws guiding this project include the Endangered Species Act (ESA) (19 U.S.C. 1536 (c), 50 CFR 402.12 (f) and 402.14). Section 7(a) (1) of the ESA requires federal agencies to use their authorities to further the conservation of listed species. Section 7(a) (2) requires that federal agencies ensure any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of federally-listed species, or destroy or adversely modify designated critical habitat.

Forest Service policy requires that a review of programs and activities, through an effects analysis document (referred to in current Forest Service policy as a biological evaluation or BE), be conducted to determine their potential effect on threatened and endangered species, species proposed for listing, and Regional Forester-designated sensitive species (FSM 2670.3). Under the ESA, the effects analysis report is called a biological assessment (BA) and must be prepared for federal actions that are “major construction activities” to evaluate the potential effects of the proposal on listed or proposed species and critical habitats. The contents of the BA are at the discretion of the federal agency, and will depend on the nature of the federal action (50 CFR 402.12(f)). A BE may be used to satisfy the ESA requirement to prepare a Biological Assessment. Preparation of a Biological Evaluation as part of the NEPA process ensures that TEPS species receive full consideration in the decision-making process. A separate biological evaluation was prepared to address Forest Service sensitive species and Management Indicator Species (MIS).

This document also includes types of information specific to analyzing projects under the Southern Rockies Lynx Management Direction (SRLA). This helps ensure that the appropriate

information is used in the effects analysis and provided to the U.S. Fish and Wildlife Service that leads to streamlined consultations on SRLA projects.

Threatened & Endangered Species & Critical Habitat

Summary of Changes between Draft and Final

Canada Lynx

- Use of PTA to examine effects of treatment to lynx and their prey under current and adapted treatment (all salvage) conditions.
- Geographic Areas, Lynx Analysis Unit (LAU) and Lynx Linkage Areas (LLA) level analysis by alternative on key risk factors affecting lynx - Habitat connectivity, treatment induced conversion of habitat from suitable to unsuitable, influence of roads, influence of snow compaction, and influence on snowshoe hare and red squirrel habitat.
- Cumulative effects analysis by summarizing of past actions (e.g. timber harvest, constructed roads, etc.) and wildfire that converted lynx habitat from suitable to unsuitable. Proposed treatments under SBEADMR were considered as well as reasonably foreseeable actions. An impact limit of 30 percent by LAU as described in the Southern Rockies Lynx Amendment (SRLA) was used to ensure effects are within acceptable limits (USDA Forest Service, 2008)..
- Design features were clarified and in some cases added to minimize or avoid predicted impacts.

Gunnison sage-grouse

- Acres of designated critical habitat potentially affected under each alternative were analyzed.
- Clarified treatment objectives by vegetation type within critical habitat. The goal is restoration of targeted vegetation as described in the Gunnison sage-grouse Range Wide Plan (Gunnison Sage-grouse Rangewide Steering Committee, 2005).
- Design features were clarified and in some cases added to minimize or avoid predicted impacts.

Greenback cutthroat trout

- Added to the analysis since 7 watersheds have streams that could be affected by the project.
- Design features added to minimize or avoid predicted impacts.

Design Features Applied to Avoid or Minimize Effects to Wildlife including T&E

Design criteria for all resources applicable to both action alternatives can be found in Appendix B. Table 223 lists wildlife design criteria for all action alternatives for the SBEADMR project. Design features are used during treatment planning and are intended to avoided or minimize impacts or help achieve treatment objectives.

Table 223. Wildlife-Related Design Criteria for Both Action Alternatives.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Canada lynx (threatened) and snowshoe hare. Other sensitive species and MIS also benefit, including goshawk, boreal owl, olive-sided flycatcher, pygmy shrew, and American marten.	WFRP-1	All applicable management Objectives, Standards and Guidelines contained in the Southern Rockies Lynx Amendment will be applied during project planning, analysis and implementation. **Avoidance or minimizing impact mechanism:** Objectives, standards and guidelines in the SRLA are designed to provide habitat for lynx at multiple scales. Specifically the SRLA provided guidance on habitat threats to reproduction, foraging, and movement. Anthropogenic influences that are of greatest concern to lynx are climate change, vegetation management, wildland fire management, and habitat fragmentation. The SRLA explicitly addresses 3 out of the 4 influences and through maintenance of high quality habitat for lynx addresses potential influences of climate change.
	WFRP-12	Areas supporting live advanced regeneration will be avoided to the extent possible during unit layout. Focus should be placed on areas with >35% Dense Horizontal Cover in blocks greater than 0.3 acres. **Avoidance or minimizing impact mechanism:** The SRLA and other more recent scientific literature (see Interagency Lynx Biology Team, 2013) provide a primary conservation goal is to provide a mosaic that includes dense early-successional coniferous and mixed –coniferous stands, along with a component of mature multi-story coniferous stands to produce the desired snowshoe hare density within each LAU. Standard VEG S6 limits projects that reduce winter snowshoe hare habitat in multi-story mature or late successional conifer forests to specific situations: 1. Within 200 feet of dwellings, recreation sites, etc.; 2) for research studies; 3) for incidental removal during salvage harvest (removal due to skid trails and landings); 4) when un-even-aged management (single tree and group selection) practices are used.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Canada lynx (threatened) and snowshoe hare. Other sensitive species and MIS also benefit, including goshawk, boreal owl, olive-sided flycatcher, pygmy shrew, and American marten.	WFRP - 18	To maintain the amount and distribution of lynx foraging habitat over time, manage so that no more than 30% of the lynx habitat in an LAU is in early stand initiation structural stage (SISS) or has been silviculturally treated to remove cover (Standard VEG S1).. **Avoidance or minimizing impact mechanism:** Standard VEG S1 states that unless board scale assessments have been completed that substantiates different historical levels of stand initiation structural stage limit disturbance to each LAU to no more than 30 percent of the lynx habitat in a LAU in a stand initiation structural stage that does not yet provide winter snowshoe hare habitat (trees above average snow depth). Emphasize sustaining snowshoe hare habitat in an LAU. If more than 30% of the lynx habitat in an LAU is in early stand initiation structural stage or has been silviculturally treated to remove horizontal cover (e.g., clear-cuts, seed tree harvest, pre-commercial thinning, or understory removal), no further increase as a result of vegetation management projects should occur on federal lands. Cumulative impacts include all roads (assessed at 100% impact to the understory) and past management activity affecting the understory (harvest, prescribed fire, thinning, etc.) going back 25 years. A 25% residual impact to the understory due to past vegetation management activities is assumed. As management occurs in the affected LAU over the life of the project, acres affected will be tracked to ensure consistency with this conservation measure.
	WFRP-17	Habitat connectivity will be maintained at the Lynx Analysis Unit (LAU) scale. Multiple harvest methods including resiliency and variable retention. Other methods including protection of advanced regeneration to the extent possible will also be employed. **Avoidance or minimizing impact mechanism:** The SRLA and other more recent scientific literature (see Interagency Lynx Biology Team, 2013) provide a primary conservation goal is to provide a mosaic that includes dense early-successional coniferous and mixed –coniferous stands, along with a component of mature multi-story coniferous stands to produce the desired snowshoe hare density within each LAU. Standard VEG S6 limits projects that reduce winter snowshoe hare habitat in multi-story mature or late successional conifer forests to specific situations. Management of vegetation toward Potential Natural Vegetation (PNV) is the primary mechanism used to ensure connectivity is maintained at the LAU scale. PNV accounts for site specific factors (soils, elevation, etc.) and natural disturbances to establish a range expected vegetative seral conditions (USDA Forest Service 2005e). Treatment-level design features will also be employed to help maintain connectivity.
	WFRP-11	Skid trails and landings will be located to minimize impacts to advanced regeneration. Skid trails will be placed at least 100 feet apart, except where they need to tie in together at landings. **Avoidance or minimizing impact mechanism:** Maintaining regeneration in the understory creates habitat for hares and other wildlife requiring ground-level cover. Use of designated skid trails also reduces soil impacts to harvest units, keeping adverse soil impacts within the 15% threshold as required by the GMUG Forest Plan.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Big game and retention of hiding cover	WFRP-5	In forested areas where salvage, resiliency, combination, prescribed burn and mechanical treatments are implemented, strive to maintain forested cover on 60% or more of the perimeter of all natural and created openings, and along at least 60% of each NFS Road (level 5 and below) that has high levels of human use during the time deer and elk would be expected to inhabit an area. Roads with restricted use could provide for less cover. Except where natural openings or parks exist along roads and when applying hazard tree removal activities along roads to meet public safety goals, gaps along roads should not exceed ¼ mile. Cover should be well-distributed across the landscape. Minimum sizes for hiding and thermal cover patches are 2 -5 acres for mule deer, and 30 – 60 acres for elk. **Avoidance or minimizing impact mechanism:** The intent is to maintain or improve habitat diversity and make or keep the area in a condition where deer and elk can effectively use the area by managing the vegetation and human activity. This design feature provides an opportunity to implement the proposed commercial and noncommercial activities in a way that accomplishes these wildlife habitat objectives while also meeting the purpose and need of the project. District wildlife, timber and fire programs will coordinate closely during the planning and design phase of projects to accomplish these objectives.
	WFRP-6	Provide hiding cover within 1,000 feet of any known elk calving areas. The District wildlife biologist will be responsible for coordinating with Colorado Parks and Wildlife (CPW) to identify calving areas and informing timber and fire staff on locations. **Avoidance or minimizing impact mechanism:** When calving areas are identified, a 1,000 foot buffer will be applied and existing vegetation conditions within the buffer will be assessed by the District biologist to determine cover needs, identify areas to avoid with treatments, or coordinate with timber and fire staff to determine how treatments could be designed to maintain or enhance cover.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Big game and retention of hiding cover	WFRP-15	Winter logging is encouraged to limit direct disturbance to the fewest number of wildlife species as possible. When possible, avoid treatment activities in areas where big game (elk, pronghorn and moose) are known to occur. When big-game winter range is bisected by proposed haul routes and there are concentrations of animals along these routes minimize stress to wintering animals to the extent practicable by: A. Re-routing along another acceptable route. B. Restrict haul times between 9 am and 4 pm The District Biologist will coordinate with CPW to assess big game use and identify areas where animals concentrate during winter, and assess if there is a need to implement conservation measures. This would be a coordinated effort with GMUG, CPW and the timber purchaser. Consideration for a waiver if the specified route is regularly used by the public during the specified restriction period. **Avoidance or minimizing impact mechanism:** Winter logging during cold weather minimizes impacts to understory vegetation and soils. Disturbance to wintering big game resulting from log hauling is anticipated to be minimal but could occur. Winter is often one of the most stressful times for wildlife due to limited food availability and exposure. Big game easily become stressed during sever winters. Minimizing disturbance can help increase survival rate and reduce probability of aborted fetuses.
Gunnison sage-grouse (threatened)	WFRP-16	Gunnison sage-grouse – Portions of haul routes may occur in occupied habitat in few areas. Where use of haul routes have the potential to impact Gunnison sage-grouse as determined by the effects analysis, timing restrictions should be applied that prohibit the use of haul routes that occur within 0.6 mi of active leks (breeding sites) from March 15 – May 15. **Avoidance or minimizing impact mechanism:** Vehicle use of a route within 0.6 miles of a lek has been found to disturb sage grouse when they are on the lek. This is especially true when vehicles ae traveling at a high rate of speed and during early morning in late afternoon. Specific haul routes that could be used for hauling have been identified and the restriction applied from March 15- May 15. Currently in the Gunnison Basin, many of these routes already have timing restrictions for sage grouse.
	WFRP-17	When planning non-commercial treatments in critical habitat for Gunnison sage grouse, avoid direct treatment to sagebrush. When treatments could affect critical habitat coordinate but are not dominated by sagebrush, coordinate with local experts to determine if current vegetation conditions are limiting sage-grouse productivity and design projects accordingly. **Avoidance or minimizing impact mechanism:** Because of the sensitivity of managing sage-brush to accomplish site-specific objectives avoidance is the primary mechanism to minimize effects to Gunnison sage-grouse. Management of sagebrush habitat will be completed under separate NEPA and consultation with Fish and Wildlife Service.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Cavity nesters, small mammals, raptors.	WFRP-2	At a minimum, in spruce-fir forest types maintain 90 to 225 snags per 100 acres, 10 inches in diameter at breast height (dbh) or greater (where biologically feasible). In aspen forest types, maintain 120 – 180 snags per 100 acres, 8 inches dbh or greater (where biologically feasible). Snags would be maintained away from structures, roads and trails so that they do not create safety hazards to the public. Trees to retain include large live trees with broken or dead tops (snag replacement trees), and other trees showing wildlife signs (dens, nests, cavities, squirrel middens, woodpecker activity) within and adjacent to harvest units to provide for perching, foraging, roosting, and nesting sites for wildlife. To compensate for the lack of snags along road corridors due to removal for OSHA safety needs, leave a greater density of wildlife trees in areas away from roads and landings. Snags within 500 feet of water (creeks, ponds, wet meadows, seeps, and springs), meadows/parks/forest openings, and ridge tops are particularly valuable to wildlife. Where possible, groups of snags in close proximity to each other or associated with green trees will be retained. Retention of snag groups will reduce wind-throw. Where possible, utilize natural sinuosity or drainages for linking groups. Leave snags with a variety of heights, shapes, and decay condition. Generally, taller and larger diameter snags provide better habitat for more species. Leave snags of all species type. Protect standing wildlife trees from damage during site preparation and post-sale activities. Focus on retention of snags in areas that support DHC >35%. **Avoidance or minimizing impact mechanism:** retention of snags and down wood will provide habitat for cavity nesters, small mammals and raptors within harvest units and within the matrix areas. Snags groups will be centered on areas supporting advanced regeneration to the greatest extent possible and be large enough to avoid wind throw. The goal is to create a mosaic that includes dense-early successional areas along with a component of live and dead mature trees across a treatment area.
Lynx, marten, and other species	WFRP-3	Maintain 10-20 tons per acre of coarse woody debris within harvest units to maintain soil moisture at ground level for mosses, fungi, and lichens and to encourage faster re-colonization of harvest units by small mammals and other prey species. Retain some small slash piles to provide habitat for small mammals. Where possible in regeneration units, create piles of logs, stumps, or other woody debris to minimize the effects of larger openings and to provide connectivity to adjacent stands for lynx, marten, and other species that may generally avoid open areas and utilize concentrations of down wood for foraging or denning. **Avoidance or minimizing impact mechanism:** Large wood on the forest floor is extremely important for soil nutrient re-cycling, shelter to encourage tree regeneration and habitat for variety of small mammals including hares and marten.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
	WFRP-4	Maintain large diameter downed logs in various stages of decomposition within harvest units (50 linear feet/acre of 10 inches diameter or larger at the large end of lodgepole pine and aspen logs and/or 12 inches diameter or larger for Engelmann spruce, subalpine fir and Douglas fir logs). Utilize lop and scatter to the greatest extent practicable. **Avoidance or minimizing impact mechanism:** Large wood on the forest floor is extremely important for soil nutrient re-cycling, shelter to encourage tree regeneration and habitat for variety of small mammals including hares and marten.
Northern Goshawk (other sensitive and Management Indicator Species)	WFRP-7	Northern goshawk - No activities will be allowed within ½ mile of active nests from March 1 to August 31 or until fledging has occurred. The timing restriction buffer could be reduced to ¼ mile if topographic features and/or adequate screening cover are present that would protect the nest site from disturbance. No harvest activities will be allowed within a 30-acre buffer of nest sites. Outside of a 30-acre area around goshawk nest sites, timing restrictions are not needed for project layout, marking, and any other activities that are non-disturbing (i.e., activities not involving the use of heavy equipment or chainsaws). Timing restrictions will only apply to active nests, as confirmed by the USFS wildlife biologist. **Avoidance or minimizing impact mechanism**: Retention of a ½ mile buffer during the nesting and post-fledging period provides protection of the post-fledging area (PFA) during the period when goshawks fledge until the time that they leave the nest and are no longer dependent on the parents. Other design features (WFRP-2, 3, 4 and15) complement this design feature by providing for retention of snags, pockets of dense understory and large wood which provide habitat for prey species.
	WFRP-8	Northern goshawk – provide or leave 20% of pole or mature tree stands adjacent to nesting sites with at least 150 square feet of basal area. Provide or leave at least one class 1 log adjacent to nest sites. The District wildlife biologist will be responsible for coordinating with timber and fire staff on nest locations and assessing vegetation conditions adjacent to nest sites. **Avoidance or minimizing impact mechanism**: Helps maintain habitat within PFA.
Other raptors potentially occurring on the GMUG.	WFRP-9	On-going surveys for raptors would be conducted to determine locations of individuals or populations of these species and allow for the implementation of protection measures using the appropriate buffer or timing restriction, as determined by Colorado Parks and Wildlife raptor guidelines. **Avoidance or minimizing impact mechanism:** Under the Migratory Bird Act, management actions are to be designed to minimize effects to migratory birds. Many of the raptors the frequent the project area could be affected so use of buffer or timing restrictions as appropriate will avoid or minimize these effects.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
Lynx, MIS and various sensitive species	WFRP-10	Retain all live trees in salvage units, except for trees that need to be removed for operational/safety or silvicultural purposes. Operational/safety or silvicultural purposes include the need to remove live trees if necessary to access dead trees for salvage or to address safety concerns. Clump live trees as much as possible to prevent wind throw. **Avoidance or minimizing impact mechanism**: In areas with extensive mortality, retention of live trees creates a mosaic of patches of live and dead trees throughout the treatment. The use of a partial retention silvicultural prescription where the understory is retained (generally trees under 8 inches dbh and all tree species) maintains multiple age classes in the stand (shrub-seedlings and saplings-pole habitat structural stages). These habitat conditions provide habitat goshawk, American Marten, and hares as well as various small mammals.
Lynx, MIS and various sensitive species	WFRP-23	In LAU with extensive mortality of mid-late and late seral spruce (Habitat Structural Stages 4A, 4B and 4C), retain these live stands to the greatest extent practicable during project planning. **Avoidance or minimizing impact mechanism:** Retention of live stands of habitat structural stages 4A, 4B and 4C spruce is an important conservation measure for any species that requires this habitat in a landscape with extensive mortality. These stands provide old-growth and multi-story characteristics important to lynx and their prey.
Canada lynx, snowshoe hares, minimize soil impacts	WFRP-9	Skid trails and landings will be located to minimize impacts to advanced regeneration. Skid trails should be placed at least 100 feet apart, except where they need to tie in together at landings. **Avoidance or minimizing impact mechanism:** See WFRP-12 above.
	WFRP-20	Within secondary habitat for lynx (300 foot buffer from primary habitat) retain spruce and fir in aspen-spruce mix stands. Primary habitat is defined as having a dominance of spruce-fir cover type. Most of the secondary habitat includes either pure aspen or aspen-spruce mixed stands. **Avoidance or minimizing impact mechanism**: While hares and lynx prefer multi-story spruce-fir stands, aspen with an understory of spruce does provide habitat value. This is especially true when aspen-spruce stands are adjacent to primary (core) lynx habitat. In secondary habitat allowing these mixed stands to succeed to stands dominated by spruce are a benefit to hares and lynx.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
	WFRP-13	Landings and main skid trails will be evaluated by a specialist to determine if detrimental soil compaction has occurred. Based on review by a specialist, when detrimental compaction is found, subsoil ripping may be applied to reduce soil impacts when a site prep contract is necessary for an area. When a site prep contract is necessary, this provides the opportunity to rip skid trails and landings in the area and potentially in nearby adjacent areas. This would provide for a more suitable seedbed for future regeneration, thus preventing permanent impacts of skid trails that when left in a compacted state, often do not regenerate as well as adjacent un-compacted areas. Importantly, all operations will conform to the direction in Chapter 10 of the Water Conservation Practices Handbook including managing treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area. **Avoidance or minimizing impact mechanism:** Logging activities can result in compaction of soils which will inhibit vegetation growth. When soil compaction is adverse, subsoiling will all grasses, forbs and trees to become reestablished. Recovery of vegetation provides long-term productivity for a variety of wildlife species.
TES policy requirements and assurance with Forest Plan requirements.	WFRP - 14	Surveys for threatened, endangered, and sensitive (TES) species will occur prior to design of a project. However, since it may take several years to fully implement a project, some level of TES re-survey will occur on an annual basis. If TES species are confirmed present the appropriate standards from the Forest Plan apply. Results of surveys for threatened, endangered, and sensitive species will be incorporated into project design and/or implementation. **Avoidance or minimizing impact mechanism:** Under Forest Service policy TES surveys are required to determine habitat use by these species in a treatment area. Data from these surveys are used to plan and implement a specified treatment.
Purple Marten	WFRP-22	When planning treatments in mature aspen, complete inventories for purple martin and avoid these areas if birds are detected. **Avoidance or minimizing impact mechanism**: In Colorado, habitat preference seems very specific: edges of mature aspen stands, usually near a stream, spring of pond. Retention of mature aspen in these areas helps conserve the species due to relative rareness on the GMUG.
Boreal toad	WFRP-24	To minimize spread of Amphibian Chytrid Fungus, at least one member of the Aquatics Team will participate in the planning and implementation of project-level operations. Design feature IW-2 requires equipment washing that will further reduce possible spread of Chytrid. **Avoidance or minimizing impact mechanism:** The use of heavy equipment in and around water can transfer spores from one area to another. Involvement of the aquatics team to assist in planning of projects will minimize this risk.

Threatened, endangered, proposed, sensitive or MIS species	Number	Design Feature
	WFRP-25	In areas where Boreal Toad is known to exist the timing of ground based activities may be limited by the season were possible. Boreal Toads forage up to 1.6 miles from breeding sites between July and late October to over winter. Ground based operations of commercial or non-commercial equipment will be limited to when there is at least 4 inches of frozen soil or over snow. **Avoidance or minimizing impact mechanism:** Toads migrate into forested areas in late summer an early fall to forage and winter in forested stands. Heavy equipment use in these stands during this time period could crush toads. Use of heavy equipment during winter when the ground is frozen or over snow also reduces risk to hibernating toads during winter. Only 2 watersheds (Buzzard and Cement Creek) with PTA are currently known to support toads.
	WFRP-26	Where non-commercial fuel reduction treatments overlap the occurrence of Boreal Toad there will be no mechanical operations (i.e. mastication, etc.). In these areas pile burning will be used to reduce fuels while concurrently minimizing ground disturbance and the possibility of indirect toad mortality and reduction or loss of hibernaculum habitat. **Avoidance or minimizing impact mechanism:** Boreal toads forage up to 1.6 miles from breeding sites between July and late October, and winter in small mammal burrows. Minimizing ground disturbance and mechanical operations in these areas reduces the risk to foraging/dispersing toads and prevents loss of hibernaculum habitat.

Threatened, Endangered, And Proposed Species and Designated Critical Habitat Considered and Analyzed

The following list includes threatened, endangered, and proposed species, and/or designated critical habitat that are located on the GMUG National Forest, or are located adjacent to or downstream of the project and could potentially be affected. This list of species was generated from a Forest-wide list generated on May 2015. A pre-field review will be conducted prior to treatments being planned. Data generated from the surveys will be used to plan treatments both to benefit various wildlife species and to avoid or minimize potential impacts. The Treatment Design Checklist will be used to document required surveys have been completed as well as identifying which design features will be applied to a specific treatment. Required monitoring T&E monitoring and annual reporting to Fish and Wildlife Service is discussed in the monitoring section of the Biological Assessment (BA), which is located in the project file.

No further analysis is needed for species that are not known or suspected to occur in the project area, and for which no suitable habitat is present. Table 224 documents the rationale for excluding a species. If suitable but unoccupied habitat is present, then additional survey is needed, or presence can be assumed and potential effects evaluated. This BA is supplemented by other documents addressing effects to T&E plants and fish (Dare and Woody, 2016; Parker and Johnston, 2016). Only those species where the analysis determined a “May affect” where brought forward into the BA for consultation with U.S. Fish and Wildlife Service (FWS).

Table 224. Federal Threatened, Endangered or Proposed Species That May Occur in the Action Area.

Common Name	Scientific Name	Status	Known/ suspected to be present?	Suitable habitat present?	Designated Critical Habitat present or could be affected?	Rationale if not carried forward for analysis
Mammals						
Black-Footed ferret	*Mustela nigripes*	Experimental Population, Non-Essential	No	No	No	Pre-field review and field surveys verified there is no suitable habitat in the SBEADMR project area. This species has not been documented in the action area.
Canada Lynx	*Lynx canadensis*	Threatened	Yes	Yes	Yes	*(carried forward)*
North American wolverine	*Gulo gulo luscus*	Proposed Threatened	No	No	Yes	*(carried forward)*
Birds						
Gunnison sage-grouse *Centrocercus minimus*		Threatened	Yes	Yes	Yes	*(carried forward)*
		Designated Critical Habitat	Yes	Yes	Yes	
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	No	No	No	Pre-field review verified there is suitable habitat on the GMUG NF, but there is no suitable habitat present in spruce-fir and aspen habitats that may be treated.
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Endangered	No	No	No	Pre-field review and a site visit verified there is suitable habitat in the SBEADMR project area; however the areas where treatments may occur do not include willow stands.
Yellow-billed cuckoo	*Coccyzus americanus*	Proposed Threatened	No	No	No	Pre-field review verified there is suitable habitat in the SBEADMR project area, however areas where treatments may occur will not include open woodland habitat.
Insects						
Uncompahgre Fritillary butterfly	*Boloria acroncnema*	Endangered	No	No	No	Pre-field review verified there is suitable habitat within the SBEADMR project area; however areas where treatments may occur will not include alpine habitats used by this species.
Fish						

Common Name	Scientific Name	Status	Known/ suspected to be present?	Suitable habitat present?	Designated Critical Habitat present or could be affected?	Rationale if not carried forward for analysis
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	Threatened	Yes	Yes	No	*(carried forward)*

Species Evaluated in Detail – Species Descriptions

Canada Lynx Lynx Canadensis

The Canada lynx is a threatened species under the Endangered Species Act. The lynx's range in North America closely follows the distribution of boreal forests. Its northern most range is in Alaska and Canada where they inhabit the taiga, a classic boreal forest ecosystem. In the western United States, lynx populations extend south into subalpine forests and in the eastern United States, the population extends into the boreal/hardwood forest ecotone. Geographically, lynx populations in the lower contiguous United States extend south along the North Cascade and Rocky Mountain Ranges, the western Great Lakes Region and in northern Maine. The biology, ecology, habitat requirements, anthropogenic influences on lynx and their habitat, and recommended conservation measures are provided in the Interagency Lynx Biology Team Report (Interagency Team Report 2013), the Southern Rockies Lynx Amendment (USDA Forest Service 2008), and the Southern Rockies Lynx Amendment Biological Assessment (USDA Forest Service 2008) and Biological Opinion (US Fish and Wildlife Service 2008) and are hereby incorporate by reference. Information presented below is a summary of these documents as well as other information pertinent to the analysis.

Lynx have been confirmed to be present on the GMUG National Forest by Colorado Parks and Wildlife researchers. Researchers used radio-telemetry to also confirm reproduction on the GMUG. From February 4, 1999 through February 1, 2005, 121 individual lynx were located within the GMUG National Forests (Shenk 2005). Colorado Parks and Wildlife monitoring of radio-collared lynx from April 2000 to April 2009 (Shenk 2009) and an assessment of "population-level" habitat use from 1999 – 2010 (Theobald and Shenk 2011) indicates lynx have been documented within the project planning area. In addition, the SRLA identifies all lynx habitat for the National Forests in the Southern Rocky Mountains as occupied.

The lynx biology team identified possible risk factors to lynx and lynx habitat:

> **Risk factors affecting productivity:** timber management, wildland fire management, livestock grazing, recreational uses, forests back country roads and trails, and other human developments. These activities may affect lynx productivity by altering habitat that supports snowshoe hare prey base. Removal of cone producing trees can also reduce red squirrel numbers, which is an important secondary prey item for lynx. The SRLA provides considerable direction to guide these activities and therefore are included in this analysis.
>
> **Risk factors affecting mortality:** trapping, shooting, predator control, highways and predation by other species. These factors directly cause lynx deaths.

State regulations no longer allow legal trapping or hunting in the State of Colorado. Incidental or illegal shooting may still occur. This risk factor is largely not addressed in the SRLA since they are authorized and conducted by other agencies (Colorado Parks and Wildlife, and USDA Animal and Plant Health Inspection Services- Wildlife Services).

Highways (generally defined as having two or more lanes of traffic, high speeds, and high traffic volume) are a known source of direct lynx mortality. Depending upon the situation some activities authorized or carried out by the Forest Service may increase vehicular traffic on specific routes. The SRLA provides management direction applicable to highways and therefore is included in this analysis.

Lynx are also believed to have a competitive advantage where deep, soft snow in mid-winter tends to exclude other predators (e.g., coyotes) at a time when prey availability is most limited for lynx. Winter recreation and plowing of snow to conduct timber management actions can increase snow compaction, thereby increasing competition with lynx and possible predation on lynx. Guidelines are included in the SRLA to address this issue.

Risk factors affecting movement: Highways and associated development and private land development.

Within lynx home ranges highways and associated high intensity uses and developments can constrain habitat use and impede daily movements. Maintaining connectivity within and between lynx sub-populations is an important consideration for long-term persistence. The SRLA provides guidance to maintain connectivity with LAU and between LAU through establishment of Lynx linkage zones (LLA).

Critical Habitat

Critical habitat has not been designated for Canada lynx in the Southern Rocky Mountains.

Management Direction for Canada Lynx – Southern Rockies Lynx Amendment

The Canada lynx was listed as threatened on March 24, 2000 (http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2000_register&docid=00-7145-filed.pdf). In August 2004, the Second Edition of the Canada Lynx Conservation Assessment and Strategy (LCAS) was released, to provide a consistent and effective approach to conserve Canada lynx on federal lands. The Science Report (Ruggiero et al. 2000) and the LCAS (Ruediger et al. 2000, Interagency Lynx Biology Team 2013) provide best available science on habitat requirements and conservation measures. In 2008, the Southern Rockies Lynx Management Direction Record of Decision on the Southern Rockies Lynx Amendment (SRLA) was published, which integrated the LCAS standards and guidelines and amended the Forest Plan (USDA Forest Service, 2008). The purpose and need for the amendment was to establish management direction that conserves and promotes the recovery of lynx, and reduces or eliminates potential adverse effects from land management activities and practices on National Forests in the southern Rocky Mountains, while preserving the overall multiple-use direction in

existing Forest Plans. In May 2009, the Forest Service published an Implementation Guide for the SRLA (USDA Forest Service, 2009d). The Implementation Guide provided the basis for much of the interpretation of the SRLA used in this analysis.

Objectives, Standards and Guidelines Applicable to the SBEADMR Project

The following objectives, standards and guidelines from the SRLA (http://www.fs.fed.us/r2/projects/lynx/documents/index.shtml) are applicable to the proposed project:

- **Objective ALL O1:** Maintain or restore lynx habitat connectivity in and between Lynx Analysis Units (LAUs), and in linkage areas.
- **Objective VEG O1:** Manage vegetation to mimic or approximate natural succession and disturbance processes while maintaining habitat components necessary for the conservation of lynx.
- **Objective VEG O2:** Provide a mosaic of habitat conditions through time that support dense horizontal cover, and high densities of snowshoe hare. Provide winter snowshoe hare habitat in both the stand initiation structural stage and in mature, multi-story conifer vegetation.
- **Objective VEG O4:** Focus vegetation management in areas that have potential to improve winter snowshoe hare habitat but presently have poorly developed understories that lack dense horizontal cover.
- **Standard VEG S1:** If more than 30% of the lynx habitat in an LAU is currently in a stand initiation structural stage that does not yet provide winter snowshoe hare habitat, no additional habitat may be regenerated by vegetation management projects.
- **Standard VEG S2:** Timber management projects shall not regenerate more than 15% of lynx habitat on NFS lands within an LAU in a ten-year period. Salvage harvest within stands killed by insect epidemics does not add to the 15%, unless the harvest treatment changes the habitat to unsuitable.
- **Standard VEG S6:** Vegetation management projects that reduce winter snowshoe hare habitats in multi-story mature or late successional conifer forests may occur only: 1) within 200 feet of administrative sites, dwellings, outbuildings, etc.; 2) for research studies; 3) incidental removal during salvage harvest and 4) when uneven-aged management (resiliency – single tree and small group selection) are employed to maintain and encourage multi-story attributes as part of gap dynamics. Exception 1, 3 and 4 apply under SBEADMR. 3 apply – For incidental removal during salvage harvest (e.g. removal due to location of skid trails) or Exception 4 – Where single tree and small group selection practices are employed.
- **Guideline VEG G1:** Vegetation management projects should be planned to recruit a high density of conifers, hardwoods, and shrubs where such habitat is scarce or not available. Priority for treatment should be given to stem-exclusion, closed-canopy structural stage stands to enhance habitat conditions for lynx or their prey (e.g. mesic, monotypic lodgepole stands). Winter snowshoe hare habitat should be near denning habitat.

- **Guideline VEG G5:** Habitat for alternate prey species, primarily red squirrel, should be provided in each LAU.
- **Guideline VEG G11:** Denning habitat should be distributed in each LAU in the form of pockets of large amounts of large woody debris, either down logs or root wads, or large piles of small wind thrown trees ("jack-strawed" piles). If denning habitat appears to be lacking in the LAU, then projects should be designed to retain some course woody debris, piles, or residual trees to provide denning habitat in the future.

North American Wolverine ***Gulo gulo luteus***

The wolverine is included in this analysis because proposed management activities involve suitable habitat that may be occupied. Although occasional sightings of wolverine occur and are reported on the Forest, there had been no confirmed occurrences locally or in Colorado since 1919 until the recent arrival of M56, an individual male who arrived in 2009 from Wyoming and apparently remains in the north-central portion of the state (Colorado Division of Wildlife Website, Species of Concern, Wolverine, 2013). In addition, a wolverine was documented as a traffic-related mortality on Interstate 70 in 2012 within Region 3 of the Colorado Department of Transportation (CDOT 2012b).

In August 2014 (79 FSR 47522), the U.S. Fish and Wildlife Service (FWS) withdrew the proposed rule issues on February 4, 2013 (78 FR 7864) to list the Distinct Population Segment (DPS) of the wolverine that occurs in the contiguous U.S. as a threatened species under the ESA. The FWS also withdrew in August 2014, the associated proposed rule under section 4(d) of the Act to designate wolverine as a nonessential population under section 10(j) of the Act for the Southern Rocky Mountains.

Given that all potential habitat associated with the proposed action is currently unoccupied there will be no direct effect to the species. However, if the species is eventually reintroduced to or recolonizes Colorado, activities such as vegetation management and fuels reduction are not expected to have measureable influences on wolverine habitat because changes in vegetative characteristics has little affect to the species. These activities are also not identified as a potential threat to the species and are included in the proposed Section 4(d) incidental take allowances.

The SBEADMR project will not result in a loss of habitat for wolverines because habitat is not based on vegetative and geologic conditions, but more on the climatic conditions of an area. They have been found to use areas that are cold and receive enough winter precipitation to maintain deep snow late into the warm season in a variety of vegetation and geologic types. Forage conditions for wolverines will be altered as a result of the proposed project because vegetation treatments will result in changes in the types of plant and animal species available in treated areas. However, this is also not likely to affect wolverines because they are opportunistic feeders and consume a variety of fruits, nuts, berries, animals, birds and carrion. It is the availability of forage, not the type that makes up their diet. Therefore, treatments proposed for the SBEADMR project will not affect individual wolverines or their habitat.

Based on this analysis, I determine that the proposed management activities associated with this analysis ***"will not jeopardize"*** the wolverine or influence any future options for achieving a self-sustaining population in the Southern Rocky Mountains.

Critical Habitat

Critical habitat has not been designated for the North American wolverine.

Gunnison Sage Grouse ***Centrocercus minimus***

On November 20, 2014, the U.S. Fish and Wildlife Service (FWS) issued a final rule listing the Gunnison sage-grouse as threatened under the Endangered Species Act (79 FR 69192). The FWS also issued a final rule designating 1,429,551 acres of critical habitat in Delta, Dolores, Gunnison, Hinsdale, Mesa, Montrose, Ouray, Saguache, and San Miguel Counties in Colorado, and in Grand and San Juan Counties in Utah (79 FR 69312). Although the proposed commercial treatment activities do not involve suitable habitat for this species, Gunnison sage-grouse could potentially be affected because transportation routes to access treatment areas and haul material may cross occupied habitat consisting of National Forest, Bureau of Land Management and private lands. Non-commercial treatment does have the potential to affect designated critical habitat in the Gunnison and San Miguel populations.

On GMUG administered lands, there are 156,266 acres of critical habitat. The vast majority of critical habitat is located in the Gunnison Basin (620,616 total acres on federal, state, and private lands). The action alternatives have the potential to affect Gunnison sage-grouse in the Gunnison Basin population area and critical habitat unit. Gunnison sage-grouse habitat in the Gunnison Basin ranges from 7,500 to over 9,500 feet. Precipitation levels range from 7 to 16 inches depending on geographic area and elevation. The majority of sage-grouse habitat within the Gunnison Basin receives less than 12 inches of precipitation a year. Typical sagebrush types include mountain big sagebrush, Wyoming big sagebrush, and black sage. Mountain big sagebrush occurs at higher elevations and at lower elevations containing moist sites, and is the most common big sagebrush species on National Forest lands within Gunnison sage-grouse occupied areas and critical habitat.

The USDI Fish and Wildlife Service identified the following risk factors to Gunnison sage-grouse or their critical habitat (79 FR 69192 and 79 FR 69312):

- The most substantial current and future threats include habitat loss and decline due to human development and associated infrastructure.
- Due to low numbers in some of the satellite populations they are unlikely to persist into the foreseeable future (40-60 years), especially in the face of current and future threats identified above.
- Other threats that are impacting Gunnison sage-grouse to a lesser degree include overgrazing, mineral development, piñon-juniper encroachment, fences, invasive plants, fire, large scale water development, predation (primarily associated with human disturbance and habitat decline), and recreation.

Critical Habitat

Critical habitat has been designated for Gunnison sage-grouse.

Greenback Cutthroat Trout Oncorhynchus clarki stomias

There are at least 40 Conservation Populations of Greenback Cutthroat Trout (GBCT) on the GMUG. Greenback cutthroat trout populations on the GMUG are generally confined to mid- to high-elevation streams (> 2,500 m) with associated high gradients. Conservation Populations tend to occupy relatively pristine streams, although the surrounding watersheds may contain a substantial human footprint. Large-scale patterns of habitat occupancy observed today are most likely the result of incursion of non-native fish species along with water development in downstream portions of occupied watersheds. In the SBEADMR project area, 7 populations are known to exist in 3 GA.

Critical Habitat

Critical habitat has not been designated for Greenback cutthroat trout.

Effects of the Alternatives

Canada Lynx

Environmental Baseline

The existing condition in the action area has been affected by past and ongoing activities and natural processes, including forestry activities such as timber harvests, grazing, various recreational activities, wildlife use, and wildfire and associated suppression activities. Forested stands have been affected by bark beetle infestation resulting in mortality of trees that can be seen across the landscape.

The SBEADMR project will primarily treat Engelmann spruce-subalpine fir (*Picea engelmannii-Abies bifolia*) and aspen (*Populus tremuloides*) vegetation types. Both spruce-fir and aspen occur as or within a matrix of other vegetation types. Most spruce-fir stands in the project area range from 100 to 200+ year old and aspen range from 80 to 120 years old. Spruce-fir stands provide high quality denning, foraging and dispersal habitat for Canada lynx. Other species that utilize spruce-fir are boreal owls, olive-sided flycatchers and sometimes northern goshawks, and mammal species such as the American marten and pygmy shrews. Treatments in the planning area include opportunities to promote/maintain multi-storied, mature stand structures for denning and dispersal habitat that exist within the spruce-fir in the project area.

Aspen is also a common constituent in the primary vegetation type of the subalpine zone in the Southern Rocky Mountains, and can also form homogeneous stands. Aspen can also occur in the lower-elevation montane zone (Johnston, 2001). The species considered in this document generally occur in rare or unusual habitats within the montane and subalpine zones. Some of the aspen stands are those in which conifers are unlikely to succeed them. These stands are mature and are near the end of the physiological life span. Due to heavy browse pressure on aspen sprouts by wildlife species, the successful establishment of a new aspen stand is reduced. Aspen stands provide habitat for a variety of mammal and birds species including but not limited to deer, elk, small mammals (e.g. chipmunks, gophers, squirrels and voles), northern flicker, black-capped chickadee, house wren, warbling vireo, yellow-rumped warbler and dark eyed junco.

The spruce-fir zone, or subalpine zone, is the highest forested zone on the GMUG NF, occurring from around 9,500 ft. (2,900 m) elevation to the upper treeline, often called timberline. Upper treeline occurs around 11,500 – 12,000 ft. (3,500 – 3,650 m), somewhat higher in the south part of the forests and on north-facing slopes (Johnston and others 2001). The subalpine zone is dominated by large, continuous stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies bifolia*); sometimes lodgepole pine (*Pinus contorta*) or aspen (*Populus tremuloides*) will be dominant, but slowly seral to fir and spruce. There are openings and parks within this zone, a few large parks, with big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) or fescue grasses (*Festuca thurberi* or *F. idahoensis*). Riparian areas in relatively undisturbed condition are dominated by one of the smaller willows (*Salix planifolia, S. wolfii, S. brachycarpa*, etc.) and sedges (*Carex aquatilis* etc.). Most of the fens are in the subalpine zone (Johnston and others 2012).

The subalpine zone for the last few decades has seen a great deal of tree mortality. Various root diseases have affected subalpine fir, and beetles, budworms, and dwarf-mistletoe the Engelmann spruce. Almost all stands in this zone are at least partially dead; a trail through the subalpine will often be blocked by fallen trees, even a few days after a trail crew cleared it. Then in the last decade, spruce beetle has been increasing dramatically, killing whole stands of Engelmann spruce within a few years. This spruce beetle epidemic is the major focus of this project.

The montane zone, occurs below the subalpine zone, and on the GMUG NF it occurs between about 8,700 ft. (2,650 m) and 10,500 ft. (3,200 m). The montane zone is only partially forested, the forested portion dominated by lodgepole pine, aspen, ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*). There are occasional stands of blue spruce (*Picea pungens*). The rest of the montane zone is dominated by big sagebrush, Gambel oak (*Quercus gambelii*), and various other shrublands and grasslands. Riparian areas in relatively undisturbed condition have narrowleaf cottonwood (*Populus angustifolia*), blue spruce, various tall willows (*Salix monticola, S. geyeriana, S. drummondiana*, etc.) and sedges (*Carex utriculata*, etc.).

Many aspen stands in the montane zone experienced significant mortality from sudden aspen decline after a deep drought early in this century (Worrall, 2010; Worrall, 2013), especially aspen stands that had not been treated previously. Aspen decline is projected to continue in tandem with climate change, especially following future droughts (Worrall 2010). The severe epidemic by mountain pine beetle in lodgepole pine that decimated northern Colorado forests during that same period has yet to be seen on these national forests, although mountain pine beetle is present here, mostly in endemic quantities.

Specific details of environmental baseline for lynx include current condition and trend of affected Geographic Areas (GA), Lynx Analysis Units (LAU) and Lynx Linkage Zones (LLA), assessment of snowshoe hare and red squirrel habitat, influence of roads, and existing snow compaction levels in affected LAU and LLA. A detailed description for each of these factors is available in the Biological Assessment located in the project file.

Analysis Approach

Analysis of the SBEADMR project to Canada lynx and their habitat is based on the framework and incidental take statement established by SRLA and supporting documents (USDA Forest Service 2008) and the Biological Opinion (BO) issued by Fish and Wildlife Service (USDI Fish and Wildlife Service, 2008). Most of the impacts associated with the SBEADMR project were

addressed by these documents and therefore is included by reference. Analysis completed under SBEADMR builds on this analysis by examining potential effects of completing the maximum amount of treatment (60,000 acres commercial mechanical and 60,000 acres of non-commercial or prescribed burning) primarily at the Lynx Analysis Unit (LAU) scale.

Use of Potential Natural Vegetation (PNV) provides a benchmark from which current vegetative conditions can be compared, and it accounts for the Historic Range of Variability (HRV) under which an ecosystem has evolved. In the case of Canada lynx, management toward PNV provides for a range of habitat conditions important to all life stages, including but not limited to foraging, denning and dispersal. Specific assumptions include:

- At the Geographic Area (GA), e.g. Grand Mesa, and Lynx Analysis Unit (LAU) scales, vegetation will be managed toward Potential Natural Vegetation (PNV) as defined by the 2006 Comprehensive Assessment. The PNV data is summarized by Geographic Area, and it directly ties to the FS-Veg-Spatial data used for treatment planning. Environmental factors such as soils, slope, aspect, climate, elevation and natural disturbance regimes were used to define PNV.
- Managing a GA/LAU toward PNV helps mimic or approximate natural succession and disturbance processes while maintaining habitat components necessary for the conservation of lynx (VEG O1), provides a mosaic of habitat conditions through time to support dense horizontal cover, and supports high densities of hares in both the stand initiation structural stage and in mature, multi-story conifer vegetation (VEG O2).
- Design features identified in Appendix B of the FEIS will be used during treatment design to minimize or avoid impact to the understory (WFRP-11, 12, 20); to maintain connectivity (WFRP-17); to retain areas of live and dead trees (WFRP-2, 10, 20 and 23); to maintain large woody debris (WFRP 3 and 4); and to ensure LAU impact limits are not exceeded (WFRP-18).
- Annual tracking and reporting to the FWS will occur to ensure all aspects of the project are consistent with the SRLA.
- Annual Interdisciplinary Team reviews of one treatment per year will be completed to validate compliance and effectiveness of design feature implementation. In addition to the annual tracking reports required for all treatments, these SBEADMR IDT reviews will be provided to the Fish and Wildlife Service annually.

Since commercial mechanical treatments directly affect spruce-dominated ecosystems, it is assumed that 100 percent of these acres will affect lynx habitat to some extent. Road construction, reconstruction and use will also affect lynx. During treatment planning, the appropriate silvicultural prescription in the Silvicultural Prescription Matrix and the appropriate Design Feature to avoid or minimize negative effects would be applied (Appendices A and B). Impacts discussed below would occur and impacts would stay within predicted ranges. The following assumptions and data are used to assess impacts under current stand conditions and adapted (future) stand conditions if spruce beetle activity continues leading to higher levels of mortality in the future. The adaptive stand condition analysis allows flexibility during implementation with ever changing forest stand conditions resulting from spruce beetle induced mortality.

Commercial Harvest Related Impact Assumptions:

Current stand condition analysis approach (levels of spruce-fir and spruce-fir-aspen overstory mortality as of 2015 - <40%; >40% but less than 90%; and >90% in spruce and spruce-aspen stands).

- For each priority treatment area existing conditions of spruce-fir and spruce-fir-aspen stands were determined based upon current levels of overstory mortality using Remote Sensing Application Center Data (RSAC) – tree data comparing vegetation data from 2002 to 2014.
- For LAU and lynx linkage area (LLA) affected by SBEADMR the following data was summarized for mapped lynx habitat.
    - Existing stand conditions were divided into three treatment types - resiliency (<40% overstory mortality), combination (>40% but less than 90% overstory mortality) and salvage (>90% overstory mortality).
    - Acres of potential resiliency, combination and salvage treatment were calculated.
    - Using FSVEG, acres of single storied versus multi-storied stands were determined.
    - It was assumed than 50% of multi-story stands support high quality lynx habitat defined as having greater than 35% Dense Horizontal Cover (USDA Forest Service 2008).
    - In single storied stands it was assumed that the presence of >90% over story mortality makes the stand unsuitable per requirements of the SRLA. It is assumed that single storied stands lack an understory and therefore are unsuitable as lynx habitat even if salvage were to occur. Multi-story stands would remain suitable lynx habitat since they have a live understory providing habitat for snowshoe hare.
    - Acres of existing road and proposed road were determined (40 foot clear width x 5280 feet x # miles). It is assumed that construction of a road will result in a long-term loss of lynx habitat. However, under SBEADMR all constructed roads will be decommissioned and vegetation including trees will be reestablished over time. To simplify the analysis, it is assumed that this habitat will be lost over the life of the SBEADMR project (10-12 years).
- For each LAU, acres of lynx habitat that is in unsuitable conditions as defined by VEG S1 and S2 were updated using vegetation treatment data derived from the Forest Service Activities Tracking System (FACTS). Data was updated through fiscal year 2015.
- By LAU, acres of lynx habitat currently unsuitable and the acres of habitat either through natural widespread mortality from spruce beetle activity or acres converted to unsuitable due to management were determined.
- Compliance with VEGS1(no more than 30% of lynx habitat converted to a Stand Initiation Structural Stage (SISS) from anthropogenic or natural causes and VEGS2 (no

more than 15% of lynx habitat converted to SISS from timber management actions over a 10-year period were determined).

- Compliance with VEG S6 (applies to multi-story spruce-fir stands) that considered high quality having a DHC >35%.

Adapted/Potential Future Stand Condition Analysis Approach

This approach considered the potential future forest condition based upon the assumption that all mid-late and late (habitat structural stages 4A, 4B and 4C) in spruce-fir and spruce-fir-aspen die, and that all subsequent spruce treatments administered under the SBEADMR project are salvage.

- For each priority treatment area, adapted/potential future stand conditions of spruce and spruce-aspen stands were determined.
- For LAU and lynx linkage area (LLA) affected by SBEADMR the following data was summarized for mapped lynx habitat.
    - All analyzed acres were assumed to be treated with salvage; these were calculated for single and multi-storied stands.
    - Using FSVEG, acres of single storied versus multi-storied stands were determined.
    - It was assumed than 50% of multi-story stands would continue to support high quality lynx habitat defined as having greater than 35% Dense Horizontal Cover (USDA Forest Service 2008).
    - In single storied stands, it was assumed that the presence of >90% over story mortality makes the stand unsuitable per requirements of the SRLA. It is assumed that single storied stands lack an understory and therefore are unsuitable as lynx habitat irrespective of salvage activities. Multi-story stands would remain suitable lynx habitat since they have a live understory providing habitat for snowshoe hare.
- For each LAU, acres of lynx habitat that is in unsuitable conditions as defined by VEG S1 and S2 were updated using vegetation treatment data derived from the Forest Service Activities Tracking System (FACTS). Data was updated through fiscal year 2015.
- By LAU, acres of lynx habitat currently unsuitable and the acres of habitat either through natural widespread mortality from spruce beetle activity or acres converted to unsuitable due to management were determined.
- Compliance with VEGS1(no more than 30% of lynx habitat converted to a Stand Initiation Structural Stage (SISS) from anthropogenic or natural causes and VEGS2 (no more than 15% of lynx habitat converted to SISS from timber management actions over a 10-year period) were determined.
- Compliance with VEG S6 (applies to multi-story spruce-fir stands) that considered high quality having a DHC >35%.

The analysis compares key environmental baseline factors affecting lynx at a LAU, LLA and treatment level: Requirements of the SRLA, silvicultural prescription used, hazard tree and non-commercial treatments, road – construction and use, snow compaction, hare and red squirrel habitat, cumulative effects.

Alternative 1 (No Action Alternative) – Direct and Indirect Effects

Importantly, the main factor influencing lynx habitat is the spruce beetle epidemic. Activities associated with the proposed action alternatives are additive. Under the no action alternative there are no potential direct effects to lynx, as no human-influenced vegetation management activity would occur. Single story spruce stands experiencing extensive mortality (>90 percent dead overstory) would be converted to and suitable condition because they lack an understory of sufficient height to support hares. In multi-story spruce fir stands and in aspen with a spruce or fir understory above average snow depth would still support hares and therefore remains suitable lynx habitat. Through time, a patchy distribution of course woody debris (both standing dead and down trees) and newly regenerating trees and shrubs would develop across the landscape. Some areas would improve in quality as jackstraw piles form, root wads are exposed, and more course woody debris becomes available for denning. Other areas would become more open, releasing the understory vegetation. Most conifers less than 4 inches are expected to survive but mortality in areas heavily impacted by spruce beetles have killed trees as small as 1 inch (Eager, pers. comm.)

The spruce beetle epidemic is likely to indirectly affect lynx population dynamics by affecting the population dynamics of the lynx's primary and main alternate prey species, the snowshoe hare and red squirrel. Colorado Parks and Wildlife have recently examined the effects of beetle kill on red squirrel (Ivan, pers. comm.). Ivan data suggests that when overstory mortality is low (20 percent) occupancy (use) by red squirrels doesn't change. When overstory mortality reaches 60 percent, occupancy of red squirrels is reduced after about 3 years. As overstory mortality reaches 90 percent squirrel occupancy drops even further. At 90 percent mortality, Ivan only expects about 50 of 100 stands to have red squirrels.

Under this alternative, there would be no human-influenced (in terms of habitat manipulation) impact on lynx movement in the area and no additional road work would occur beyond standard forest-wide system road maintenance activities and implementation of the 2010 Travel Management Plan.

Overall, this alternative may offer lynx and lynx habitat the best opportunity for a continued mosaic pattern across the landscape with a mix of habitat types as influenced by natural processes. Areas with mortality in old spruce (late-mid and late seral) will shift many stands toward early to mid-seral even in the absence of active management.

Influences of climate change will continue at some level. Effects on lynx include 1) potential upward shifts the distribution of spruce-fir will force lynx and their prey to also move up in elevation and reductions in the amount of lynx habitat and associated lynx population size due to changes in precipitation, particularly snow suitability and persistence, and changes in the frequency and pattern of disturbance events (e.g., fire and insect outbreaks). The influence of climate change in the project area would occur, however, irrespective of active management.

This action would not introduce vegetation management as an additional factor potentially affecting lynx hunting, movement, or reproduction. Conversely, this alternative would not provide land managers the opportunity to implement the Southern Rockies Lynx Amendment (SRLA) and examine the influence of management techniques on lynx habitat and lynx use of the area.

In areas with extensive overstory mortality, the amount of large wood falling to the forest floor will increase availability of denning habitat and facilitate regeneration of spruce and aspen. In many mixed spruce and aspen stands with heavy over story mortality in the Gunnison Basin-South GA, aspen appears to becoming dominate. In spruce-fir stands having a seed source, regeneration of spruce and fir is also occurring. These regenerated stands are providing habitat for hares as well as lynx.

Alternative 1 (No Action Alternative) Cumulative Effects

Impacts from past management actions are reflected in the environmental baseline above. Impacts from present and reasonably foreseeable management actions, such as grazing, recreation use, roads use and maintenance, and other vegetation management projects occurring on State and private land would continue to have impacts to varying a varying degree. Any future management actions carried out by the federal government having an effect to Canada lynx are subject to analysis and project-specific consultation which will be completed at the time they are proposed.

Alternative 2 and Alternative 3 – Generalized Effects

A detailed description of direct and indirect effects from vegetation management activities are provided in the 2008 Biological Assessment (USDA Forest Service 2008) and 2008 Biological Opinion (USDI Fish and Wildlife Service 2008) and the final Record of Decision for the Southern Rockies Lynx Amendment (USDA Forest Service 2008). This analysis tiers to the 2008 BO and summarizes the effects of the proposed action at the site-specific level.

Table 225 provides a summary of direct and indirect effects to lynx, their habitat and preferred and secondary prey items as they relate to silvicultural prescriptions that will be applied. Generalized impacts un-related to silviculturalist prescriptions are also presented.

Table 225. Effects to Lynx Based on Type of Treatment in the Silvicultural Prescription Matrix.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
Single Storied	<40%	• Individual tree selection or group selections less than 2 acres in size. • Removal focused on pockets of dead and dying spruce-fir or live green stands. • Remove no more than 40% in the matrix to retain "wind firmness". • May require mechanical site preparation to stimulate seed germination. • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger. • All constructed roads will be closed during timbering operations. All roads will also be decommissioned within 5-years of sale closure with an estimated 70% closed by the purchaser when logging is complete (3-4 years).	Treatment design must be consistent with VEG O1, O2, and O4. No tracking under SRLA exemptions or exceptions.	Lynx productivity - Single storied stands are not high quality habitat for lynx or for hares. Treatments in these stands will not result in a significant loss of habitat. Use of Individual Tree Selection (ITS) and group selection prescription will help regenerate a multi-storied stand, increasing hare habitat in the understory. Stands will continue to provide suitable foraging habitat and are expected to improve quality over time. This prescription is considered a conservation measure under SRLA. Areas supporting regeneration will be avoided during road and harvest unit layout to the greatest extent practicable. All roads will be decommissioned within 5 years of the close of the sale. Road effects will occur over a period of 20-25 years following decommissioning (time period for all regenerated or planted spruce to grow to above-average snow depth). Incidental loss to the understory from skid trails and landings is estimated at 15%. Road construction and reconstruction will affect 100% within the road prism until such time that the roads are decommissioned and revegetated. See LAU-level analysis by management alternative below. Red squirrels are a secondary but important food source for lynx. In spruce-fir stands with less than 20% overstory squirrel use, (occupancy) does not change at all (Ivan, Pers. comm.) Group selections to enhance understory regeneration will have no measurable effect on squirrel density. Lynx mortality- Direct lynx mortality could occur during operations in a logging unit. Mechanical equipment could result in mortality to lynx, particularly young kittens, from felling trees. However, this is extremely unlikely due to noise and human activity that would likely cause lynx to be displaced from the area during harvest.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
				Areas of high quality denning habitat will be identified and avoided during layout (WFRP 11, 12). Mortality could also occur from collisions with logging trucks and other project related vehicles (see more detailed discussion and analysis under roads section below). Lynx movement – Typically small patch cuts and single tree selection mimics natural stand dynamics and have not been documented to impede lynx movement. Roads, especially highways and associated uses have been documented to impeded lynx movement. Lynx may also be displaced temporarily from an area do to noise and human activity. (see more detailed discussion and analysis under roads section below).
	Between 40-90%	• Remove all dead and dying spruce-fir in areas where adequate seed source are lacking. • Group selection where mortality is patchy up to 2 acres in size. • Where mortality is extensive the entire stand may be removed. • Maximum removal is 40% of present stocking within residual stand to maintain "wind firmness". • May require mechanical site preparation to stimulate seed germination. • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger.	Project design must be consistent with VEG O1, O2, and O4. No tracking under SRLA exemptions or exceptions.	Lynx productivity, mortality and movement are the similar as above. Single storied stands that are greater than 90% over-story mortality are considered unsuitable as defined by the SRLA. Salvage logging in these stands will not make them more "unsuitable". Removal of large trees to a greater extent can convert a "patch" into an opening which may discourage use by lynx by degrading horizontal cover, especially in winter. Lynx typically select homogeneous spruce-fir patches that support hares and avoid recent clear-cuts or other openings. Providing a mosaic that includes dense- early seral coniferous and mixed coniferous stands, along with a component of mature multi-story stands at the LAU scale is desirable for lynx (See LAU Habitat Structural Stage analysis below). Red squirrels are a secondary but important food source for lynx. In spruce-fir stands with greater than 60% squirrel number decline after 3 years (Ivan, pers. comm.). As overstory mortality increased to 90% squirrel number decline even further. Ivan further predicts to find only 50 out of 100 stands heavily impacted by spruce-beetles to support squirrels after 3 years. Removal of dead trees that are no longer producing a cone crop should have no

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
		• All constructed roads will be closed during timbering operations. All roads will also be decommissioned within 5-years of sale closure with an estimated 70% closed by the purchaser when logging is complete (3-4 years).		measureable increase in squirrel decline beyond what is caused through spruce-beetle induced mortality. Engelmann spruce trees won't produce a cone crop until they reach 15-40 years old and not a substantial crop until they reach 150 years old. Therefore in stands with heavy over-story mortality occupancy by large number of red squirrels will not occur for decades.
	>90%	• Remove all dead and dying spruce-fir and plant where adequate seed sources are lacking. • May require mechanical site prep. • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger.	Project design must be consistent with VEG O1, O2, and O4. No tracking under SRLA exemptions or exceptions.	If >90% is dead or projected to be dead in two years and there is no green understory present, it is considered unsuitable lynx habitat and further salvage logging will not make it "more" unsuitable. Effects top lynx productivity, mortality and movement are the same as above. Salvage harvest units are likely to be larger than 2 acres and therefore could impede lynx movement and use of openings at the stand scale. In stands with heavy over-story mortality, impacts to red squirrel are the same as described in single story – 40% to 90% over-story mortality. When treatment areas lack a seed source, spruce-fir will be replanted. Over time these planted stands will grow above average snow depth, once again provide hare habitat on the site. Regrowth to this height is expected to take 25 + years.
Two Storied	<40% and ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. Focus treatments in areas where understory is lacking or of poor quality. • Removal focused on pockets of dead and dying spruce-fir. • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger.	Veg S1, S2 and S6	High quality habitat will continue to exist for lynx after treatments are implemented. Both denning and foraging habitat will continue to exist post treatment and stands are expected to be more resilient to future bark beetle attacks. This will also result in stands continuing to support lynx habitat and will decrease the chances of habitat loss in the long term. Some incidental impact to the understory will occur from skid trails and landings which are estimated to be 15%. Road construction will result in loss of understory vegetation on 100% of the footprint of the road. Effects to lynx productivity, mortality and movement are the same as described for single-storied stands with <40% mortality.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. Focus on pockets of dead and dying. • Reduction of ladder fuels within 200' of infra-structure in WUI is allowed. • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger where they occur in the stand.	Veg S1 and S2	Generally same as above. Areas with less than 35% DHC, will be the areas targeted for treatment with group selection treatments with the goal of to mimic natural stand dynamics and to encourage understory regeneration. Some incidental impact to the understory will occur from skid trails and landings which are estimated to be 15%. Road construction will result in loss of understory vegetation on 100% of the footprint of the road
	Between 40-90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness". • Pockets of high quality hare habitat (>35% DHC) will be protected to extent possible in clumps of 1/3 acre or larger.	Uneven aged prescription VEG S1 and S2 Salvage or even aged prescription VEG S1, S2 and S6.	It is estimated that 50% of these stands will be managed using a salvage prescription and 50% using a resiliency prescription. These stands are high quality habitat and treatments will retain as much of that habitat in stands as possible. Areas with DHC >35% in pockets of a 1/3 acre or larger will be avoided. Lynx productivity - The removal of dead and dying trees will affect lynx habitat by altering stand structure reducing canopy cover. Understory vegetation will be retained as much as possible which will provide habitat for snowshoe hares. The 1/3 acre or larger retention areas will also provide areas of standing and down wood in the matrix providing habitat for hares and micro-sites for spruce regeneration. Use of a variable retention silvicultural prescription will provide a matrix of habitat clumps throughout the cutting unit. Some incidental impact to the understory will occur from skid trails and landings which are estimated to be 20%. Road construction will result in loss of understory vegetation on 100% of the footprint of the road. In heavy over-story stands, impacts to red squirrel are the same as described in single story – 40% to 90% over-story mortality. Lynx mortality – Same as single storied stand prescription.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
				Lynx movement – Removal of large trees to a greater extent can convert a "patch" into an opening which may discourage use by lynx by degrading horizontal cover, especially in winter. Lynx typically select homogeneous spruce-fir patches that support hares and avoid recent clear-cuts or other openings. Providing a mosaic that includes dense- early seral coniferous and mixed coniferous stands, along with a component of mature multi-story stands at the LAU scale is desirable for lynx (See LAU Habitat Structural Stage analysis below).
	Between 40% and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Uneven-aged prescription VEG S1 and S2 Salvage or even aged prescription VEG S1, S2.	It is estimated that 50% of these stands will be managed using a salvage prescription and 50% using a resiliency prescription. These stands are high quality habitat and treatments will retain as much of that habitat in stands as possible. Areas with DHC >35% in pockets of a 1/3 acre or larger will be avoided. Lynx productivity – Generally same as treatments in 40-90% and >35% DHC. However, when un-even-aged prescriptions (group selections and ITS) are used they will be concentrated in areas where DHC is lacking or of poor quality. Residual impact to the understory is estimated to be 20%. These prescriptions will help maintain or promote age-class diversity and regeneration of an understory. Resulting managed stand will have a matrix of habitat islands of varying size between managed stands. These islands will provide a source of snags and down wood. Maintaining large wood in cutting units (WFRP-3) will create microsites for vegetation establishment and additional cover for various wildlife species. Lynx mortality – Same as 40-90% and >35% DHC. Lynx movement - Same as 40-90% and >35% DHC.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
	>90% and ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• Stand no longer two storied due to dead overstory. • Salvage of dead and dying spruce-fir.	Incidental damage to advanced regeneration tracked under VEG S1 and S2	>90% and ≥35% DHC – Generally these areas will be avoided during layout using a variable retention silvicultural prescription in 1/3 acre groupings or larger. Impacts to lynx productivity, are the same as over-story mortality 40-90% and ≥35% DHC. Lynx movement - Same as 40-90% and >35% DHC. Stands with >90% overstory mortality and <35% DHC will be the focus areas for salvage. Again pockets of DHC >35% are likely to be interspersed in the treatment unit and will be left as retention areas. Residual impact to the understory is estimated to be 25%.
Multiple Canopies	<40% ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Veg S1, S2 and S3.	Lynx productivity, mortality and movement: same as described for <40% and ≥35% DHC above. Residual impact to the understory is estimated to be 15%.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Veg S1 and S2	Lynx productivity, mortality and movement: same as described for two-storied <40% and <35% DHC above.
	Between 40 and 90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Uneven-aged prescription Veg S1 and S2. Salvage or even aged prescription Veg S1, S2 and S6.	Lynx productivity, mortality and movement: same as described for two-storied between 40 and 90% and ≥35% DHC above. Residual impact to the understory is estimated to be 20%.

Stand Condition	Overstory Mortality Level	Treatment	SRLA Tracking	Effects to Lynx Habitat
	Between 40 and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Uneven aged prescription Veg S1 and S2. Salvage or even aged prescription Veg S1 and S2.	Lynx productivity, mortality and movement: same as described for two-storied between 40 and 90% and <35% DHC above.
	>90% ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• If two canopies still alive, it is a multi-storied stand. • Salvage of dead and dying.	Incidental damage to advanced regeneration tracked under VEG S1 and S2	Lynx productivity, mortality and movement: same as described for two-storied with >90% over-story mortality with <35% DHC and ≥35% DHC above. Residual impact to the understory is estimated to be 25%.

Commercial Mechanical – Generalized Effects

Direct and Indirect Effects - Common to Both Action Alternatives

Direct effects are those that are caused by the action (salvage-related harvest activities) and occur contemporaneous with the action (e.g., felling a tree directly causes lynx mortality or direct loss of habitat). Harvest of dead trees could result in mortality to lynx, particularly young kittens, from felling trees but this is extremely unlikely due to noise and human activity that would likely cause lynx to be displaced from the area during harvest. Direct impacts may range from temporary disturbance due to harvest and possible, but unlikely, direct mortality resulting from salvage activities.

Noise from logging operations may reduce lynx use in the immediate harvest areas and haul routes. Displacement of lynx during operations is expected to be short-term with increasing use of the area once operations subside. Based on anecdotal information, individuals would most likely avoid disturbance in the immediate area but otherwise continue to utilize undisturbed portions of the LAUs and linkage area as well as the project area when human activity and logging operations are lacking. Harvest operations and associated activities could occur for up to nine months each year for a period up to 10-12 years, but harvest operations will be staggered spatially and temporary and will not impact the entire project area at once.

Lynx kittens are vulnerable when very young and/or could be present nearby or in den sites while salvage operations are taking place and could potentially be injured or killed by logging equipment and activities. However, much of the salvage activity will occur during the summer, fall, and winter months outside of the lynx denning period (April – late June) due to wet soil conditions.

Indirect Effects - Common across All Action Alternatives

Indirect effects are caused by or will result from the proposed action and are later in time, but are reasonably certain to occur. The proposed action would have short-term and long-term effects to lynx and habitat for snowshoe hare and red squirrel in the project area. Incidental loss of understory vegetation from logging will reduce the quality and quantity of winter foraging habitat for hares, displacing them to adjacent areas still providing habitat. Reduced foraging opportunities for lynx within and surrounding treatment areas may occur due to displacement of prey species and reductions in prey habitat. Reduced winter foraging and denning opportunities would occur due to the reductions in potential large coarse woody debris as trees are salvaged, and as trees fall causing further changes in canopy closure. However, as described above under the No Action Alternative, it is important to keep in mind that the main factor affecting lynx habitat and their prey base is the influence on habitat by the spruce-beetle itself which are both positive and negative; activities associated with the SBEADMR project are additive.

Both commercial and non-commercial mechanical treatments will be used to implement silvicultural prescriptions (see Appendix A). Both methods will degrade habitat by reducing cover and density of trees as a result of salvage activities and select harvest of trees. Mechanical treatments can also crush understory vegetation. This will also have a heavier impact on soils and to the overall landscape compared to non-mechanical treatments. Crushed vegetation and soil impacts will result in incidental loss of younger age class trees, such as sapling and pole size trees as equipment moves through stands. Mechanical treatments will result in a temporary loss

of habitat due to coppice cuts, road construction and pre-commercial thinning associated with WUI. Pre-commercial thinning in association with fuels treatments would only occur within 200 feet of structures, per requirements of the SRLA and would be subject to Forest-wide caps associated with VEG S1, VEG S5 and VEG S6. Non-commercial mechanical treatments will impact habitat, but will not have the same magnitude as commercial treatments. Incidental loss of saplings and pole size trees will be minimal as will impacts to soils and shrubby and herbaceous vegetation. Habitat will change in quality, but is not expected to result in a complete loss of habitat.

Resiliency treatments in spruce fir stands are intended to treat those stands where individual or pockets of trees are dead or dying due to bark beetle infestations. Treatments are intended to improve the resiliency of stands by removing dead and dying trees and habitat will remain because stands will still have live healthy trees standing. The goal of these treatments, per SRLA direction, is to maintain and promote multi-story attributes as part of gap dynamics. Resiliency treatments designed to maintain or encourage creation of a multi-story spruce-fir stand are considered a conservation measure under the SRLA.

Salvage treatments will occur in those stands where the majority of trees have been affected by bark beetle infestations. Salvage of all dead and dying trees in these stands will occur through mechanical means and will be followed up with reforestation activities. Once these areas have been treated, there will be few if any large spruce fir standing but residual pockets of dead and live trees will be retained within harvested units and in matrix areas surrounding harvest units. Where seed sources are lacking, seedlings will be planted. Establishment of young age classes of trees within the LAU will create a mosaic of old and young age classes across the landscape.

Combination treatments will include both resiliency where overstory mortality is low and salvage as the percent of overstory mortality increases. In multi-story spruce-fir stands a variable retention prescription would be applied, retaining everything spruce and fir of at least 8 inches in DBH or larger depending upon the silvicultural prescription applied to a specific stands. Treatments will be designed to minimize effects to understory vegetation particularly high quality hare habitat. Indirect effects of this prescription are retention of understory vegetation allowing the treated stand to retain its multi-storied characteristic in the long-term.

Road construction will result in a 100 percent loss of understory vegetation until timber harvest and post-sale activities have been completed. All newly constructed roads will be decommissioned within 5-years following sale closure. It is estimated that 70 percent of the new roads will be decommissioned by the purchaser when logging is complete. All newly constructed roads will also be closed to the public during logging operations. Road construction and reconstruction needed to access harvest units will reduce the amount of habitat within the PTA. It is assumed that the average road clearance width is 40 feet or 4.8 acres of understory habitat loss per mile of road construction. When roads are decommissioned, scarified to allow revegetation will occur when needed. Since it takes considerable time (25 + years) for spruce to regenerate a site and grow to above average snow depth, roaded areas will remain unsuitable for the foreseeable future.

Interrelated and Interdependent Actions - Common Across All Action Alternatives

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from

the action under consideration. Road maintenance, reconstruction of existing roads to facilitate log truck use, site preparation and re-planting of trees are all considered interrelated actions.

Reconstruction of an existing road is typically done to improve drainage and ensure the road can accommodate heavy loads. Reconstruction includes creation of drainage structures (rolling dips, cross drain culverts, etc.) and re-surfacing with gravel. Heavy equipment is used to complete this work. When road reconstruction occurs in suitable lynx habitat, lynx in the immediate area can be displaced due to noise and the presence of humans. Impacts are short-term, ending when heavy equipment ceases.

Site preparation occurs in harvest areas where re-generation of spruce occurs from natural sources or when re-planted when a natural seed source is lacking. Within the harvest unit, soils are scarified to create a seed bed. Established trees are avoided and typically only grass and forbs are disturbed. This is typically accomplished with heavy equipment. As with road re-construction, noise associated with human presence and heavy equipment will temporary displace lynx from the immediate area, ending with the activity has been completed.

Where a natural seed source is lacking, trees (typically Engelmann spruce) are replanted in harvest units. Planting is done by hand with large crews. Short-term, increases human presence will temporary displace lynx from the immediate area. Seedling spruce take approximately 25 years to grow above average snow depth 6-10 feet at which time the harvest unit will convert to unsuitable to suitable lynx habitat. Depending upon the density of the planted trees, hare habitat could range from suitable to high quality.

Non- Commercial Mechanical and Prescribed Fire – Generalized Effects

Table 226 provides a summary of direct and indirect effects to lynx, their habitat and preferred and secondary prey items as they relate to non-commercial silvicultural prescriptions that could be applied in lynx habitat. Other generalized impacts un-related to silviculturalist prescriptions are also presented in narrative below the table.

Table 226. Summary of Treatment Effects to Secondary Lynx Habitat in Aspen and Spruce-fir Aspen Stands

Aspen Stand Condition	Treatment		Effects
	High Suckering Potential	Low Suckering Potential	
No SAD or <50% SAD in stands	• Coppice treatments of aspen if tree defect is low to high. • Prescribed burn feasible if there are sufficient fine fuels	No treatment	
>50% SAD in stands.	Treatment- specific prescriptions to be determined based on site conditions.	• Allow continued succession of stand. • Plant site adapted conifer species as an option.	Secondary habitat for lynx is likely low quality because the amount of the stand affected by SAD. Treatments may further

Aspen Stand Condition	Treatment		Effects
	High Suckering Potential	Low Suckering Potential	
			degrade habitat unless DHC is retained at or above 35%.
Aspen Overstory with Spruce Fir Understory	• Since a spruce-fir understory in secondary lynx habitat (300 m of primary habitat) provides suitable hare habitat, removal of spruce-fir will not occur. Out-side lynx habitat, coppice cuts and/or selective removal of spruce-fir will occur to maintain aspen component. • Exception - treatments in WUI to remove spruce within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA	• Since a spruce-fir understory in secondary lynx habitat (300 m of primary habitat) provides suitable hare habitat, removal of spruce-fir will not occur. Out-side lynx habitat, coppice cuts and/or selective removal of spruce-fir will occur to maintain aspen component. • Exception - treatments in WUI to remove spruce within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA	Stands will continue to succeed to spruce-fir overtime, providing habitat for hares and lynx. Removal of spruce-fir in stands with an aspen overstory will reduce hare habitat in treated areas. These effects have already been addressed in the SRLA. Treatments will be tracked and reported to FWS annually under VEG S5.
Mixed Conifer with Aspen	• Since a spruce-fir understory in secondary lynx habitat (300 m of primary habitat) provides suitable hare habitat, removal of spruce-fir will not occur. Out-side lynx habitat, coppice cuts and/or selective removal of spruce-fir will occur to maintain aspen component. • Exception - treatments in WUI to remove spruce within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA	• Since a spruce-fir understory in secondary lynx habitat (300 m of primary habitat) provides suitable hare habitat, removal of spruce-fir will not occur. Out-side lynx habitat, coppice cuts and/or selective removal of spruce-fir will occur to maintain aspen component. • Exception - treatments in WUI to remove spruce within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA	Stands will continue to succeed to spruce-fir overtime, providing habitat for hares and lynx. Removal of spruce-fir in stands with an aspen overstory will reduce hare habitat in treated areas. These effects have already been addressed in the SRLA. Treatments will be tracked and reported to FWS annually under VEG S5.

Most non-commercial mechanical and prescribed fire activities will not occur in lynx habitat. Where is does, removal of spruce in mixed stands of aspen and spruce in secondary lynx habitat will be prohibited since they provide suitable hare habitat (WFRP -20). Thinning in WUI will occur as required under VEG S5 (within 200 feet of administrative sites, outbuildings or structures). In secondary lynx habitat (aspen within 300 meters – 984 feet of primary spruce

habitat), treatment of stands affected by SAD will help regenerate the affected stand. Coppice cuts in aspen on the GMUG have resulted in substantial regeneration (Shepperd, W.D and F.W. Smith, 2013). These thick stands of aspen provide hare habitat during the summer and once they get above average snow depth, habitat during winter. As the stands mature they self-prune, becoming less dense and become less suitable for hare.

Non-mechanical treatments include hand cutting usually with the use of chain saws, chipping and prescribe fire. Lynx will likely be temporarily displaced by these activities due to the increase in human presence, noise generated by chainsaws and chippers and smoke associated with prescribed fire activities. As described for commercial treatments, there will also be an increase in traffic associated with treatment activities, but it is unlikely to cause any direct collisions with lynx. As described above, both treatment types will likely temporarily displace lynx due to noise and the increased presence of humans. They will likely return to these areas once treatment activities cease. Based on anecdotal information, individuals would most likely avoid disturbance in the immediate area but otherwise continue to utilize undisturbed portions of the LAUs and LLAs. Treatment activities may occur at any time of the year, but will occur in different areas during different periods of time.

No road construction will occur to accomplish non-commercial treatments.

Alternative 2 (Agency Preferred Alternative) – Direct and Indirect Effects

Alternative 2 focuses on protection of community infrastructure and public safety, allow for a steady supply of timber to local mills, and move affected ecosystems toward desired conditions. Treatment methods include commercial mechanical, non-commercial mechanical and prescribed fire. Total acres of commercial PTA in lynx habitat are approximately 99,000 with an additional 8,425 acres of lynx habitat that could be treated for hazard tree removal. Acres of non-commercial mechanical or prescribed fire in Lynx habitat are 27,103. Total acres of lynx habitat potentially affected are 134,528.

Analysis on the effects to lynx was completed at the GA scale, LAU and LLA scales. At the appropriate scales factors known to affect long-term persistence of lynx on a landscape are addressed.

Alternative 2 – Magnitude of Effect at GA and LAU Scales

The purpose of this section is to provide an overview of the types of management that could occur in lynx habitat over the life of the project. A maximum impact approach is taken by assuming every acre in a commercial or non-commercial PTA will be managed and hazard trees will be removed on all roads. The reality is that both commercial and non-commercial treatments are capped at 60,000 acres each. Road side hazard tree removal is included in cap acres. Maps G-43 through G-48 (Appendix G) display lynx habitat by GA that could be affected under Alternative 2.

Grand Mesa

There are 6 LAU containing PTA in the Grand Mesa GA (Table 227). Total acres that could be managed are 15,440 acres commercial. Hazard tree removal will affect an additional 714 acres in 7 LAU. There are 6 LAU having non-commercial treatments, totaling 7,562 acres.

Approximately 13 percent of the total lynx habitat in the Grand Mesa GA could be affected by commercial treatment within all priority treatment areas that receive treatment. The Cottonwood Lakes LAU has the highest acreage in commercial PTA and also highest percent of lynx habitat that could be affected and Huntsman Mountain the least. However the current level of stands with greater than 90 percent overstory mortality (salvage) is less than 1 percent of the lynx habitat in the GA and 50 percent (4402 acres – 4 percent) will be managed with a salvage prescription. Resiliency treatments will occur on 6,149 or where mortality is relatively low to salvage harvest as mortality increases. The vast majorities of the stands (66 percent) in commercial PTA have less than 40 percent overstory mortality and therefore would be managed with a resiliency prescription. Hazard tree removal would occur on less than 1 percent of the suitable habitat in the GA.

Table 227. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat on the Grand Mesa GA.

	Combination	Resiliency	Salvage	Hazard Trees	Total (%)
Grand Mesa	**8805**	**6149**	**485**	**714**	**16153 (13)**
Cottonwood Lakes	4014	3152	141	95	7402 (30)
Green Mountain	1305	151	35	272	1763(7)
Huntsman Mtn	0	0	0	73	73(<1)
Island Lake	1544	239	309	43	2135(12)
Kannah Creek	493	1423	0	199	2115(18)
Mesa Lakes	1044	969	0	85	2098(12)
The Flat Tops	405	215	0	115	735(3)

Non-commercial treatments in lynx habitat will occur within WUI (Table 228). Three percent of lynx habitat in the GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Within spruce-aspen areas, spruce will be retained (WFRP-19). Pure aspen stands in lynx habitat and will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 228. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat within WUI.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Total (%)
Grand Mesa	**7,562**	**4,217**	**2,364**	**705**	**276**	**7562(3)**
Cottonwood Lakes	0	0	0	0	0	0(0)
Green Mountain	759	514	157	45	0	716(3)
Huntsman Mountain	782	769	11	2	0	782(1)
Island Lake	1768	1455	264	43	3	1765(10)
Kannah Creek	0	0	0	0	0	0(0)
Mesa Lakes	4870	2248	1,932	417	273	4870(28)
The Flat Tops	0	0	0	0	0	0(0)

Gunnison Basin – North and South

There are 23 LAU containing PTA in the Gunnison Basin North and South GAs. Total acres that could be managed commercially in the North GA are 16,700 and 28,493 in the South GA (Table 229). Hazard tree removal will affect an additional 2307 acres in 7 LAU in the Gunnison Basin – North and 2,728 in Gunnison Basin-South. Approximately 4 percent of the total lynx habitat in Gunnison Basin – North and 12 percent of lynx habitat in Gunnison Basin-South could be affected by commercial treatment.

Seven LAU have 10 percent or greater of lynx habitat proposed for commercial treatment. Gunnison Basin-North only has 1548 acres (<1 percent of lynx habitat in the GA) with greater than 90 percent overstory mortality and therefore will be managed as salvage. Approximately 50 percent of the combination acres will also receive salvage treatments (3150 acres or 1 percent). Resiliency treatments would occur on 6,548 acres or 2 percent of lynx habitat in the GA.

A high percentage of the stands in Gunnison-Basin-South are currently over 90 percent overstory mortality or are approaching 90 percent (combination acres). Due to the extensive beetle activity in the GA, most if not all combination stands will be greater than 90 percent overstory mortality prior to treatment. Only 15 percent of the stands in affected LAU have less than 40 percent overstory mortality. Within commercial PTA, this equates to loss of 85 percent of habitat structural stages 4A, 4b, and 4C (mid-late to late seral). Because mature spruce are an important habitat structural element for lynx and supporting prey, retention of live mature spruce where they are expected to persist is an important management consideration. WFRP –23 requires retention of live mature spruce in high mortality areas. At the GA-scale, 7 percent of lynx habitat could be treated with a salvage prescription and 4 percent of lynx habitat with resiliency prescriptions. Hazard tree removal would occur on less than 1 percent of the lynx habitat in the GA.

Table 229. Alternative 2 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type within Commercial PTA in Lynx Habitat on the Gunnison North and South GA.

	Combination	Resiliency	Salvage	Hazard Trees	Total
Gunnison Basin North	**6243**	**6548**	**1548**	**2307**	**16699(4)**
Brush Creek	302	41	0	322	665(2)
Castle Pass	512	117	48	16	693(2)
Fossil Ridge	0	0	0	24	24(<1)
Gothic	617	653	388	129	1787(6)
Grizzly Peak	0	0	0	5	5(<1)
Pitkin	803	646	339	358	2146(6)
Red Creek	1013	3304	154	584	5055(12)
Rocky Brook	2800	601	573	462	4436(11)
Soap Creek	0	0	0	2	2(<1)
Upper Taylor	0	0	0	247	247(1)
Upper Tomichi	133	73	0	158	364(1)
Whetstone Peak	63	1114	0	0	1177(8)
Gunnison Basin South	**10430**	**4254**	**11083**	**2728**	**28493(12)**
Alpine	1133	1081	289	83	2586(8)
Cathedral	566	86	1387	56	2095(10)
Cebolla	1013	306	3018	107	4444(11)
Chester	2669	705	1640	501	5515(17)
Cochetopa	730	546	27	623	1926(8)
Lake City	34	48	28	159	269(1)
Los Pinos Creek	2404	626	2756	504	6290(26)
Needle-Razor	553	225		158	936(5)
Sawtooth Mtn	0	0	0	102	102(<1)
Stewart Creek	1327	630	1938	427	4322(10)
Whitecross Mtn	0	0	0	8	8(<1)
Total	**16726**	**10802**	**12632**	**4276**	**45,193(7)**

Gunnison Basin-North has 4 LAU with 9,819 acres and Gunnison Basin-South has 4 LAU with 4272 acres of non-commercial treatments proposed (Table 230). Non-commercial treatments in lynx habitat will only occur within WUI. Two percent of lynx habitat in Gunnison-North and Gunnison Basin-South could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Pure aspen stands in secondary lynx habitat will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 230. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
Gunnison North	**10,195**	**6,137**	**2,068**	**1,131**	**859**	**2**
Fossil Ridge	4182	3504	227	184	267	11
Pitkin	3647	2106	328	626	587	9
Red Creek	767	151	593	23	0	2
Upper Tomichi	1223	376	920	298	5	4
Gunnison South	**4,272**	**2,281**	**1,143**	**746**	**102**	**2**
Chester	2,233	1003	448	704	78	10
Lake City	1,430	771	639	20	0	5
Los Pinos	0	0	0	0	0	0
Stewart Creek	578	507	56	1	14	<1

North Fork Valley

There are 9 LAU containing PTA in the North Fork Valley GA (Table 231). Total acres that could be managed are 8,940 acres commercial. Hazard tree removal could occur across any of the identified LAU where spruce and/or aspen are the dominate cover types associated with roads. Total acres of hazard tree removal are 879.

The Crater Lake LAU has the highest acreage in commercial PTA and also highest percent of lynx habitat. Five of the LAU have less than 5 percent of lynx habitat that could be affected. Under current stand conditions, only 6 percent of the stands in commercial PTA have overstory mortality greater than 90 percent. Approximately 50 percent of the combination acres will also receive salvage treatments (1700 acres). Therefore at the GA-scale <1 percent will be salvaged and resiliency would occur on 2 percent of lynx habitat in the GA. Hazard tree removal would occur on 879 acres (<1 percent) of the suitable habitat in the GA.

Table 231. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the North Fork Valley GA.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
North Fork Valley	**3409**	**4941**	**590**	**879**	**9722(4)**
Anthracite	0	0	0	8	8(<1)
Bald Mountain	177	548	159	43	927(3)
Beckwith Mtn	0	0	0	127	127<1)
Black Mesa	877	504	332	256	1969(6)
Chalk Mountain	200	1184		47	1431(6)
Crater Lake	1750	2706	54	221	4731(13)
Mount Gunnison	0	0	0	122	122(1)
Peeler Lakes	405	0	46	9	361(2)
Ragged Mtn	0	0	0	46	46(<1)

Approximately 1,898 acres of non-commercial treatments proposed in the GA (Table 232). Non-commercial treatments in lynx habitat will only occur within WUI. Less than 1 percent of lynx habitat in the North Fork GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Pure aspen stands in secondary lynx habitat will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 232. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
North Fork Valley	**1,898**	**1,878**	**0**	**5**	**16**	**<1**
Chalk Mountain	175	168	0	0	7	<1
Crater Lake	1,723	1,710	0	5	9	7

San Juan Mountains

There are 9 LAU containing commercial PTA in the San Juan Mountains GA (Table 233). Total acres that could be managed are 16,152 acres. Hazard tree removal could occur across any of the identified LAU where spruce and/or aspen are the dominate cover types associated with roads. Total acres of hazard tree removal are 1,456 acres.

Alpine, Iron Mountain and Lone Cone LAUs have greater than 10 percent of lynx habitat in commercial PTA. Little Cone is at 9 percent and the remainder are <1 percent. Under current stand conditions, 2,120 acres would be salvaged. Approximately 50 percent of the combination acres will also receive salvage treatments (4452 acres). Therefore approximately 4 percent of lynx habitat in the GA could receive salvage treatments and 2 percent managed for resiliency.

Table 233. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the San Juan Mountains GA.

	Combination	Resiliency	Salvage	Hazard Trees	Total(%)
San Juans	**8904**	**3672**	**2120**	**1456**	**16152(10)**
Alpine	3222	1090	1010	248	5570(11)
Amphitheater	0	0	0	100	100<1)
Chimney Rock	0	0	0	233	233(<1)
Dallas Creek	0	0	0	13	13(<1)
Iron Mountain	2026	355	4	13	2398(10)
Little Cone	1130	506	188	117	1941(9)
Lone Cone	2473	1714	813	270	5270(22)
Matterhorn	53	7	105	17	182(1)
Turret Ridge	0	0	0	445	445(2)

Approximately 410 acres of non-commercial treatments proposed in the GA all within the Little Cone LAU (Table 234). Non-commercial treatments in lynx habitat will only occur within WUI. Less than 1 percent of lynx habitat in the San Juan GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Pure aspen stands in secondary lynx habitat will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 234. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
San Juan Mountains	**410**	**333**	**67**	**10**	**0**	**<1**
Alpine	31		21	10		<1
Little Cone	379	333	46	0	0	2

Uncompahgre Plateau

There are 2 LAU containing PTA in the Uncompahgre Plateau GA. Total acres that could be managed are 28,524 acres commercial (Table 235). Hazard tree removal could occur across any of the identified LAU where spruce and/or aspen are the dominate cover types associated with roads. Total acres of hazard tree removal are 341acres.

If all stands are managed in affected LAU, 51 percent of lynx habitat would be affected. However under current stand conditions, only 351 acres (1 percent) have greater than 90 percent overstory mortality and therefore salvaged. Approximately 50 percent of the combination acres will also receive salvage treatments (6,836 acres or 12 percent). Approximately 26 percent of habitat in the GA managed for resiliency. Hazard tree removal would occur on 341acres (1 percent) of the suitable habitat in the GA.

Table 235. Alternative 2 - Acres of Spruce-Fir and Spruce-Fir-Aspen by Treatment Type in Lynx Habitat in the Uncompahgre Plateau GA.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
Uncompahgre Plateau	**13673**	**14159**	**351**	**341**	**28524(51)**
Spring Creek	8801	8449	124	55	17429(57)
Traver Mesa	4872	5710	227	286	11095(44)

Approximately 2,766 acres of non-commercial treatments proposed in the GA all within two LAUs (Table 236). Non-commercial treatments in lynx habitat will only occur within WUI. Approximately 5% of lynx habitat in the Uncompahgre Plateau GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Pure aspen stands in secondary lynx habitat will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 236. Alternative 2 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
Uncompahgre Plateau	**2,766**	**1,631**	**1,097**	**36**	**1**	**5**
Spring Creek	2,543	1,465	1,040	36	1	8
Traver Mesa	223	166	57	0	0	<1

Hazard Trees and Non-Commercial Mechanical and Prescribed Fire – Direct and Indirect Effects

Hazard trees could affect 8,043 acres of lynx habitat across 49 LAU and 3 LLA. On slopes less than 40 percent, horizontal distance from the edge of the road is 150 feet. On slopes greater than 40 percent hazard trees could be removed up to 300 feet. Prescription use to remove hazard trees includes single tree selection when mortality is low and partial retention when the overstory is dead but the understory is still alive. When (combined) variable retention prescription is used, typically trees under 8 inches dbh will be retained.

Direct effects of hazard tree removal are a reduction of cover for hares and security cover for lynx movement. Since public safety is the primary objective for removing hazard trees, retention of understory vegetation will occur to the greatest extent practicable. Design Feature WFRP – 12 which required retention of standing dead trees when the understory >35 percent DHC may not occur in some instances when public safety is a concern. While cover will be retained, hare habitat retained will generally be of low quality following harvest. Areas that support a mixture of spruce and aspen, removal of hazard trees will disturb the soils through mechanical operations and increase sun exposure to the forest floor. Aspen is expected to be regenerated in such circumstances, creating dense stands of young aspen.

Hazard tree removal will also result in a loss of large wood. Large wood provide cover and may enhance lynx foraging habitat in the short term. Since hazard trees are being removed in close proximity to roads, it is unlikely these areas would be used as denning habitat. Removal of down wood will have minimal effect to denning habitat. WFRP-3 requires retention of 10-20 tons of down wood with a preference toward larger sized material.

Vegetation management prescription resulting in an opening with no or limited cover greater than 328 feet can change lynx movement and use patterns until such time that sufficient reestablishment of forest vegetation occurs (Interagency Lynx Biology Tem 2013). In most

cases, hazard trees could create an opening 328 feet across if both sides of a road are treated at the same time (e.g. road clearing width range from 20-50 feet depending on road maintenance levels). However, retention of understory vegetation will provide some cover allowing lynx movement in these areas. Design features for big game (WFRP-5) and American (Pine) Marten will also help maintain connectivity in these areas. While impacts to lynx movement could occur at a road segment scale, it is not anticipated to be measureable at a LAU scale.

Non-commercial mechanical and prescribed fire areas were identified because they represent landscapes where fire has or should play a significant role in shaping ecosystems. Priority treatment areas were also selected because they are in close proximity to infra-structure and/or communities (WUI). In order to create manageable burn treatment units, man-made or natural features were selected which included non-target vegetation communities. In the case of lynx habitat, the vast majority of the 28,708 acres identified for potential non-commercial treatment is primarily mapped as secondary habitat composed of pure aspen stands and aspen-spruce stands within 300 meters of primary, spruce-fir habitat. As mentioned previously, spruce-fir in stands with an overstory of aspen will not be removed when they occur in secondary lynx habitat. Aspen stands that lack a regenerated understory or affected by SAD will be targeted.

The goal of restoring aspen is part of a broader Forest Service goal to restore ecosystem processes, forest structure, composition and structure. Restoration of aspen in areas that are in decline but is expected to be retained in the future even with the influence of climate change, increases resiliency of the Forest as a whole. Over time, fire suppression has altered vegetation mosaics, species composition and age-class distribution. As previously mentioned, aspen and spruce-fir stands across all GA are dominated by mid-late to late seral stands. Regenerating aspen stands will benefit secondary lynx habitat by increase are class distribution. Increasing aspen on the landscape along with commercial mechanical treatments strategically placed on the landscape will afford increased protection to local communities and infra-structure when spruce-fir stand replacing fires occur.

Habitat Connectivity at GA Scale - Direct and Indirect Effects

Geographic Area Scale

Grand Mesa

The Grand Mesa supports approximately 125,000 acres of suitable lynx habitat. This habitat is characterized by aspen and spruce-fir cover types each currently occupy 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area. Approximately 84 percent of the forest and woodland cover types are in the mature size class. There is very little early seral condition in any cover type on the Grand Mesa Geographic Area.

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 237 and Table 238 provide a comparison of current range of seral conditions as compared to PNV. Potential Natural Vegetation is established as a long-term goal for lynx habitat since it provides for a mosaic of habitat conditions which includes dense early–coniferous and mixed-coniferous-deciduous stands along with components of mature multi-story coniferous stands. The Grand Mesa is currently dominated by mid-late or late serial conditions. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, mortality in mature spruce intensifies retention of mature live spruce needs to be a management priority. Removal of dead spruce is not expected to be a significant effect at the GA scale as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx habitat at the GA scale.

Table 237. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Grand Mesa GA.

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	1%	7%	92% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	2%	11%	87%	

Table 238. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Grand Mesa GA

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	15%	83% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	12%	14%	74%	

Gunnison Basin North and South

The current vegetation within the Gunnison Basin Geographic Area can be characterized by approximately 46 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent are in mature size class (mostly in the spruce-fir cover type). Photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists. The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 239 and Table 240 provide a comparison of current range of seral conditions as compared to PNV. Of the 428,681 acres of suitable lynx habitat in Gunnison Basin North and 247,686 acres in the Gunnison Basin South, Alternative 2 has 6 percent and 16 percent respectively within a commercial PTA. Gunnison Basin North and South are currently at or slightly above VDDT modeled range of mid-late or late seral conditions. Early-mid percentages are higher than modeled values. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Natural mortality of mature spruce is likely to continue in the GA especially in Gunnison Basin – South. Where extensive mortality has occurred and the understory has regenerated, levels of early and early-mid will shift at the GA and LAU scales. In areas with high overstory mortality, retention of live

mature spruce needs to be a management consideration. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA scale.

Table 239. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Gunnison Basin North and South GA.

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	31%	59% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	1%	45%	54%	

Table 240. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Gunnison North and South GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers , and occasional lodgepole pine with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and occasional lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	52%	47% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	5%	50%	45%	

North Fork Valley

The vegetation in the North Fork Valley Geographic Area can be characterized as aspen being currently the dominant tree species occurring on the North Fork Valley Geographic Area, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area. Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type).

The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 241 and Table 242 provide a comparison of current range of seral conditions as compared to PNV. North Fork GA is currently at or slightly above VDDT modeled range of mid-late or late seral conditions. Early-mid percentages are higher than modeled values but early seral are well below modeled ranges. Alternative 2 has 3 percent of the lynx habitat in the GA within a commercial PTA. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. These management induced shifts are expected to be relatively small since such a small amount lynx habitat in the GA will be managed. Under current levels of mortality in the GA, landscape –level shifts from late to early seral have not occurred. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA scale.

Table 241. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the North Fork GA.

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	34%	66% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	0%	35%	65%	

Table 242. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the North Fork GA

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	54%	45% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	3%	53%	44%	

San Juans

The vegetation in the San Juans Geographic Area can be summarized as having Spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juans Geographic Area. The San Juans Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types. Approximately 86 percent of the forest and woodland cover types are in mature size classes. There is very little early seral condition in any cover type on the San Juans Geographic Area.

The trend across all vegetation cover types on the San Juans is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 243 and Table 244 provide a comparison of current range of seral conditions as compared to PNV. Lynx habitat in the San Juan GA is currently dominated by mid-late or late serial conditions. Of the 155,185 acres of suitable lynx habitat in the GA, alternative 2 has 8 percent of the landscape in a commercial PTA. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive at this time; retention of live mature spruce is not a high priority management consideration. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA scale.

Table 243. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32 percent	20-24%	12-13%	31-40%
Current Seral Conditions	0%	11%	88% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	3%	13%	84%	

Table 244. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	0%	22%	78% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	0%	22%	78%	

Uncompahgre Plateau

The vegetation within the Uncompahgre Plateau Geographic Area can be characterized as a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66 percent are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).

The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

Table 245 and Table 246 provide a comparison of current range of seral conditions as compared to PNV. Lynx habitat in the Uncompahgre GA is currently dominated by mid-late or late serial conditions. Of the 55,572 acres of suitable lynx habitat in the GA, alternative 2 has 51% of the landscape in a commercial PTA. Alternative 2 will treat mature stands, moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive at this time; retention of live mature spruce is not a high priority management consideration. However, as mortality in mature spruce increases, retention of mature live spruce needs to be a management priority in treated stands. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA scale.

Table 245. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the Uncompahgre GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	14%	84% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	15%	22%	63%	

Table 246. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Uncompahgre Plateau GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory, lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	1%	37%	62% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 2	7%	37%	57%	

Standard Veg S2 - Direct and Indirect Effects

VEG S2 applies to all vegetation management projects that regenerate forested stands, except for fuel treatments in WUI. Timber management projects shall not regenerate more than 15 percent of lynx habitat within an LAU in a ten-year period. Because SBEADMR is designed to be adaptive, the analysis was completed under current stand conditions and under future adaptive stand conditions. The analysis assumes all stands within a PTA would be managed and all roads proposed under alternative 2 would be constructed. Assumptions regarding level of impact by silvicultural prescription previously described in the Analysis Approach were used to estimate impact.

Table 247 summarizes projected levels of conversion by treatment type for alternative 2. Under current stand conditions, acres converted to stand initiation structural stage (SISS) and incidental loss to the under story from proposed logging activities will not regenerate more than 15 percent in any of the affected LAU. The balance of acres range from a low of 714 acres in the Spring Creek LAU in the Uncompahgre Plateau GA, to a balance high of 5,390 acres in the Red Creek LAU, North Gunnison GA. If the level of mortality increases resulting in complete loss of all mature spruce, management actions would shift to exclusively salvage harvest and the level of potential impact increases. If all stands in PTA were to be managed with salvage treatments, two LAU could exceed 15 percent conversion to SISS (Alpine LAU - San Juan GA; and Spring Creek LAU - Uncompahgre Plateau GA). All treatments will be tracked and reported to FWS annually as required by the VEG S2 standard. If at any time the VEG S2 standard is approached, management actions will be modified or discontinued to ensure that the standard is not exceeded.

Table 247. Alternative 2 Commercial Treatments under Current Conditions with Lynx Habitat and Adapted/Potential Future Conditions of Spruce Beetle-Induced Mortality Becomes Widespread Across the GMUG.

Current stand conditions are those that exist in 2015. Potential future stand conditions are those that could exist if all mature spruce were to die from spruce beetle infestation. In both scenarios, all single-storied stands with greater than 90 percent overstory mortality would be converted to stand initiation structural stage (SISS) making then unsuitable as lynx habitat.

Geographic Area	LAU	Overlapping Lynx Habitat Acres	Proposed Action: Assumed Incidental Impact to Stand Acres	Adapted/Potential Future Action (All Salvage): Assumed Incidental Impact to Stand Acres	Total Suitable Habitat in LAU	Total unsuitable Habitat in LAU from past activities	15% of lynx habitat	Acres converted to SISS - Existing	Balance acres based upon existing stand conditions (15% standard)	Acres converted to SISS - Adapted	Balance acres under adapted treatment (all salvage) (15% standard)
Grand Mesa											
	Cottonwood Lakes	7,189	1,328	998	24,994	63	3,759	890	2,806	3,276	420
	Green Mountain	1,489	290	18	24,113	17	3,617	650	2,950	1,416	2184
	Island Lake	2,090	364	314	18,327	132	2,769	510	2,127	860	1777
	Kannah Creek	1,894	326	484	11,698	47	1,755	0	1,708	17	1691
	Mesa Lakes	2,013	400	477	17,113	279	2,609	0	2,330	253	2077
	The Flat Tops	620	118	139	27,774	4	4,167	21	4,142	83	4080
Gunnison Basin North											
	Brush Creek	342	71	5	36,745	0	5,512	149	5,363	68	5444
	Castle Pass	671	139	110	30,599	111	4,606	104	4,391	250	4245
	Gothic	1,636	256	223	28,844	90	4,340	424	3,826	91	4159
	Pitkin	1,768	348	416	38,849	1,132	5,997	95	4,770	161	4704
	Red Creek	4,355	724	890	41,930	896	6,424	138	5,390	879	4649
	Rocky Brook	3,926	807	997	41,833	60	6,284	8	6,216	15	6209
	Upper Tomichi	177	33	38	30,032	129	4,524	9	4,386	27	4368
	Whetstone Peak	787	131	50	15,553	0	2,333	21	2,312	597	1736

Geographic Area	LAU	Overlapping Lynx Habitat Acres	Proposed Action: Assumed Incidental Impact to Stand Acres	Adapted/Potential Future Action (All Salvage): Assumed Incidental Impact to Stand Acres	Total Suitable Habitat in LAU	Total unsuitable Habitat in LAU from past activities	15% of lynx habitat	Acres converted to SISS - Existing	Balance acres based upon existing stand conditions (15% standard)	Acres converted to SISS - Adapted	Balance acres under adapted treatment (all salvage) (15% standard)
Gunnison Basin South											
	Cathedral	2,024	453	488	21,286	147	3,215	155	2,913	155	2913
	Cebolla	4,316	1,035	1,079	40,869	1,434	6,345	85	4,826	125	4786
	Chester	4,848	1,039	1,192	32,067	144	4,832	186	4,502	273	4415
	Cochetopa	3,033	242	305	25,087	345	3,815	326	3124	452	3018
	Lake City	82	18	19	25,251	213	3,820	0	3,607	13	3594
	Los Pinos Creek	5,433	1,116	1,191	23,834	1,073	3,736	570	2,093	780	1,883
	Needle-Razor	684	132	123	17,822	82	2,686	98	2,506	488	2116
	Stewart Creek	4,552	824	908	26,858	861	4,158	363	2,971	499	2,756
North Fork Valley											
	Bald Mountain	799	150	128	32,171	335	4,876	19	4,522	298	4243
	Black Mesa	1,571	330	394	33,391	501	5,084	20	4,563	59	4524
	Chalk Mountain	604	109	158	24,639	0	3,696	0	3,696	0	3696
	Crater Lake	3,987	728	797	36,357	79	5,465	84	5,302	912	4474
	Peeler Lakes (Kebler	541	92	62	23620	915	22664	158	21591	1345	20404
San Juans											
	Alpine	5,298	909	345	32,051	990	4,956	2156	1810	3987	-21
	Iron Mountain	2,349	453	68	24,618	0	3,693	999	2,694	2,077	1616
	Little Cone	1,568	275	3	22,125	284	3,361	0	3,077	1,577	1500
	Lone Cone	4,732	867	438	24,476	618	3,764	1,207	1,939	3,081	65
	Matterhorn	165	12	3	25,594	0	3,839	125	3,714	152	3687

Geographic Area	LAU	Overlapping Lynx Habitat Acres	Proposed Action: Assumed Incidental Impact to Stand Acres	Adapted/Potential Future Action (All Salvage): Assumed Incidental Impact to Stand Acres	Total Suitable Habitat in LAU	Total unsuitable Habitat in LAU from past activities	15% of lynx habitat	Acres converted to SISS - Existing	Balance acres based upon existing stand conditions (15% standard)	Acres converted to SISS - Adapted	Balance acres under adapted treatment (all salvage) (15% standard)
Uncompahgre Plateau											
	Spring Creek	16,579	3,046	929	30,485	397	4,632	3,521	714	12,955	-8,720
	Traver Mesa NEW	9,659	1,747	2,063	25,087	436	3,828	1,216	2,176	1,611	1,781

Lynx Linkage Area - Direct and Indirect Effects

There are four Lynx Linkage Areas (LLA) that overlap PTA for the SBEADMR project area (Table 248). Linkage areas may consist of forest stringers that connect large forested areas, or mountain passes that connect subalpine forests on opposite sides of a mountain range. These LLAs total 413,296 acres and provide habitat connectivity for lynx to move from one forested area to another. Acres of potential treatment in the Poncha Pass and North Pass LLA are less than 2%; acres of potential treatment in Battlement Mesa amount to 4% of the LLA. Each of the potential treatment acres in the Battlement Mesa LLA are in aspen affected by Sudden Aspen Decline and not considered lynx habitat. Due to the small acreage proposed in these LLAs and through proper implementation of design features, connectivity will be maintained or improved in these LLA. For example, regeneration of aspen as a result of the proposed treatments in the Battlement Mesa LLA will increase cover for lynx movement in the medium and long-term. In addition, no treatment will span the entire length or width of any linkage and therefore connectivity will be maintained. Forest Service District Biologists will work closely with marking crews during treatment layout.

As much as 1/3 of the Slumgullion/Spring Creek Pass could be actively managed under alternative 2. To determine how management of approximately 2,298 acres could affect connectivity, a comparison of current seral conditions was compared to PNV. Currently 95% of the spruce-fir and spruce-fir-aspen stands in the LLA are mid-late to late seral. Five percent are early-mid and no stands are currently mapped as early. Recent mortality in spruce of habitat structural stages 4A, 4B and 4C (mid-late to late seral) have significantly reduced this component of the ecosystem.

At current levels of overstory mortality, management of 2,298 acres of spruce-fir and spruce-fir-aspen cover types will result in a shift from the current 95% to 31% in mid-late to late seral. Early mid-seral will increase to 39% and early will increase by 1%. Modeled PNV ranges are 27-35% early, 20-24% early-mid and 45-60% mid-late/late. However, since these trees are already dead, salvage will have no additional impact on seral stage distribution. Retention of live mid-late and late seral stands should be a primary objective for management in the LLA. In addition, retention of advanced regeneration (<8 inches) and exclusion of areas supporting >35% DHC will retain sufficient cover to allow lynx movement in the LLA.

Table 248. Lynx Linkage Areas Occurring in the Proposed Action Area (Alt 2).

Name	Priority Treatment Areas acres and as percent of total acres in LLA	Total Acres in the LLA
Poncha Pass	1,196 (1.3%)	88,735
North Pass/Cochetopa Hills	484 (1.5%)	33,212
Slumgullion/Spring Creek Pass	2,298 (28.9%)	7,965

Name	Priority Treatment Areas acres and as percent of total acres in LLA	Total Acres in the LLA
Battlement Mesa	1,339 (4%)	283,475
Total Acres	**5,317**	**413,296**

Habitat Connectivity in LAU - Direct and Indirect Effects

Grand Mesa

When comparing the gap between the current condition and desired PNV in spruce-fir, all affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). The current levels of stands with greater than 90% overstory mortality in commercial PTA are 485 acres with an additional 8,805 acres with between 40-90% overstory mortality. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 65% of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift toward an earlier seral forest.

Under alternative 2, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 249). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35%) will be avoided. At the LAU scale, all shifts are less than 10% and most are less than 5%. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 249. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen by LAU in the Grand Mesa GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: spruce-fir PNV Type*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV Type*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Grand Mesa	Cottonwood Lakes	Current Seral Conditions	1%	3%	96% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	1%	12%	87%	
	Green Mountain	Current Seral Conditions	0%	5%	95%	
		Post Treatment Alternative 2	7%	6%	87%	
	Island Lake	Current Seral Conditions	0%	6%	94%.	
		Post Treatment Alternative 2	4%	11%	85%	
	Kannah Creek	Current Seral Conditions	0%	33%	67%.	
		Post Treatment Alternative 2	0%	35%	65%	
	Mesa Lakes	Current Seral Conditions	1%	10%	90%.	
		Post Treatment Alternative 2	1%	15%	84%	
	The Flat Tops	Current Seral Conditions	0%	2%	98%.	
		Post Treatment Alternative 2	0%	3%	97%	

Gunnison Basin - North

When comparing the gap between the current condition and desired PNV in spruce-fir, most affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). Exceptions are Peeler Lakes, Red Creek and Rocky Brook which approximate PNV ranges. The current levels of stands with greater than 90% overstory mortality in commercial PTA are 1,548 acres with an additional 6,296 acres with between 40-90% overstory mortality. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 78% of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift toward and earlier seral forest.

Under alternative 2, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 250). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35% protected where feasible) will be avoided. At the LAU scale, all shifts are less than 5%. Two of the LAUs (Peeler Lakes and Upper Tomichi) will not deviate from current conditions due to the low acres proposed for active management. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 250. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Gunnison GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Gunnison Basin - North	Brush Creek	Current Seral Conditions	0%	6%	94% .	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	1%	6%	93%	
	Castle Pass	Current Seral Conditions	0%	9%	91%.	
		Post Treatment Alternative 2	1%	10%	90%	
	Gothic	Current Seral Conditions	0%	22%	78%.	
		Post Treatment Alternative 2	2%	23%	74%	
	Peeler Lakes	Current Seral Conditions	0%	84%	16%.	
		Post Treatment Alternative 2	0%	84%	16%	
	Pitkin	Current Seral Conditions	0%	26%	74%.	
		Post Treatment Alternative 2	0%	28%	71%	
	Red Creek	Current Seral Conditions	0%	43%	56%.	
		Post Treatment Alternative 2	1%	46%	53%	
	Rocky Brook	Current Seral Conditions	0%	48%	52%.	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	0%	53%	47%	
	Upper Tomichi	Current Seral Conditions	0%	12%	88%	
		Post Treatment Alternative 2	0%	12%	88%	
	Whetstone Peak	Current Seral Conditions	0%	6%	94%	
		Post Treatment Alternative 2	0%	7%	93%	

Gunnison Basin - South

When comparing the gap between the current condition and desired PNV in spruce-fir, most affected LAU fall within PNV ranges for late-mid and late seral conditions - habitat structural stages 4A, 4B and 4C (Table 251). Exceptions are Stewart and Los Pinos that are slightly below PNV ranges. However both of these LAU have relatively high percentage of earl-mid meaning these stands are predominately pole-sized material. The current levels of stands with greater than 90% overstory mortality in commercial PTA are 11,083 acres with an additional 10,430 acres with between 40-90% overstory mortality. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 87% of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift toward and earlier seral forest.

Under alternative 2, approximately 25,767 acres would be managed commercially in the GA. Under current stand conditions, 11,083 acres of lynx habitat would be managed via salvage prescriptions, 10,430 acres combined treatment and 4,254 acres resiliency. Hazard tree removal could occur on 2,645 acres. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 77% of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Table 251. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Gunnison Basin- South GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Gunnison Basin - South	Alpine	Current Seral Conditions	0%	38%	62%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	2%	43%	54%	
	Cathedral	Current Seral Conditions	0%	58%	42%	
		Post Treatment Alternative 2	0%	58%	42%	
	Cebolla	Current Seral Conditions	0%	36%	64%	
		Post Treatment Alternative 2	0%	44%	55%	
	Chester	Current Seral Conditions	0%	37%	63%	
		Post Treatment Alternative 2	1%	48%	51%	
	Cochetopa	Current Seral Conditions	0%	43%	57%	
		Post Treatment Alternative 2	0%	44%	56%	
	Lake City	Current Seral Conditions	0%	32%	68%	
		Post Treatment Alternative 2	0%	32%	68%	
	Los Pinos Creek	Current Seral Conditions	0%	62%	38%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	0%	68%	31%	
	Needle-Razor	Current Seral Conditions	0%	37%	63%	
		Post Treatment Alternative 2	1%	39%	60%	
	Stewart Creek	Current Seral Conditions	1%	56%	43%	
		Post Treatment Alternative 2	1%	61%	38%	

North Fork Valley

When comparing the gap between the current condition and desired PNV in spruce-fir, most affected LAU fall within PNV ranges for late-mid and late seral conditions - habitat structural stages 4A, 4B and 4C (Table 252). Under alternative 2, approximately 9,722 acres could receive commercial treatment. Under current stand conditions, 590 acres would be salvaged and an additional 3,409 acres combined and 4,941 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 65% of the stands in commercial PTA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift toward and earlier seral forest.

Under alternative 2, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 45). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35%) will be avoided. At the LAU scale, all shifts are less than 5%. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 252. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Fork GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
North Fork Valley	Bald Mountain	Current Seral Conditions	0%	20%	80%	
		Post Treatment Alternative 2	0%	21%	79%	

			Early	Early-Mid	Late-Mid	Late
	Black Mesa	Current Seral Conditions	0%	38%	62%	
		Post Treatment Alternative 2	0%	41%	59%	
	Crater Lake	Current Seral Conditions	1%	48%	51%	
		Post Treatment Alternative 2	2%	51%	47%	
	Peeler Lakes	Current Seral Conditions	0%	10%	90%	
		Post Treatment Alternative 2	1%	12%	87%	

San Juan Mountains

When comparing the gap between the current condition and desired PNV in spruce-fir, all affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). The current levels of stands with greater than 90% overstory mortality in commercial PTA are 1,830 acres with an additional 7,772 acres with between 40-90% overstory mortality. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 16% of the stands in the GA are mapped as multi-story, overstory mortality and the loss of these habitat structural stages in these stands would experience the greatest shift toward an earlier seral forest.

Under alternative 2, all three commercial treatment methods would shift spruce-fir toward PNV (Table 253). Since the acre footprint associated with alternative 2 is greatest, shift toward PNV is greatest under this alternative. In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35%) will be avoided. At the LAU scale, most shifts are less than 5%. The Alpine LAU could see the greatest shift with 16% of the spruce-fir shifting from late-mid or late to early-mid. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 253. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the San Juan GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
San Juans		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
	Alpine	Current Seral Conditions	0%	3%	97%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 2	3%	19%	78%	
	Iron Mountain	Current Seral Conditions	0%	11%	89%	
		Post Treatment Alternative 2	8%	12%	80%	
	Little Cone	Current Seral Conditions	0%	10%	90%	
		Post Treatment Alternative 2	6%	10%	84%	
	Lone Cone	Current Seral Conditions	3%	14%	83%	
		Post Treatment Alternative 2	11%	18%	72%	
	Matterhorn	Current Seral Conditions	0%	12%	88%	
		Post Treatment Alternative 2	0%	12%	88%	
	Turret Ridge	Current Seral Conditions	0%	8%	92%	
		Post Treatment Alternative 2	0%	8%	92%	

Uncompahgre Plateau

When comparing the gap between the current condition and desired PNV in spruce-fir, all affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). The current levels of stands with greater than 90% overstory mortality in commercial PTA are 351 acres with an additional 13,673 acres with between 40-90% overstory mortality. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 45% of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift toward an earlier seral forest.

Under alternative 2, all three commercial treatment methods would shift spruce-fir toward PNV (Table 254). Since the acre footprint associated with alternative 2 is greatest, shift toward PNV is greatest under this alternative. In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35%) will be avoided. Removal of dead mature spruce in single-storied stands will shift then to early seral. Since approximately 55% of the stands in the Uncompahgre Plateau are single-storied, shift to early seral under alternative 2 is more evident in this GA. This is especially true in the Spring Creek LAU.

Table 254. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Uncompahgre Plateau GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
Uncompahgre Plateau		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions: Spruce-aspen PNV*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
	Spring Creek	Current Seral Conditions	4%	6%	91%	
		Post Treatment Alternative 2	24%	11%	64%	

			Early	Early-Mid	Late-Mid	Late
	Traver Mesa	Current Seral Conditions	0%	24%	76%	
		Post Treatment Alternative 2	5%	34%	61%	

Roads – Direct and Indirect Effects

Vehicle traffic associated with timber sale activities would increase traffic levels above existing conditions (Table 255). We estimate that there will be 81,000 log truck loads generated by the proposed action over a 10-12 year implementation period. Timber sales would be distributed over a 10-12 year period resulting in 6,750 - 8,100 loads per year. We anticipate that logging will take place for up to nine months each year, five days per week excluding holidays. These loads would occur on different road segments with high speed greater than 50 mi per hour. For any given timber sale the number or trucks per day is not expected to be greater than 20. When added to the existing baseline all National Forest System (NFS) routes would stay well-below the 2,000 vehicles per day now and with projected traffic volumes for 2025 which potential impairment to lynx (Clevenger et al. 2002, Alexander et al. 2005). State Highways (Hwy) will also be utilized for hauling. Of the highways that could potentially be used, traffic volume range from a high of 3,400 Average Annual Daily Traffic (AADT) on Highway 50 at the junction of Hwy140 near Gunnison to a low of 120 ADDT on Highway 114. Over the life of the project traffic volume is expected to increase by 10% to a range of 181 to 3755 ADDT. While both under current Hwy use and projected use by 2025 exceeds the threshold of 2,000 vehicles per day, the increase associated with increase log traffic associated with the project is <1 to 10 percent increase on Highway 114 which is well within daily variation in traffic volume. Log truck traffic and associated noise impacts are likely to influence how lynx choose to use the landscape. However these effects will be short-term, only occurring during operations which are anticipated to be 2-3 years.

Table 255. Comparison Of Existing Average Daily Traffic, Projected Traffic in 2025 and the Influence Of Increase Truck Traffic Associated with SBEADMR.

Haul routes and probable increases in daily traffic are the same between alternative 2 and 3.

Forest Service Roads (NFS)[1] or Hwy[2]	**Starting mile post**	**End Mile Post**	**Actual Average Daily Traffic (AADT)**	**Projected Maximum percent increase @ 20 trucks per day**	**2025 Actual Average Daily Traffic (AADT)**	**Projected Maximum percent increase @ 20 trucks per day**
Hwy 50 @ Hwy 140 Junction	148	153	3400	<1	3755	<1
Hwy 62	0	19	3200	<1	3411	<1
Hwy 65	14	27	820	2.4	883	2.2
Hwy 92	30	31.5	1900	1	2,172	<1
Hwy 114	20	56	120	17	181	10
Hwy 145	84	96	1500	1.3	1541	1.2
Hwy 149	72	73	590	3.2	655	3.0

Forest Service Roads (NFS)[1] or Hwy[2]	Starting mile post	End Mile Post	Actual Average Daily Traffic (AADT)	Projected Maximum percent increase @ 20 trucks per day	2025 Actual Average Daily Traffic (AADT)	Projected Maximum percent increase @ 20 trucks per day
NFS Rd 121	NA	NA	158	11	205	9
NFS Rd 123	NA	NA	168	11	218	8.4
NFS Rd 317	NA	NA	961	2	1236	1.6
NFS Rd 701	NA	NA	71	22	92	18
NFS Rd 742	NA	NA	800	2.4	1040	1.9
NFS Rd 788	NA	NA	58	26	75	21
NFS Rd 790	NA	NA	47	30	61	25
NFS Rd 794	NA	NA	21	195	27	174
NFS RD 867	NA	NA	750	2.6	975	2

[1] USDA Forest Service Traffic Count data (2000 to 2012) – Internal Electronic files.

[2] Colorado State Department of Transportation (2014 data) - http://dtdapps.coloradodot.info/otis/TrafficData

Snow Compaction - Direct and Indirect Effects

Table 256 provides a comparison of the snow compaction baseline for LAU and LLA in the project area. Maintenance level 4 and 5 roads that are likely to be plowed during winter logging operations. A total of 90.5 miles of these routes could be plowed on any given winter. Of the 90.5 miles, 84.6 miles are already included in the snow compaction baseline for the Forest. These routes are either groomed for winter recreation use or routinely plowed for some other use besides winter access for logging operations. Approximately 5.9 miles of route are not currently included in the snow compaction baseline. LAU affected are Kannah Creek and Chester. Snow plowing to allow access for logging is considered a short-term impact, and as such is exempted from Guideline HU G10 of the SRLA.

Table 256. Haul Routes and Acres of Potential Addition Snow Compaction over Environmental Baseline.

Geographic Area	LAU/LLA	Snow Compaction Acres	Percent of LAU/LLA	Maintenance Level 4 or 5 roads likely to be plowed for winter hauling	Already included in snow compaction baseline. If no additional
Grand Mesa					
	Cottonwood Lakes	12,268	36	NFSR-121 (6.4 miles) and NFSR-257.1D (0.1 miles)	Yes
	Green Mountain	12,264	34	NFSR-121 (3 miles)	Yes
	Island Lake	13,418	52	NFSR-121 (5.1 miles) and NFSR-129 (3.5 miles)	Yes
	Kannah Creek	16,473	69	NFSR-65-2A (0.35 miles)	No (0.4 acres)
	Mesa Lakes	2,074	9	None	NA
	The Flat Tops	14,838	34	None	NA
	Battlement Mesa (LLA)	3326	0	None	NA
Gunnison Basin - North					
	Brush Creek	52	<1	None	NA
	Castle Pass	327	<1	None	NA
	Fossil Ridge	15	<1	None	NA
	Gothic	6,969	1	None	NA
	Grizzly Peak	3	<1	None	NA
	Pitkin	6,247	8	None	NA
	Red Creek	12	<1	None	NA
	Rocky Brook	25	<1	None	NA
	Soap Creek	0	0	None	NA
	Tincup	80	<1	None	NA
	Upper Taylor	42	<1	None	NA
	Upper Tomichi	693	1	None	NA
	Whetstone Peak	6	<1	None	NA
	Cottonwood-Tincup - LLA	12	<1	None	NA

Geographic Area	LAU/LLA	Snow Compaction Acres	Percent of LAU/LLA	Maintenance Level 4 or 5 roads likely to be plowed for winter hauling	Already included in snow compaction baseline. If no additional
Gunnison Basin - South					
	Cathedral	2	<1	None	NA
	Cebolla	4,354	6	None	NA
	Chester	35	<1	NFSR-7243 – 15.7 miles	Yes – 10.2 miles No – 5.5 miles (4 acres)
	Cochetopa	18	<1	None	NA
	Lake City	559	1	None	NA
	Los Pinos Creek	15	<1	None	NA
	Needle-Razor	0	0	None	NA
	Sawtooth Mountain	0	0	None	NA
	Stewart Creek	0	0	None	NA
	Whitecross Mtn	0	0	None	NA
	Slumgullion/Spring Creek Pass - LLA	1351	17	None	NA
	Poncha Pass - LLA	697	<1	None	NA
North Fork Valley					
	Anthracite	0	0	None	NA
	Bald Mountain	57	<1	None	NA
	Beckwith Mountain	9	<1	None	NA
	Black Mesa	2,112	4	None	NA
	Chalk Mountain	740	2	NFSR-257.1D (0.1 miles) and NFSR-701 (9.5 miles)	Yes
	Crater Lake	48	<1	NFSR-701 (9.5 miles)	Yes
	Peeler Lakes (Kebler	1,123	4	None	NA
	Mount Gunnison	0	0	None	NA
	Ragged Mountain	0	0	None	NA

Geographic Area	LAU/LLA	Snow Compaction Acres	Percent of LAU/LLA	Maintenance Level 4 or 5 roads likely to be plowed for winter hauling	Already included in snow compaction baseline. If no additional
San Juan Mtns					
	Alpine	2,125	4	None	NA
	Iron Mountain	470	<1	None	NA
	Little Cone	16	<1	None	NA
	Lone Cone	51	<1	NFSR-611 (13 miles)	Yes
	Matterhorn	465	1	None	NA
	Turret Ridge	668	1	None	NA
	Lizard Head Pass - LLA	453	<1	None	NA
	Red Mountain - South Mineral - LLA	146	<1	None	NA
Uncompahgre Plateau					
	Spring Creek	715	2	NFSR-402 (16.25 miles) NFSR-540 (4.9 miles) and NFSR-510 (1.1 miles)	Yes
	Traver Mesa NEW	330	<1	NFSR-503 (2 miles)	Yes

Snowshoe Hare and Red Squirrel Habitat - Direct and Indirect Effects

Snowshoe hares are the primary prey item for lynx. Red squirrels are reported to be the second most important in much of the lynx range, including Colorado (Interagency Lynx Biology Team, 2013). Both species prefer multi-storied spruce-fir forests with abundant coarse woody debris, and in the case of red squirrel, abundant cone production.

Mature spruce stands that are multi-storied most likely provide habitat for both species. Table 257 summarizes acres of multi-storied and single-storied stands within alternative 2 commercial PTA. If all multi-storied were treated with resiliency, combined (variable retention), or salvage treatments with proper use of WFRP-12 a total of 15,324 acres of hare habitat and 7,641 acres of high quality (>35% DHC) hare habitat could be affected. However, since there are approximately 116,000 acres identified for potential commercial treatment and the maximum acres that could be treated are 60,000, projected actual impact is 52% of this amount or 3,973 acres. The current balance under VEG S6 (high quality hare habitat that can be affected forest-wide) is 4,955 acres which is greater than the 3,973 acres projected impact. Balances remaining under VEGS6 will be reported annually as required by SRLA.

Spruce beetle induced mortality of mature trees or removal of green mature spruce will affect the abundance of red squirrel. In Colorado red squirrels have been documented to decline when over

story mortality reaches 60% after 3 years (Ivan, pers. comm.). When overstory mortality reaches 90% squirrel numbers decline even further. At greater than 90% overstory mortality, only about 50% of the stands could be expected to support squirrels. Harvesting of dead mature spruce that are no longer producing a cone crop and are greater than 90% overstory mortality are expected to have minimal additional impact to red squirrel populations. However, removal of live mature spruce in areas of moderate to high overstory mortality could additional incremental effects to squirrel numbers.

Table 257. Alternative 2 – Acres of Lynx Habitat in Commercial PTA and Hazard Trees.

M signifies multi-storied stands and S signifies single-storied stands.

Geographic Area	Layering	Overlapping Lynx Habitat Acres – Alt 2 PTA and hazard trees (ac)	Percent of the stands in GA	Proposed Road Acres[1]	Proposed Roads Outside PTA[1]	Projected acres of hare habitat affected	Projected acres of high quality (>35% DHC) hare habitat that could be affected
Grand Mesa		16,152					
	M	9930	61	109	5	2,100	1,050
	S	6222	39				
Gunnison Basin North		16,807					
	M	12,938	77	97	22	2,701	1,353
	S	3,869	23				
Gunnison Basin South		31,135					
	M	27,212	87	305	28	5,649	2,825
	S	3,923	13				
North Fork Valley		9,877					
	M	7,768	79	90	8	1,651	826
	S	2,109	21				
San Juans		13,648					
	M	2,217	16	37	43	523	221
	S	11,431	84				
Uncompahgre Plateau		28,521					

Geographic Area	Layering	Overlapping Lynx Habitat Acres – Alt 2 PTA and hazard trees (ac)	Percent of the stands in GA	Proposed Road Acres[1]	Proposed Roads Outside PTA[1]	Projected acres of hare habitat affected	Projected acres of high quality (>35% DHC) hare habitat that could be affected
	M	12,975	45	105	33	2,700	1,366
	S	15,546	55				
			Total			15,324	7,641

Note: Acres of multi-story and single story stands for hazard trees removal are estimated based upon percent single story versus multi-story within PTA for a given LAU.

[1] New Road construction is calculated at 100% loss to the understory.

Alternative 2, Agency Preferred Alternative - Cumulative Effects

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (50 CFR 1508.7). Under NEPA, cumulative impacts are the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. In contrast, under ESA the estimated effects of future federal activities are not included, because those future federal actions will be subject to their own Section 7 consultation at the appropriate time. This BA is intended to fulfill ESA requirements. The cumulative effects analysis in the Environmental Assessment included an analysis of the potential effects caused by future federal actions, fulfilling NEPA requirements.

The cumulative effects analysis of the SBEADMR projects considered past activities that have occurred in the project area, future non-federal actions occurring on State and private land that are reasonably certain to occur. Past Forest Service vegetation management that converted lynx habitat to unsuitable (e.g. clear-cuts), powerlines and other features that permanently convert lynx habitat and roads were all considered. Time period used to enumerate acres is 1990-2015 (25 years). Since lynx habitat does re-grow and it takes 25 years for a germinated spruce to reach a height of 6-10 feet (above average snow depth), a residual impact of 25% was assumed. Permanent roads were considered a 100% loss of lynx habitat. Activities proposed by BLM Gunnison Field Office were also considered in the analysis. Total acres of commercial mechanical treatments, acres of new road construction, and acres of hazard under current stand conditions and adapted/potential future stand conditions were analyzed. It was assumed that all stands in PTA would receive management. Total acres of impact were compared to the 30% conversion to unsuitable identified in the SRLA.

Under current stand conditions and application of the appropriate silvicultural prescription (resiliency, combined and salvage), 2 LAU could exceed the 30% conservation threshold - Stewart Creek and Spring Creek (Table 258). Under adapted/potential future stand conditions, the availability of single storied stands with greater than 90% would increase and since one of

the objectives under SBEADMR is to protect the understory vegetation where it exist, the percent of single-storied stands treated could increase. Under adapted/potential future stand conditions, the 30% threshold could again be exceeded in the Stewart Creek and Spring Creek LAUs. To ensure the conservation threshold is not exceeded, road construction, harvest associated and other non-SBEADMR related actions will be tracked via Forest Service databases annually. Since the conservation threshold also takes into account natural process (wildfire or widespread spruce beetle conversion to unsuitable), these processes will also be tracked when data is available.

No reasonably foreseeable activities are known to be planned on non-federal land within affected LAU that would compromise the quantity and quality of lynx habitat. Foreseeable future federal activities (e.g., Crested Butte Ski Resort Expansion) identified in the table will be subject to analysis and possible consultation with Fish and Wildlife when and if they occur.

Table 258. Projected Cumulative Effects Under Current Stand Conditions and Adapted/potential future Stand Conditions Conditions for Alternative 2.

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under alt 2.- Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activities	Cummula-tive Acres of impact-Current	Cummula-tive Acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current	Balance Adapted
						SISS Current	Incid-ental Current	SISS adapted	Incid-ental adapted								
Grand Mesa	Cottonwood Lakes	24,994	398	3,576	1,292	765	1,328	3285	998	95	3	0	3,483	5,673	7,498	4,015	1,825
	Green Mountain	24,113	200	539	335	650	290	1422	18	101	0	0	1376	1876	7,234	5,858	5,358
	Island Lake	18,327	280	2,184	826	513	364	875	314	43	0	466	2212	2524	5,498	3,286	2,974
	Kannah Creek	11,698	197	3,900	1,171	22	326	31	484	199	1	0	1719	1886	3,509	1790	1,623
	Mesa Lakes	17,113	170	1,073	438	56	400	309	477	85	2	0	981	1311	5,134	4,153	3,823
	The Flat Tops	27,774	143	335	227	26	118	89	139	115	0	0	486	570	8,334	7,848	7,764
Gunnison Basin - North	Brush Creek	36,745	354	312	407	154	71	329	5	322	2	0	956	1065	11,023	10,067	9,958
	Castle Pass	30,599	112	315	191	117	139	262	110	16	0	0	463	579	9,180	8,717	8,601
	Fossil Ridge	36,570	283	4,067	1,300	0	0	0	0	24	0	0	1324	1324	10,971	9,647	9,647
	Gothic	28,844	576	751	764	446	256	804	223	129	9	102	1706	2031	8,653	6,947	6,622
	Grizzly Peak	17,001	65	329	147	0	0	0	0	5	0	0	152	152	5,100	4,948	4,948
	Pitkin	38,849	1,275	3,136	2,059	101	348	181	416	358	3	0	2869	3017	11,654	8,785	8,634

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under alt 2.- Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activities	Cummula-tive Acres of impact-Current	Cummula-tive Acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current	Balance Adapted
	Red Creek	44,930	565	3,842	1,526	275	724	910	890	584	4	0	3113	3914	13,479	10,366	9,565
	Rocky Brook	41,833	523	9,624	2,929	33	807	41	997	462	4	0	4,235	4,433	12,550	8,315	8,117
	Soap Creek	42,711	108	3,922	1,088	0	0	0	0	2	0	0	1,090	1,090	12,813	11,723	11,723
	Tincup	37,328	601	1,252	914	0	0	0	0	102	0	0	1,016	1,016	11,198	10,182	10,182
	Upper Taylor	30,654	380	760	570	0	0	0	0	247	0	0	817	817	9,169	8,379	8,379
	Upper Tomichi	30,032	425	1,056	689	13	33	27	38	165	0	0	900	919	9,009	8,109	8,098
	Whetstone Peak	15,553	64	0	64	33	131	609	50	0	0	0	228	723	4,665	4,437	3,942
Gunnison Basin - South	Cathedral	21,286	89	1,028	346	107	453	188	488	56	0	0	962	1078	6,385	5,423	5,307
	Cebolla	42,869	259	1,956	748	88	1,035	170	1,079	107	2	442	2,422	2,548	12,260	9,838	9,712
	Chester	32,067	616	8,349	2,703	251	1,039	339	1,192	501	6	0	4,500	4,741	9,620	5,120	4,879
	Cochetopa	25,087	1,000	6,219	2,555	76	553	148	671	623	7	0	3,814	4,004	7,526	3,825	3,635
	Lake City	25,251	97	1,351	435	1	18	14	19	159	0	100	713	727	7,575	6,862	6,868
	Los Pinos Creek	23,834	469	3,018	1,223	624	1,152	797	1,230	504	9	0	3,512	3,763	5371	1925	1677
	Needle-Razor	17,822	285	5,520	1,665	100	132	198	123	158	0	0	2,055	2,144	5,347	3,292	3,203

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under alt 2.- Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activities	Cummula-tive Acres of impact-Current	Cummula-tive Acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current	Balance Adapted
	Sawtooth Mtn	27,668	210	1,331	543	0	0	0	0	102	0	0	645	645	8,300	7,655	7,655
	Stewart Creek	26,858	563	5,591	1,961	204	1,025	321	1,123	427	3	0	3,620	3,835	8,057	4,437	4,222
	Whitecross Mtn	6,947	49	8	51	0	0	0	0	8	0	0	59	59	2,084	2,025	2,025
North Fork Valley	Anthracite	20,742	27	0	27	0	0	0	0	8	0	0	35	35	6,223	6,188	6,188
	Bald Mountain	32,171	143	1,392	491	27	150	356	128	43	1	0	712	,1019	9,651	8,939	8,632
	Beckwith Mtn	53,369	138	0	138	0	0	0	0	127	0	0	265	265	16,011	15,746	15,746
	Black Mesa	33,391	482	3,727	1,414	25	330	64	394	256	5	0	2,030	2,133	10,017	7,987	7,884
	Chalk Mountain	24,639	158	369	250	10	109	10	158	5	3	2	379	428	7,392	7,013	6,964
	Crater Lake	36,357	357	1,688	779	130	728	399	797	221	6	0	1,864	2,202	10,907	9,043	8,705
	Peeler Lakes (Kebler)	23,620	167	35	175	110	92	214	62	9	2	0	388	462	7,086	6,698	6,624
	Mount Gunnison	22,417	144	78	163	0	0	0	0	122	0	0	285	285	6,725	6,440	6,440
	Ragged Mtn	11,805	54	0	54	0	0	0	0	46	0	0	100	100	3,542	3,442	3,442
San Juans	Alpine	32,051	278	4,253	1,342	2,209	909	3608	345	248	24	200	4,932	5,767	9,615	4,683	3,848
	Iron Mountain	24,618	359	273	427	999	453	2,076	68	13	0	0	1,892	2,584	7,385	5,493	4,801

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under alt 2.- Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activities	Cummula-tive Acres of impact-Current	Cummula-tive Acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current	Balance Adapted
	Little Cone	22,125	117	43	128	765	275	1,577	3	117	2	0	1,287	1,827	6,638	5,351	4,811
	Lone Cone	24,476	346	2,036	855	1,291	867	3,186	438	270	17	0	3,300	4,766	7,343	4,043	2,577
	Matterhorn	25,594	330	193	378	125	12	145	3	17	0	0	532	543	7,678	7,146	6,810
	Turret Ridge	26,320	175	0	175	0	0	0	0	445	0	0	620	620	7,896	7,276	7,776
Uncompahgre Plateau	Spring Creek	30,485	469	6,039	1,979	3,689	3,046	13,112	929	55	25	0	8,794	16,100	9,145	351	-6,955
	Travers Mesa	25,087	457	4,590	1,771	728	1,747	1,689	2,063	286	8	0	4,540	5817	7,526	2,986	1,709

Alternative 3 (WUI Focus) – Direct and Indirect Effects

Alternative 3 focuses on protection of community infrastructure and public safety. Both commercial mechanical and non-commercial mechanical and prescribed fire treatments could be employed. Total acres of commercial PTA in lynx habitat are 44,908 with an additional 9,383 acres of lynx habitat that could be treated for hazard tree removal. Acres of non-commercial mechanical or prescribed fire in lynx habitat are 24,945. Total acres of lynx habitat potentially affected are 79,236.

Analysis on the effects to lynx was completed at the GA scale, LAU and LLA scales. At the appropriate scales factors known to affect long-term persistence of lynx on a landscape are addressed. Maps G-49 through G-54 (Appendix G) display lynx habitat by GA that could be affected under alternative 3.

Magnitude of Effect at GA and LAU Scales – Alternative 3

The purpose of this section is to provide an overview of the types of management that could occur in lynx habitat over the life of the project. A maximum impact approach is taken by assuming every acre in a commercial or Non-commercial PTA will be managed and hazard trees will be removed on all roads. The reality is that both commercial and non-commercial treatments are capped at 60,000 acres each. Road side hazard tree removal is included in cap acres.

Grand Mesa

There are 6 LAU containing PTA in the Grand Mesa GA (Table 259). Total acres that could be managed are 10,744 acres commercial. Hazard tree removal will affect an additional 1,472 acres. Approximately 13 percent of the total lynx habitat in the Grand Mesa GA could be affected by commercial treatment will all priority treatment received treatment.

The Cottonwood Lakes LAU has the highest acreage in commercial PTA and also highest percent of lynx habitat that could be affected and Huntsman Mountain the least. However the current level of stands with greater than 90 percent overstory mortality (salvage) is less than 1 percent of the lynx habitat in the GA and combined treatments (40-90 percent overstory mortality) is at 8805 acres or 7 percent of lynx habitat in the GA. These stands will be managed with a combination of resiliency where mortality is relatively low to salvage harvest as mortality increases. The vast majorities of the stands (66 percent) in commercial PTA have less than 40 percent overstory mortality and therefore would be managed with a resiliency prescription. Hazard tree removal would occur on less than 1 percent of the suitable habitat in the GA.

Table 259. Alternative 3 – Commercial Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Grand Mesa GA.

(%) – Represents percent of Lynx total lynx habitat in GA/LAU affected.

	Combination (%)	Resiliency (%)	Salvage (%)	Hazard Tree (%)	Total (%)
Grand Mesa	**5283 (4)**	**3605 (3)**	**376 (<1)**	**1472(1)**	**10744(9)**
Cottonwood Lakes	2130(8)	2147(8)	38(<1)	95(<1)	4410(18)
Green Mountain	880(4)	133(<1)	28(<1)	101(<1)	1,142(5)
Island Lake	1207(6)	208(1)	309(2)	43(<1)	1787(10)
Kannah Creek	466(4)	461(4)	0	199(2)	1,126(10)
Mesa Lakes	598(3)	647(4)	0	85(<1)	1,330(8)
Flat Top	0	0	0	949(3)	949(3)

Non-commercial treatments in lynx habitat will occur within WUI (Table 260). Thirteen percent of lynx habitat in the GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Aspen stands in affected LAU are predominately secondary lynx habitat and will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration. The Mesa Lakes and Island Lake LAU have the highest percent of lynx habitat potentially affected at 35 percent and 19 percent respectively.

Table 260. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat within WUI.

(%) – Represents percent of Lynx total lynx habitat in GA/LAU affected.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
Grand Mesa	**5,434**	**4,217**	**2,364**	**705**	**276**	**4**
Chalk Mountain	0	0	0	0	0	0
Cottonwood Lakes	0	0	0	0	0	0
Green Mountain	759	514	157	45	0	3
Huntsman Mountain	782	769	11	2	0	2
Island Lake	1768	1455	264	43	3	9
Kannah Creek	0	0	0	0	0	0)
Mesa Lakes	4870	2248	1,932	417	273	17
The Flat Tops	0	0	0	0	0	0

Gunnison Basin North and South

There are 23 LAU containing PTA in the Gunnison Basin North and South GAs (Table 261). Total acres that could be managed commercially in the North GA are 6,396 and 5,653 in the South GA. Hazard tree removal will affect an additional 2416 acres in 7 LAU in the Gunnison Basin – North and 2,645 in Gunnison Basin-South. Approximately 1 percent of the total lynx habitat in Gunnison Basin – North and 2 percent of lynx habitat in Gunnison Basin-South could be affected by commercial treatment. Hazard tree removal would occur on less than 1 percent of the suitable habitat in the GA.

Wheatstone LAU and Chester LAU have 8 percent and 9 percent of lynx habitat proposed for commercial treatment. All other LAU are 5 percent or less. Gunnison Basin-North only has 668 acres (<1 percent) with greater than 90 percent overstory mortality and therefore will be managed as salvage. Approximately 50 percent of the combination acres will also receive salvage treatments (617 acres or <1 percent). Therefore the vast majority of stands within PTA will be managed for resiliency In the Gunnison South GA.

A high percentage of the stands in Gunnison-Basin-South are currently over 90 percent overstory mortality or are approaching 90 percent (combination acres). Due to the extensive beetle activity in the GA, most if not all combination stands will be greater than 90 percent overstory mortality prior to treatment. Approximately 30 percent of the stands in PTAs have less than 40 percent overstory mortality. Within commercial PTA, this equates to loss of 70 percent of habitat structural stages 4A, 4b, and 4C (mid-late to late seral). Because mature spruce are an important habitat structural element for lynx and supporting prey, retention of live mature spruce where they are expected to persist is an important management consideration.

Table 261. Alternative 3 – Commercial Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Gunnison Basin North and South GAs.

(%) – Represents percent of Lynx total lynx habitat in GA/LAU affected.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
Gunnison Basin North	**1,234**	**2,182**	**668**	**2.416**	**6,500(1)**
Brush Creek	276	18	0	322	616(2)
Castle Pass	88	37	0	16	141(<1)
Fossil Ridge	0	0	0	24	24(<1)
Gothic	410	533	355	129	1,427(5)
Grizzly Peak	0	0	0	5	5(1<)
Pitkin	480	321	313	358	1,473(4)
Red Creek	9	22	0	584	615(1)
Rocky Brook	340	137	0	462	940(2)
Soap Creek	0	0	0	2	2(<1)
Tincup	0	0	0	102	102(<1)
Upper Taylor	0	0	0	247	247(1)
Upper Tomichi	0	0	0	165	165(1)

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
Whetstone Peak	63	1114	0	0	1177(8)
Gunnison Basin South	**1356**	**614**	**1128**	**2,645**	**5,743(2)**
Cathedral	150	54	271	56	531(2)
Cebolla	0			107	107(<1)
Chester	975	409	857	501	2,743(9)
Cochetopa	173	92		623	265(1)
Lake City	21	41		159	221(1)
Los Pinos	0	0	0	504	504(2)
Needle-Razor	37	18		158	212(1)
Sawtooth Mtn	0	0	0	102	102(1)
Stewart Creek	0	0	0	427	427(2)
White cross Mtn	0	0	0	8	8(<1)

Gunnison Basin-North has 4 LAU with 10,195 acres and Gunnison Basin-South has 4 LAU with 4272 acres of non-commercial treatments proposed. Non-commercial treatments in lynx habitat will only occur within WUI (Table 262). Two percent of lynx habitat in Gunnison-North and Gunnison Basin-South could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings in spruce-aspen or spruce stands. Aspen stands in affected LAU are predominately secondary lynx habitat and will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 262. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI.

(%) – Represents percent of Lynx total lynx habitat in LAU affected.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
Gunnison North	**10,195**	**6,137**	**2,068**	**1,131**	**859**	**2**
Fossil Ridge	4182	3504	227	184	267	11
Pitkin	3647	2106	328	626	587	9
Red Creek	767	151	593	23	0	2
Upper Tomichi	1223	376	920	298	5	5
Gunnison South	**4,242**	**2,281**	**1,143**	**726**	**92**	**2**
Chester	2,233	1003	448	704	78	7
Lake City	1,430	771	639	20	0	6
Los Pinos	0	0	0	0	0	0
Stewart Creek	578	507	56	1	14	2

North Fork Valley

There are 9 LAU containing PTA in the North Fork Valley GA (Table 263). Total acres that could be managed are 6,874 acres commercial or for hazard tree removal. The Crater Lake LAU has the highest acreage in commercial PTA and also highest percent of lynx habitat. All remaining LAU have 5 percent or less of lynx habitat that could be affected. Under current stand conditions, only 2 percent in commercial PTA have overstory mortality greater than 90 percent (salvage). Approximately 50 percent of the combination acres will also receive salvage treatments (907 acres or <1 percent of habitat in the GA). Resiliency treatment could occur on 2 percent of habitat in the GA. Hazard tree removal would occur on 834 acres (<1 percent) of the suitable habitat in the GA.

Table 263. Alternative 3 - Acres of Spruce-Fir And Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the North Fork GAs.

(%) – Represents percent of Lynx total lynx habitat in LAU affected.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
North Fork Valley	**1814**	**4223**	**112**	**834**	**6874(3)**
Anthracite	0	0	0	8	8(<1)
Bald Mountain	1	516		43	560(2)
Bechwith	0	0	0	127	127(<1)
Black Mesa	482	467	56	256	1261(4)
Chalk Mountain	54	1146	0	2	1202(5)
Crater Lake	904	2094	0	221	3219(9)
Peeler Lakes	373	0	56	9	329(1)
Mount Garrison	0	0	0	122	122(1)
Ragged Mountain	0	0	0	46	46(<1)

Approximately 1,898 acres of non-commercial treatments are proposed in the GA (Table 264). Non-commercial treatments in lynx habitat will only occur within WUI. Less than 1 percent of lynx habitat in the North Fork GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. in accordance with VEG S5 of the SRLA. Aspen stands in affected LAU are predominately secondary lynx habitat and will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 264. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI.

(%) – Represents percent of Lynx total lynx habitat in LAU affected.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
North Fork Valley	**1,898**	**1,873**	**0**	**5**	**16**	**<1**
Chalk Mountain	175	168	0	0	7	<1
Crater Lake	1,723	1,710	0	5	9	5

San Juan

There are 6 LAU containing commercial PTA in the San Juan Mountains GA (Table 265). Total acres that could be managed are 7,327 acres. Hazard tree removal could occur across any of the identified LAU where spruce and/or aspen are the dominate cover types associated with roads. Total acres of hazard tree removal are 1,675 acres.

Alpine, Iron Mountain and Little Cone LAUs have greater than 5 percent of lynx habitat in commercial PTA. The remainder of the LAU has less than 5 percent. Under current stand conditions, 783 acres would be salvaged. Approximately 50 percent of the combination acres will also receive salvage treatments (1706 acres). Therefore approximately 2 percent of lynx habitat in the GA could receive salvage treatments and less than 1 percent managed for resiliency.

Table 265. Alternative 3 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the San Juan GAs.

(%) – Represents percent of lynx total lynx habitat in LAU affected.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
San Juans	**3413**	**1456**	**783**	**1675**	**7327(5)**
Alpine	623	391	494	813	2321(7)
Iron Mountain	2026	355	4	13	2398(10)
Little Cone	567	390	180	117	1254(6)
Lone Cone	144	313		270	727(3)
Matterhorn	53	7	105	17	182(1)
Turret Ridge	0	0	0	445	445(2)

Approximately 410 acres of non-commercial treatments proposed in the GA within the Alpine and Little Cone LAU (Table 266). Non-commercial treatments in lynx habitat will only occur within WUI. Less than 1 percent of lynx habitat in the San Juan GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings,

structures etc. in accordance with VEG S5 of the SRLA. Aspen stands in affected LAU are predominately secondary lynx habitat and will be managed either mechanically or with the use of prescribed fire resulting in understory regeneration

Table 266. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI. (%) – Represents percent of Lynx total lynx habitat in LAU affected.

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
San Juan Mountains	**410**	**333**	**67**	**10**	**0**	**<1**
Alpine	31		21	10	0	<1
Little Cone	379	333	46	0	0	2

Uncompahgre Plateau

There are 2 LAU containing PTA in the Uncompahgre Plateau GA. Total acres that could be managed are 17,001 acres commercial (Table 267). Hazard tree removal could occur across any of the identified LAU where spruce and/or aspen are the dominate cover types associated with roads. Total acres of hazard tree removal are 341acres.

If all stands are managed in affected LAU, 31 percent of the 55,572 acres of lynx habitat in the GA would be affected. Under current stand conditions, only 218 acres (1 percent) have greater than 90 percent overstory mortality and therefore salvage prescriptions will be used. Approximately 50 percent of the combination acres will also receive salvage treatments (4379 acres or 8 percent). Therefore approximately 9 percent of lynx habitat in the GA will be managed with a salvage prescription and approximately 14 percent of lynx habitat managed for resiliency.

Table 267. Alternative 3 - Acres of Spruce-Fir and Spruce-Fire-Aspen by Treatment Type in Lynx Habitat on the Uncompahgre Plateau GA.

(%) – Represents percent of Lynx total lynx habitat in LAU affected.

	Combination	Resiliency	Salvage	Hazard Tree	Total(%)
Uncompahgre Plateau	**8758**	**7685**	**218**	**341**	**17001 (31)**
Spring Creek	7303	7392	124	55	14874(49)
Traver Mesa	1455	292	94	286	2128(8)

Approximately 2,766 acres of non-commercial treatments proposed in the GA all within two LAUs (Table 268). Non-commercial treatments in lynx habitat will only occur within WUI. Approximately 5 percent of lynx habitat in the Uncompahgre Plateau GA could be affected. However, treatments in WUI will be limited to aspen or within 200 feet of outbuildings, structures etc. Aspen stands in affected LAU are predominately secondary lynx habitat and will

be managed either mechanically or with the use of prescribed fire resulting in understory regeneration.

Table 268. Alternative 3 – Acres by Vegetation Type of Non-Commercial Treatments in Lynx Habitat in WUI.

(%) – Represents percent of Lynx total lynx habitat in LAU affected

	Burn and/or Mechanical	Aspen	Aspen-Spruce	Spruce	Other	Percent
Uncompahgre Plateau	**2,766**	**1,631**	**1,097**	**36**	**1**	**5**
Spring Creek	2,543	1,465	1,040	36	1	8
Traver Mesa	223	166	57	0	0	<1

Hazard Trees and Non-Commercial Mechanical and Prescribed Fire - Direct and Indirect Effects

Hazard trees could affect 7,987 acres of lynx habitat across 49 LAU. On slopes less than 40 percent, horizontal distance from the edge of the road is 150 feet. On slopes greater than 40 percent hazard trees could be removed up to 300 feet. Prescription use to remove hazard trees includes single tree selection when mortality is low and partial retention when the overstory is dead but the understory is still alive. When partial retention prescription is used, typically trees under 8 inches dbh will be retained.

Direct and indirect effects of hazard tree removal are the same as Alternative 2 but the magnitude (acres) is greater.

Non-commercial mechanical and prescribed fire is proposed for 28,708 acres of lynx habitat. Since non-commercial treatment in lynx habitat will only occur in WUI, total acres affected are the same as alternative 2, therefore direct and indirect effects are unchanged.

Habitat Connectivity at GA Scale - Direct and Indirect Effects

Grand Mesa

The vegetation on the Grand Mesa GA is characterized by aspen and spruce-fir cover types; each currently occupies 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area. Approximately 84 percent of the forest and woodland cover types are in the mature size class. There is very little early seral condition in any cover type on the Grand Mesa Geographic Area.

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

The Grand Mesa supports approximately 125,000 acres of suitable lynx habitat. This habitat is characterized by aspen and spruce-fir cover types; each currently occupies 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area. Approximately 84 percent of the forest and woodland cover types are in the mature size class. There is very little early seral condition in any cover type on the Grand Mesa Geographic Area.

The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 269 and Table 270 provide a comparison of current range of seral conditions as compared to PNV. Of the 125,000 of suitable lynx habitat, alternative 3 has 9,264 acres (7 percent) of the landscape in a commercial PTA and 8,179 acres (6.5 percent) of non-commercial and prescribed fire treatments. Potential Natural Vegetation is established as a long-term goal for lynx habitat since it provides for a mosaic of habitat conditions which includes dense early–coniferous and mixed-coniferous-deciduous stands along with components of mature multi-story coniferous stands. The Grand Mesa is currently dominated by mid-late or late serial conditions for both spruce-fir and spruce-fir-aspen PNV types.

Commercial treatments will be the primary mechanism used to shift spruce-fir PNV type toward the modeled range of seral conditions. Because the foot print of the PTA is smaller than alternative 2, the overall shift from late seral spruce-fir forests to mid or early seral will be less. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Under alternative 3, a 2 percent shift from late-mid or late to early mid is expected. The percent shift to early seral is only expected to be 1 percent. Non-commercial treatments in spruce-fir-aspen will result in a 2 percent shift from mid or late seral to early mid and a 1 percent shift to early.

Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, mortality in mature spruce intensifies retention of mature live spruce needs to be a management priority. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA.

Table 269. Comparison of Modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir on the Grand Mesa GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	1%	7%	92% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	2%	9%	89%	

Table 270. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir-Aspen on the Grand Mesa GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	15%	83% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	11%	14%	75%	

Gunnison Basin North and South

The current vegetation within the Gunnison Basin Geographic Area can be characterized by approximately 46 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent are in mature size class (mostly in the spruce-fir cover type). As mentioned above, photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists. The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 271 and Table 272 provide a comparison of current range of seral conditions as compared to PNV. Of the 428,681 acres of suitable lynx habitat in Gunnison Basin North and 247,686 acres in the Gunnison Basin South, alternative 3 has 4,616 acres (1 percent) and 3,887 acres (2 percent) respectively within a commercial PTA. Non-commercial and prescribed fire acres in lynx habitat for the spruce-fir-aspen PNV type total 9,819 (2 percent) in Gunnison Basin- North and 4,271 acres (2 percent) in Gunnison Basin-South. Gunnison Basin North and South are currently at or slightly above VDDT modeled range of mid-late or late seral conditions. Early-mid percentages are higher than modeled values.

Commercial treatments will be the primary mechanism used to shift spruce-fir PNV type toward the modeled range of seral conditions. Because the foot print of the PTA is smaller than alternative 2, the overall shift from late seral spruce-fir forests to mid or early seral will be less. Alternative 2 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Under alternative 3, a 1 percent shift from late-mid or late to early is expected. Due to the relatively small acres proposed for treatment no other shifts in habitat structural stages are predicted. Non-commercial treatments in spruce-fir-aspen will result in a 2 percent shift from mid or late seral to early seral.

Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, mortality in mature spruce intensifies retention of mature live spruce needs to be a management priority. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA.

Table 271. Comparison of Modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir on the Gunnison Basin North and South GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	41%	59% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	1%	41%	58%	

Table 272. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Gunnison Basin North and South GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers , and occasional lodgepole pine with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and occasional lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	52%	47% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	3%	52%	45%	

North Fork Valley

The vegetation in the North Fork Valley Geographic Area can be characterized as aspen being currently the dominant tree species occurring on the North Fork Valley Geographic Area, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area. Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type).

The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 273 and Table 274 provide a comparison of current range of seral conditions as compared to PNV. Of the 258,511 acres of suitable lynx habitat in North Fork Valley, alternative 3 has 6,040 acres (2 percent) within a commercial PTA. Non-commercial and prescribed fire acres in lynx habitat for the spruce-fir-aspen PNV type total 2053 acres (<1 percent). Spruce-fir is currently at or slightly above VDDT modeled range of mid-late or late seral conditions. Early-mid percentages are higher than modeled values. Early seral is generally lacking on the GA. Current conditions of spruce-fir-aspen show a similar trend as compared to modeled PNV. Mid-late and late seral fall within expected ranges, are higher than expected for early-mid and early is generally lacking at the GA scale.

Commercial treatments will be the primary mechanism used to shift spruce-fir PNV type toward the modeled range of seral conditions. Because the footprint of the PTA is smaller than alternative 2, the overall shift from late seral spruce-fir forests to mid or early seral will be less. Alternative 3 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Under alternative 3, a 1 percent shift from late-mid or late to early is expected. Due to the relatively small acres proposed for treatment no other shifts in habitat structural stages are predicted. Non-commercial treatments in spruce-fir-aspen will result in a 2 percent shift from late or early-mid seral to early seral.

Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, mortality in mature spruce intensifies retention of mature live spruce needs to be a management priority. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA.

Table 273. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the North Fork GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	34%	66% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	0%	35%	65%	

Table 274. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the North Fork GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	54%	45% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	3%	53%	44%	

San Juans

The vegetation in the San Juans GA can be summarized as having Spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juans Geographic Area. The San Juans Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types. Approximately 86 percent of the forest and woodland cover types are in mature size classes. There is very little early seral condition in any cover type on the San Juans Geographic Area. The San Juan GA also has the highest percentage of single storied spruce-fir stands of any GA in the analysis area.

The trend across all vegetation cover types on the San Juans is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Table 275 and Table 276 provide a comparison of current range of seral conditions as compared to PNV. Of the 155,185 acres of suitable lynx habitat in San Juan, alternative 3 has 4,863 acres (3 percent) within a commercial PTA. Non-commercial and prescribed fire acres in lynx habitat for the spruce-fir-aspen PNV type total 379 acres (<1 percent). Spruce-fir is above VDDT modeled range of mid-late or late seral conditions. Early and early-mid seral is below modeled PNV ranges. Current conditions of spruce-fir-aspen exceed modeled values for mid-late to late but are in line with early-mid PNV ranges. Early seral is generally lacking at the GA scale.

Commercial treatments will be the primary mechanism used to shift spruce-fir PNV type toward the modeled range of seral conditions. Because the footprint of the PTA is smaller than alternative 2, the overall shift from late seral spruce-fir forests to mid or early seral will be less. Alternative 3 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Under alternative 3, no shift from late-mid or late to early-mid is expected. A 2 percent shift is expected from late-seral to early. Non-commercial treatments in spruce-fir-aspen will result in no change to current seral conditions.

Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, mortality in mature spruce intensifies retention of mature live spruce needs to be a management priority. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA.

Table 275. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir on the San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	0%	11%	88% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	2%	11%	86%	

Table 276. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the San Juan GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	0%	22%	78% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	0%	22%	78%	

Uncompahgre Plateau

The vegetation within the Uncompahgre Plateau Geographic Area can be characterized as a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66% are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).

The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

Table 277 and Table 278 provide a comparison of current range of seral conditions as compared to PNV. Of the 55,572 acres of suitable lynx habitat in Uncompahgre Plateau GA, alternative 3 has 16,660 acres (30 percent) within a commercial PTA. Non-commercial and prescribed fire acres in lynx habitat for the spruce-fir-aspen PNV type total 2,469 acres (4 percent). Spruce-fir is above VDDT modeled range of mid-late or late seral conditions. Early and early-mid seral is below modeled PNV ranges. Current conditions of spruce-fir-aspen are at mid-late to late modeled PNV values, but are high for mid-early. Early seral is also below modeled PNV ranges.

Commercial treatments will be the primary mechanism used to shift spruce-fir PNV type toward the modeled range of seral conditions. Because the footprint of the PTA is smaller than alternative 2, the overall shift from late seral spruce-fir forests to mid or early seral will be less. Alternative 3 will treat mature stands moving vegetation toward early or early-mid seral for both spruce-fir and spruce—fir-aspen cover types. Under alternative 3, an 8 percent shift is expected from late to early-mid. An 11 percent shift is expected from late-seral to early.

Non-commercial treatments in spruce-fir-aspen will result in only minor shifts in seral conditions with a 1 percent increase in early seral expected.

Natural mortality of mature spruce is likely to continue in the GA which will further shift these cover types toward an earlier seral condition. Existing spruce mortality in the GA is not considered extensive and therefore retention of live mature spruce is not a high priority management consideration. However, as mortality in mature spruce increases, retention of mature live spruce needs to be a management priority in treated stands. Removal of dead spruce is not expected to be a significant effect to the GA as long as various design features to protect the understory are followed. Management will move lynx habitat toward a range of seral stages desirable for long-term persistence of lynx in the GA. However, most of the shifts will be minor.

Table 277. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions In Spruce-Fir on the Uncompahgre Plateau GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	2%	14%	84% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	13%	17%	70%	

Table 278. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir-Aspen on the Uncompahgre Plateau GA.

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	1%	37%	62% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
Post Treatment Alternative 3	8%	37%	56%	

Standard Veg S2 – Direct and Indirect Effects

VEG S2 applies to all vegetation management projects that regenerate forested stands, except for fuel treatments in WUI. Under VEG S2, timber management projects shall not regenerate more than 15 percent of lynx habitat within an LAU in a ten-year period. Because SBEADMR is designed to be adaptive, the analysis was completed under current stand conditions and under future adaptive stand conditions. The analysis assumes all stands within a PTA and all roads identified in alternative 3 would be managed. Assumptions regarding level of impact by silvicultural prescription previously described in the Analysis Approach were used to estimate impact.

Table 279 summarizes projected levels of conversion to stand initiation structural stage by treatment type for Alternative 3. The balance of acres range from a low of 1,186 acres in the Spring Creek LAU in the Uncompahgre Plateau GA, to a balance high of 6,211 acres in the Rocky Brook LAU, North Gunnison GA. If the level of mortality increases resulting in complete loss of all mature spruce, management actions would shift to exclusively salvage harvest and the level of potential impact increases. Again, if all stands in PTA were to be managed, one LAU could exceed 15 percent conversion to SISS (Spring Creek LAU, Uncompahgre Plateau GA). All treatments will be tracked and reported annually to FWS. If at any time the VEG S2 standard is approached, management actions will be modified or discontinued to ensure that the standard is not exceeded.

Table 279. Alternative 3 Commercial Treatment Under Current Conditions with Lynx Habitat and Adapted/Potential Future Conditions if Spruce Beetle-Induced Mortality Becomes Widespread Across the GMUG.

Geographic Area	LAU	Overlapping Lynx Habitat Acres	Proposed Action: Assumed Incidental Impact to Stand Acres	Adapted/Potential Future Action (All Salvage): Assumed Incidental Impact to Stand Acres	Total Suitable Habitat in LAU	Total unsuitable Habitat in LAU	15% of lynx habitat	Acres converted to SISS - Existing	Balance acres based upon existing stand conditions (15% standard)	Acres converted to SISS - Adapted	Balance acres under adapted treatment (all salvage) (15% standard)
Grand Mesa											
	Cottonwood Lakes	4,199	764	635	24,994	63	3,759	433	3,263	1,804	1,892
	Green Mountain	1,038	200	16	24,113	17	3,617	510	3090	1,001	2599
	Island Lake	1,724	290	228	18,327	132	2,769	528	2109	841	1796
	Kannah Creek	905	167	232	11,698	47	1,755	6	1702	11	1697
	Mesa Lakes	1,245	247	287	17,113	279	2,609	7	2323	215	2115
Gunnison Basin North											
	Brush Creek	294	62	9	36,745	0	5,512	138	5374	274	5238
	Castle Pass	118	23	29	30,599	111	4,606	2	4493	6	4489
	Gothic	1,276	190	149	28,844	90	4,340	421	3829	749	3501
	Pitkin	1,114	220	252	38,849	1,132	5,997	84	4781	132	4733
	Red Creek	24	4	6	41,930	896	6,424	0	5528	0	5528
	Rocky Brook	445	91	116	41,833	60	6,284	13	6211	17	6207
	Whetstone Peak	787	131	59	15,553	0	2,333	33	2300	600	1733
Gunnison Basin South											
	Cathedral	475	82	95	40,869	147	3,215	146	2922	146	2922
	Cebolla	0	0	0	32,067	1,434	6,345	0	4911	0	4911
	Chester	2,145	440	486	25,087	144	4,832	201	4487	274	4414

Geographic Area	LAU	Overlapping Lynx Habitat Acres	Proposed Action: Assumed Incidental Impact to Stand Acres	Adapted/Potential Future Action (All Salvage): Assumed Incidental Impact to Stand Acres	Total Suitable Habitat in LAU	Total unsuitable Habitat in LAU	15% of lynx habitat	Acres converted to SISS - Existing	Balance acres based upon existing stand conditions (15% standard)	Acres converted to SISS - Adapted	Balance acres under adapted treatment (all salvage) (15% standard)
	Cochetopa	257	49	58	25,251	345	3,815	20	3450	37	3433
	Lake City	42	9	8	23,834	213	3,820	1	3606	14	3593
	Needle-Razor	54	10	14	17,822	82	2,686	0	2604	0	2604
North Fork Valley											
	Bald Mountain	461	73	57	32,171	335	4,876	4	4537	250	4291
	Black Mesa	881	174	232	33,391	501	5,084	15	4568	15	4568
	Chalk Mountain	426	73	112	24,639	0	3,696	8	3688	8	3688
	Crater Lake	2,526	448	518	36,357	79	5,465	31	5355	567	4819
	Peeler Lakes (Kebler	419	86	55	23620	0	3,543	110	3433	212	3331
San Juans											
	Alpine	1,500	238	204	32,051	990	4,956	589	3377	796	3170
	Iron Mountain	2,349	453	68	24,618	0	3,693	999	2694	2,077	1616
	Little Cone	912	148	11	22,125	284	3,361	466	2611	912	2165
	Lone Cone	396	69	21	24,476	618	3,764	55	3091	142	3004
	Matterhorn	165	12	3	25,594	0	3,839	125	3714	145	3694
Uncompahgre Plateau											
	Spring Creek	14,132	2,588	933	30,485	397	4,632	3,049	1186	10,981	-6746
	Traver Mesa NEW	1,757	352	226	25,087	436	3,828	421	2971	910	2482

Lynx Linkage Area – Direct and Indirect Effects

Under alternative 3, there are 3 Lynx Linkage Areas (LLA) that overlap PTA for the SBEADMR project area (Table 280). The affected LAU total 121,946 acres and provide habitat connectivity for lynx to move from one forested area to another. Acres of potential treatment in the Poncha Pass and North Pass LLA are less than 1 percent. No treatment in the Slumgullion/Spring Creek Pass LLA is proposed since it largely is outside of WUI. Due to the relatively small acres in the affected LLAs, connectivity for lynx movement will be retained. In addition, no treatment will span the entire length or width of any linkage and therefore connectivity will be maintained. Forest Service District Biologists will work closely with marking crews during treatment layout.

Table 280. Lynx Linkage Areas Occurring in the Proposed Action Area (Alt 3).

Name	Priority Treatment Areas and percent of total acres in LLA	Acres currently unsuitable in LLA	Total Acres in LLA
Poncha Pass	717 (0.8)	93	88,735
North Pass/Cochetopa Hills	304 (0.9)	274	33,212
Slumgullion/Spring Creek Pass	0 (0)	885	7,965
Total Acres	**1,022**	**1,252**	**129,912**

Habitat Connectivity within LAU – Direct and Indirect Effects

Grand Mesa

When comparing the gap between the current condition and desired PNV in spruce-fir, all affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). Under alternative 3, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 281). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be protected to the extent practicable. Under current stand conditions, 376 acres of lynx habitat would be managed via salvage prescriptions, 5,283 acres combined treatment and 3,605 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 65 percent of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

At the LAU scale, all shifts are less than 5 percent. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed. Because the proposed treatment is less under alternative 3 than alternative 2, shifts toward PNV would be less. Unless current overstory mortality levels increase in the Grand Mesa GA above current levels or some

other natural event (blow down or wildfire), management of spruce stands will not move all LAU spruce or spruce-aspen stands toward a mosaic or habitat structural stages to maintain ideal lynx and connectivity long term. Mid-late and late seral mostly multi-story stands will continue to dominate the landscape maintaining lynx habitat quality at current levels.

Table 281. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen PNV Types by LAU in the Grand Mesa GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: spruce-fir PNV Type*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions:Spruce-fir-aspen*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Grand Mesa	Cottonwood Lakes	Current Seral Conditions	1%	3%	96% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	
		Post Treatment Alternative 3	4%	7%	89%	

			Early	Early-Mid	Late-Mid	Late
	Green Mountain	Current Seral Conditions	0%	5%	95%	
		Post Treatment Alternative 3	5%	5%	90%	
	Island Lake	Current Seral Conditions	0%	6%	94% .	
		Post Treatment Alternative 3	4%	10%	87%	
	Kannah Creek	Current Seral Conditions	0%	33%	67% .	
		Post Treatment Alternative 3	0%	35%	65%	
	Mesa Lakes	Current Seral Conditions	1%	10%	90% .	
		Post Treatment Alternative 3	1%	13%	86%	
	The Flat Tops	Current Seral Conditions	0%	2%	98% .	
		Post Treatment Alternative 3	0%	2%	98%	

Gunnison Basin - North

When comparing the gap between the current condition and desired PNV in spruce-fir and spruce-fir-aspen, most affected LAU are dominated by late-mid and late seral conditions (habitat structural stages 4A, 4B and 4C). Exceptions are Peeler Lakes, Red Creek and Rocky Brook which approximate PNV ranges. Under alternative 3, approximately 6,500 acres would be managed commercially. Under current stand conditions, 668 acres of lynx habitat would be managed via salvage prescriptions, 1,234 acres combined treatment and 2,182 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 78 percent of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Under alternative 3, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 282). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be protected to the extent practicable. At the LAU scale, all shifts are less than 5 percent and most are less than 2 percent. Two of the LAUs (Peeler Lakes and Upper Tomichi) will not deviate from current conditions due to no or few acres proposed for management. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed. Unless current overstory mortality levels increase in the Without a natural event (extensive beetle kill, blow down or wildfire), management of spruce stands will not move all LAU spruce or spruce-aspen stands toward a mosaic or habitat structural stages to maintain ideal lynx and connectivity long term. Mid-late and late seral mostly multi-story stands will continue to dominate the landscape maintaining lynx habitat quality at current levels.

Table 282. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen PNV Types by LAU in the Gunnison North-GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions:Spruce-fir-aspen*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Gunnison Basin - North	Brush Creek	Current Seral Conditions	0%	6%	94%.	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 3	1%	6%	93%	
	Castle Pass	Current Seral Conditions	0%	9%	91%.	
		Post Treatment Alternative 3	0%	9%	91%	
	Gothic	Current Seral Conditions	0%	22%	78%.	
		Post Treatment Alternative 3	1%	23%	76%	
	Peeler Lakes	Current Seral Conditions	0%	84%	16%.	
		Post Treatment Alternative 3	0%	84%	16%	
	Pitkin	Current Seral Conditions	0%	26%	74%.	
		Post Treatment Alternative 3	0%	28%	72%	
	Red Creek	Current Seral Conditions	0%	43%	56%.	
		Post Treatment Alternative 3	0%	43%	56%	
	Rocky Brook	Current Seral Conditions	0%	48%	52%.	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 3	0%	49%	51%	
	Upper Tomichi	Current Seral Conditions	0%	12%	88%	
		Post Treatment Alternative 3	0%	12%	88%	
	Whetstone Peak	Current Seral Conditions	0%	6%	94%	
		Post Treatment Alternative 3	0%	7%	93%	

Gunnison Basin - South

When comparing the gap between the current condition and desired PNV in spruce-fir and spruce-fir-aspen, most affected LAU are within PNV ranges for late-mid and late seral (habitat structural stages 4A, 4B and 4C). Exceptions are Stewart and Los Pinos that are slightly below PNV ranges. However both of these LAU have relatively high percentage of earl-mid meaning these stands are predominately pole-sized material. Under alternative 3, approximately 6,500 acres would be managed commercially in the GA. Under current stand conditions, 668 acres of lynx habitat would be managed via salvage prescriptions, 1,234 acres combined treatment and 2,182 acres resiliency. Hazard tree removal could occur on 2,416 acres. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 85 percent of the stands in the GA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Under alternative 3, all three commercial treatment methods would retain spruce-fir and spruce-fir-aspen either within or move toward PNV ranges (Table 283). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be protected to the extent practicable. At the LAU scale, all shifts are less than 5 percent and most showing no or little change. Due to the relatively small amount of acres proposed for treatment, 6 LAU will be un-affected at the LAU-scale. None of the LAU would move away from PNV if they are already in acceptable PNV ranges or achieve PNV conditions.

Table 283. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Gunnison Basin South GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions:Spruce-fir-aspen PNV	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Gunnison Basin - South	Alpine	Current Seral Conditions	0%	38%	62%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 3	1%	40%	59%	
	Cathedral	Current Seral Conditions	0%	58%	42%	
		Post Treatment Alternative 3	0%	58%	42%	
	Cebolla	Current Seral Conditions	0%	36%	64%	
		Post Treatment Alternative 3	0%	36%	64%	
	Chester	Current Seral Conditions	0%	37%	63%	
		Post Treatment Alternative 3	0%	42%	58%	
	Cochetopa	Current Seral Conditions	0%	43%	57%	
		Post Treatment Alternative 2	0%	44%	56%	
	Lake City	Current Seral Conditions	0%	32%	68%	
		Post Treatment Alternative 3	0%	32%	68%	
	Los Pinos Creek	Current Seral Conditions	0%	62%	38%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 3	<1%	62%	38%	
	Needle-Razor	Current Seral Conditions	0%	37%	63%	
		Post Treatment Alternative 3	0%	37%	63%	
	Stewart Creek	Current Seral Conditions	1%	56%	43%	
		Post Treatment Alternative 3	1%	56%	43%	

North Fork Valley

When comparing the gap between the current condition and desired PNV in spruce-fir, most affected LAU fall within PNV ranges for late-mid and late seral conditions - habitat structural stages 4A, 4B and 4C (Table 76). The only exception is the Bald Mountain LAU which is dominated by late-mid and late seral. Under alternative 3, approximately 6,874 acres would be managed commercially. Under current stand conditions, 112 acres of lynx habitat would be managed via salvage prescriptions, 1,814 acres combined treatment and 4,223 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 65 percent of the stands in commercial PTA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Under alternative 3, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 284). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be protected to the extent practicable. At the LAU scale, all shifts are less than 2 percent. Bald Mountain LAU will see no change due to no or little proposed management. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 284. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the North Fork GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
North Fork Valley		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions:Spruce-fir-aspen*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
	Bald Mountain	Current Seral Conditions	0%	20%	80%	
		Post Treatment Alternative 3	0%	20%	80%	

			Early	Early-Mid	Late-Mid	Late
	Black Mesa	Current Seral Conditions	0%	38%	62%	
		Post Treatment Alternative 3	0%	39%	61%	
	Crater Lake	Current Seral Conditions	1%	48%	51%	
		Post Treatment Alternative 3	1%	49%	49%	
	Peeler Lakes	Current Seral Conditions	0%	10%	90%	
		Post Treatment Alternative 3	1%	10%	89%	

San Juan Mountains

When comparing the gap between the current condition and desired PNV in spruce-fir and spruce-fir-aspen, all affected LAU are dominated by late-mid and late seral conditions - habitat structural stages 4A, 4B and 4C (Table 285). Under alternative 3, approximately 7,327 acres would be managed commercially. Under current stand conditions, 783 acres of lynx habitat would be managed via salvage prescriptions, 3,413 acres combined treatment and 1,456 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 16 percent of the stands in commercial PTA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Under alternative 3, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 285). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be protected to the extent practicable. At the LAU scale, most shifts are less than 5 percent with the exception of Iron Mountain LAU that shifts 9 percent. Turret Ridge LAU will see no change due to no or little proposed management. None of the LAU would achieve desired PNV conditions due to the small acreage that could be actively managed.

Table 285. Comparison of Modeled PNV Seral Conditions versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the San Juan GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
San Juans		VDDT Modeled Range of Seral Conditions: Spruce-fir-aspen	27-32%	20-24%	12-13%	31-40%
		Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%

			Early	Early-Mid	Late-Mid	Late
San Juans	Alpine	Current Seral Conditions	0%	3%	97%	
		Post Treatment Alternative 3	3%	4%	93%	
	Iron Mountain	Current Seral Conditions	0%	11%	89%	
		Post Treatment Alternative 3	8%	12%	80%	
	Little Cone	Current Seral Conditions	0%	10%	90%	
		Post Treatment Alternative 3	3%	10%	87%	
	Lone Cone	Current Seral Conditions	3%	14%	83%	
		Post Treatment Alternative 3	4%	14%	82%	
	Matterhorn	Current Seral Conditions	0%	12%	88%	
		Post Treatment Alternative 3	1%	12%	87%	
	Turret Ridge	Current Seral Conditions	0%	8%	92%	
		Post Treatment Alternative 3	0%	8%	92%	

Uncompahgre Plateau

When comparing the gap between the current condition and desired PNV in spruce-fir and spruce-fir-aspen, all affected LAU are dominated by late-mid and late seral conditions - habitat structural stages 4A, 4B and 4C (Table 286). Under alternative 3, approximately 17,001 acres would be managed commercially. Under current stand conditions, 218 acres of lynx habitat would be managed via salvage prescriptions, 8,785 acres combined treatment and 7,685 acres resiliency. Stands with high levels of mortality where advance regeneration is present are shifting toward younger age-classes (shrub-seedlings and sapling pole). Since approximately 45 percent of the stands in commercial PTA are mapped as multi-story, overstory mortality in these stands would experience the greatest shift.

Under alternative 3, all three commercial treatment methods would shift spruce-fir and spruce-fir-aspen toward PNV (Table 286). In multi-storied stands, seral conditions will go from mid-late or late to early-mid since understory vegetation will be retained to the greatest extent practicable (trees under 9 inches will be retained and pockets of DHC>35 percent) will be avoided. At the LAU scale, the Spring Creek LAU would shift 22 percent and Travers Mesa 5 percent. These shifts will move cover types toward PNV ranges, in particular mid-late and late would be within PNV ranges.

Table 286. Comparison of modeled PNV Seral Conditions Versus Current Seral Conditions in Spruce-Fir and Spruce-Aspen Types by LAU in the Uncompahgre Plateau GA.

			Early	**Early-Mid**	**Late-Mid**	**Late**
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions: Spruce-fir PNV*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
Uncompahgre Plateau		VDDT Modeled Range of Seral Conditions: Spruce-fir-aspen	27-32%	20-24%	12-13%	31-40%
Geographic Area	Lynx Analysis Unit	Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
		VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Uncompahgre Plateau	Spring Creek	Current Seral Conditions	4%	6%	91%	

			Early	Early-Mid	Late-Mid	Late
		Post Treatment Alternative 3	21%	10%	69%	
	Traver Mesa	Current Seral Conditions	0%	24%	76%	
		Post Treatment Alternative 3	3%	26%	71%	

Roads – Direct and Indirect Effects

Vehicle traffic associated with timber sale activities would increase traffic levels above existing conditions. While acres of commercial treatment are less under alternative 3 than alternative 2, actual acres treated (60,000) remains the same. Since the numbers of commercial PTA are fewer, the number of haul routes could be less. The estimate of 81,000 log truck loads generated by the proposed action over a 10-12 year remains the same as does the number of truck per day per any given route (20 per day). Potential impacts to lynx are the same as alternative 2.

Snow Compaction – Direct and Indirect Effects

Potential impacts from plowed routes from hauling is the same as described previously under alternative 2 since the same routes could be used. Maintenance level 4 and 5 roads are likely to be plowed during winter logging operations. A total of 90.5 miles of these routes could be plowed on any given winter. Of the 90.5 miles, 84.6 miles are already included in the snow compaction baseline for the Forest. These routes are either groomed for winter recreation use or routinely plowed for some other use besides winter access for logging operations. Approximately 5.9 miles of route are not currently included in the snow compaction baseline. LAU affected are Kannah Creek and Chester. Snow plowing to allow access for logging is considered a short-term impact, and as such is exempted from Guideline HU G10 of the SRLA.

Snowshoe Hare and Red Squirrel Habitat – Direct and Indirect Effects

Snowshoe hares are the primary prey item for lynx. Red squirrels are reported to be the second most important in much of the lynx range, including Colorado (Interagency Lynx Biology Team, 2013). Both species prefer multi-storied spruce-fir forests with abundant coarse woody debris, and in the case of red squirrel, abundant cone production.

Mature spruce stands that are multi-storied most likely provide habitat for both species. Table 287 summarizes acres of multi-storied and single-storied stands within alternative 3 commercial PTA and hazard trees. If all multi-storied were treated with resiliency, partial retention, or salvage treatments with proper use of design features a total of 5,071 acres of hare habitat and 2,536 acres of high quality (>35 percent DHC) hare habitat could be affected. An incidental loss from skid trails, landings is estimated at 20 percent. Since there are only 45,967 acres of commercial PTAs considered in Alternative 3, all of these acres could be managed. The current balance under VEG S6 (high-quality hare habitat that can be affected forest-wide) is 4,955 acres, which is greater than the 2,536 acres of projected impact. Balances remaining under VEGS6 will be reported annually as required by SRLA.

Spruce beetle induced mortality of mature trees or removal of green mature spruce will affect the abundance of red squirrel. In Colorado red squirrels have been documented to decline when overstory mortality reaches 60 percent after 3 years (Ivan, pers. comm). When overstory mortality reaches 90 percent squirrel numbers decline even further. At greater than 90 percent overstory mortality, only about 50 percent of the stands could be expected to support squirrels. Harvesting of dead mature spruce that are no longer producing a cone crop are expected to have minimal additional impact to red squirrel populations, especially in stands with greater than 90 percent overstory mortality. However, removal of live mature spruce in areas of moderate to high overstory mortality could additional incremental effects to squirrel numbers.

Table 287. Acres of Lynx Habitat in PTA and Hazard Trees.

Geographic Area	Layering	Overlapping Lynx Habitat Acres – Alt 3 PTA and hazard trees (ac)	Percent of the stands in PTA	Proposed Road Acres[1]	Proposed Roads Outside PTA[1]	Projected acres of hare habitat affected	Projected acres of high quality (>35% DHC) hare habitat that could be affected
Grand Mesa		9,749					
	M	5,638	58	61	5	1,194	597
	S	4,111	42				
Gunnison Basin North		6,572					
	M	3,698	56	28	22	790	395
	S	2,874	44				
Gunnison Basin South		6402					
	M	5,508	86	43	28	1,173	586
	S	894	14				
North Fork Valley		5,230					
	M	4,152	79	50	8	888	444
	S	1,078	21				
San Juans		5,651					
	M	458	9	1	43	136	68
	S	5,193	91				
Uncompahgre Plateau		16,230					
	M	4,107	25	36	33	890	446
	S	12,123	75				

Geographic Area	Layering	Overlapping Lynx Habitat Acres – Alt 3 PTA and hazard trees (ac)	Percent of the stands in PTA	Proposed Road Acres[1]	Proposed Roads Outside PTA[1]	Projected acres of hare habitat affected	Projected acres of high quality (>35% DHC) hare habitat that could be affected
			Total			5,071	2,536

Note: Acres of multi-story and single story stands for hazard trees removal are estimated based upon percent single story versus multi-story within PTA for a given LAU.

[1] New Road construction is calculated at 100 percent loss to the understory

Alternative 3 Cumulative Effects – Current Stand Conditions and Adapted/Potential Future Stand Conditions

The cumulative effects analysis considered past activities that have occurred in the project area, future non-federal actions occurring on State and private land that are reasonably certain to occur. Past Forest Service vegetation management that converted lynx habitat to unsuitable (e.g. clear-cuts), powerlines and other features that permanently convert lynx habitat and roads were all considered. Time period used to enumerate acres is 1990-2015 (25 years). Since lynx habitat does re-grow and it takes 25 years for a germinated spruce to reach a height of 6-10 feet (above average snow depth), a residual impact of 25 percent was assumed. Permanent roads were considered a 100 percent loss of lynx habitat. Activities proposed by BLM Gunnison Field Office were also considered in the analysis. Total acres of commercial mechanical treatments, acres of new road construction, and acres of hazard under current stand conditions and adapted/potential future stand conditions were analyzed (Table 288). It was assumed that all stands in PTA would receive management. Total acres of impact were compared to the 30 percent conversion to unsuitable identified in the SRLA.

Under current stand conditions and the silvicultural prescriptions (resiliency, combined, and salvage) that would be applied to those stands, no LAU would exceed the 30% conservation threshold. Under the adapted/potential future stand conditions and adapted prescription (all salvage), one LAU could exceed the threshold (Spring Creek). Under the adapted/potential future stand conditions, acres of single-storied stands with greater than 90 percent would increase. Since one of the objectives under SBEADMR is to protect the understory where it exists, single-storied stands will be preferred treatment areas. To ensure the conservation threshold is not exceeded, road construction, harvest associated and other non-SBEADMR related actions will be tracked via Forest Service databases annually. Since the conservation threshold also takes into account natural process (wildfire or widespread spruce beetle conversion to unsuitable), these processes will also be tracked when data is available.

No reasonably foreseeable activities are known to be planned on non-federal land within affected LAU that would compromise the quantity and quality of lynx habitat

Table 288. Projected Cumulative Effects of Proposed and Adapted Treatments, Current Stand Conditions and Potential Future Stand Conditions for Alternative 3.

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under Alt 3 - Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activi-ties	Cumulative acres of impact-Current	Cumulative acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current Stand Conditions	Balance Potential Future Stand Conditions
						SISS Current	Incidental Current	SISS adapted	Incidental adapted								
Grand Mesa	Cottonwood Lakes	24,994	398	3,576	1,292	433	764	1,804	635	95	4		2,588	3,830	7498	4910	3668
	Green Mountain	24,113	200	539	335	510	200	1,001	16	101	1		1147	1454	7234	6087	5780
	Island Lake	18,327	280	2,184	826	528	290	841	228	43	0	466	2153	2404	5498	3345	3094
	Kannah Creek	11698	197	3,900	1,171	6	167	11	232	199	5		1548	1618	3509	1961	1891
	Mesa Lakes	17,113	170	1,073	438	7	247	215	287	85	9		786	1034	5134	4348	4100
	The Flat Tops	27,774	143	335	227	0	0	0	0	115	0		342	342	8334	7992	7992
Gunnison Basin - North	Brush Creek	36,745	354	312	407	138	62	274	9	322	3		932	1015	11,032	10,100	10,017
	Castle Pass	30,599	112	315	191	2	23	6	29	16	2		234	244	9180	8946	8936
	Fossil Ridge	36,570	283	4,067	1,300	0	0	0	0	24	0		1324	1324	10971	9647	9647
	Gothic	28,934	576	751	764	421	190	749	149	129	11	102	1617	1904	5100	3483	3196
	Grizzly Peak	17,001	65	329	147	0	0	0	0	5	0		152	152	5100	4948	4948
	Pitkin	38,849	1,275	3,136	2,059	84	220	132	252	358	0		2721	2801	11654	8933	8853
	Red Creek	44,930	565	3,842	1,526	0	4	0	6	584	0		2114	2116	13479	11364	11362
	Rocky Brook	41,833	523	9,624	2,929	13	91	17	116	462	4		3499	3528	12550	9051	9022
	Soap Creek	42,711	108	3,922	1,088	0	0	0	0	2	0		1090	1090	12813	11923	11923
	Tincup	37,328	601	1,252	914	0	0	0	0	102	0		1016	1016	11198	10182	10182
	Upper Taylor	30,654	380	760	570	0	0	0	0	247	0		817	817	9169	8352	8252
	Upper Tomichi	30,032	425	1,056	689	9	33	27	38	165	0		896	919	9009	8113	8090
	Whetstone Peak	15,553	64	0	64	33	131	597	50	0	0		228	711	4665	4437	3954
Gunnison Basin - South	Cathedral	21,286	89	1,028	346	146	82	146	55	56	7		637	610	6385	5748	5775
	Cebolla	40,869	259	1,956	748	0	0	0	0	107	0	2	857	857	12260	11403	11403
	Chester	32,067	616	8,349	2,703	201	440	273	486	501	3	6	3854	3972	9620	5766	5648
	Cochetopa	25,087	1,000	6,219	2,555	20	49	37	58	623	1	7	3255	3281	7526	4271	4245
	Lake City	25,251	97	1,351	435	0	9	13	8	159	0		603	615	7575	6972	6960
	Los Pinos Creek	23,834	469	3,018	1,223	534	1,116	741	1,191	504	0	9	3386	3668	7110	3724	3442

Geographic Area	LAU	Total Suitable Lynx Habitat - LAU	Existing Road Acres	Past Activity Acres	Cumulative (Road + 25% of activities)	Activities Proposed under Alt 3 - Commercial				Hazard Tree projected Impacts	New Roads Outside PTA	Foresee-able Future Activi-ties	Cumulative acres of impact-Current	Cumulative acres of impact-Adapted	30% of lynx habitat in LAU	Balance Current Stand Conditions	Balance Potential Future Stand Conditions
	Needle-Razor	17,822	285	5,520	1,665	10	0	14	0	158	0		1833	1837	5347	3514	3510
	Sawtooth Mtn	27,668	210	1,331	543	0	0	0	0	102	0		645	645	8300	7655	7655
	Stewart Creek	26,858	563	5,591	1,961	0	0	0	0	427	0	3	2391	2391	8057	5661	5661
	Whitecross Mtn	6,947	49	8	51	0	0	0	0	8	0		59	59	2084	2025	2025
	Anthracite	20,742	27	0	27	0	0	0	0	8	0		35	35	6223	6188	6188
	Bald Mountain	32,171	143	1,392	491	19	150	298	128	43	1	1	705	962	9651	8946	8689
	Beckwith Mtn	53,369	138	0	138	0	0	0	0	127	0		265	265	16011	15749	15749
	Black Mesa	3,391	482	3,727	1,414	20	330	59	394	256	1	5	2026	2129	10017	7991	7888
	Chalk Mountain	24,639	158	369	250	0	109	0	158	5	3	3	370	419	7329	7022	6973
	Crater Lake	36,357	357	1,688	779	84	728	912	797	221	5	6	1823	2720	10907	9084	8187
	Peeler Lakes (Kebler)	23,620	167	35	175	0	92	0	62	9	2	2	280	250	7086	6806	6839
	Mount Gunnison	22,417	144	78	163	0	0	0	0	122	0		285	285	6725	6440	6440
	Ragged Mtn	11,805	54	0	54	0	0	0	0	46	0		100	100	3542	3442	3442
San Juans	Alpine	32,051	278	4,253	1,342	2,156	909	3,987	345	248	24	24	4703	5970	9615	4912	3645
	Iron Mountain	24,618	359	273	427	999	453	2,077	68	13	0		1892	2585	7385	5493	4800
	Little Cone	22,125	117	43	128	0	275	1,577	3	117	5	2	527	1832	6638	6111	4806
	Lone Cone	24,476	346	2,036	855	1,207	867	3,081	438	270	1	17	3217	4662	7343	4136	2681
	Matterhorn	25,594	330	193	378	125	12	152	3	17	0		532	550	7678	7146	7128
	Turret Ridge	26,320	175	0	175	0	0	0	0	445	0		620	620	7896	7276	7276
Uncompahgre Plateau	Spring Creek	30,485	469	6,039	1,979	3,521	3,046	12,955	929	55	32	25	8658	15975	9145	487	-6830
	Traver Mesa	25,087	457	4,590	1,771	1,216	1,747	1,611	2,063	286	1	8	5,029	5740	7526	2497	1786

Gunnison Sage-Grouse

Analysis Approach

Acres of Gunnison sage-grouse habitat in Critical Habitat in non-commercial PTA were summarized by vegetation type. Non-commercial PTA was developed based upon logical treatment (burn) boundaries and therefore included some non-target vegetation types. Non-target vegetation types include: sagebrush, grasses and forbs – particularly meadows. During treatment planning these vegetation types will be avoided. Analysis for sage-grouse includes only the target vegetation types – aspen and mixed aspen-conifer stands.

Environmental Baseline

Within the Gunnison Basin, many of the ongoing activities occurring on State and private land are directed by an approved Candidate Conservation Agreement with Assurances - CCAA (Colorado Parks and Wildlife and US Fish and Wildlife Service, 2006) and on federal lands by a Candidate Conservation Agreement - CCA (CPW et al. 2013). The CCA underwent formal consultation with Fish and Wildlife Service with issuance of a Biological Opinion. These documents provide a more detailed description of habitat conditions in that Basin. These documents also provide direction to minimize effects of land management activities affecting sage grouse

Gunnison sage-grouse sub-populations and critical habitat in the affected area of SBEADMR are Gunnison Basin, San Miguel Basin and Pinon Mesa (Maps G-55 through G-66, Appendix G). The vast majority of the acres are located in the Gunnison Basin North GA, followed by Gunnison Basin South GA then Uncompahgre Plateau GA. Vegetation targeted for treatment in PTA include aspen and mixed conifer stands affected by Sudden Aspen Decline, decadent aspen stands, of conifer encroachment into meadows.

Alternative 1, No Action Alternative – Direct and Indirect Effects

Under the No Action alternative, there would be no direct or indirect effects to Gunnison Sage-grouse or its designated critical habitat. Habitats such as aspen and aspen-mixed conifer stands would stay at their current conditions or without some natural disturbance may continue to decline (e.g. decadent aspen stands).

Alternative 1 - Cumulative Effects

The environmental baseline depicts the range of conditions resulting from past actions. Under the no action alternative these actions and resulting range of conditions will continue.

Alternative 2, Agency Preferred Alternative – Direct and Indirect Effects

Species and Critical Habitat

There are 7,365 acres of various vegetation types included in commercial and non-commercial PTA within Gunnison sage-grouse designated critical habitat (Table 289 and Maps G-56-62). Aspen, piñon-juniper, and mixed aspen-conifer stands will be the focus of treatment. During pre-treatment layout, areas of ***sagebrush, grass and forb meadows will be identified and avoided***. Approximately 13,000 acres of these habitat types fall within commercial and non-

commercial PTA. Treatments focus on moving vegetation toward habitat objectives identified in the Range-wide plan (Gunnison Sage-grouse Range-wide Steering Committee, 2005). Specifically, for habitats related to SBEADMR:

- Other mixed stands could include piñon-juniper (PJ) stands that are currently invading sagebrush parks. Removal of PJ could benefit sage-grouse.
- Improve, where deficient, understory grass and forb components within nesting and early brood-rearing areas.
- Improvement of the aspen stands adjacent to sage-brush areas. This is especially true for aspen stands from 8,500 to 9,500 feet in elevation range.
- Aspen stands that are at lower elevation, isolated and generally smaller patches. These are important areas of biodiversity that may be vulnerable with a changing climate.

While very limited in the project area, treatment of mixed conifer stands invading sagebrush parks directly benefit sage-grouse. Treatments could inadvertently affect some sagebrush in the immediate area of treatment but long-term will allow sagebrush expansion or retention of sagebrush if is still exists. Elimination of encroaching conifers will also improve understory grasses and forbs which are important components for nesting and early brood-rearing areas. Noise from the use of mastication equipment, could temporary displace birds if they are in the immediate area.

Sage-grouse utilize the transition area between sage-brush and aspen for foraging, especially during the brood period. In decadent aspen stands, the use of mechanical or prescribed burning will facilitate aspen regeneration. Young aspen, particularly in wetter areas, can increase insect production utilized by young birds. As with mixed conifer treatments, the use of mastication equipment may temporary displace birds.

Small isolated patches of aspen exist within non-commercial PTAs. These isolated patches of aspen provide important habitat for a variety of wildlife species, including sage-grouse. Within the project area, vegetative shifts resulting from climate change are predicted to occur resulting in loss of aspen in lower elevation areas. Particularly at risk are isolated patches of aspen where mortality has already been observed in the Gunnison Basin (Speas, pers. obs.). Treatment of these stands to regenerate them will help retain them longer on the landscape benefitting sage-grouse and other wildlife.

The use of prescribed fire and non-commercial mechanical in sage-grouse habitat will be completed outside the breeding, nesting and brood-rearing period to minimize direct disturbance of birds (WFRP-21). Treatments will be designed by Forest Service biologists in cooperation with CPW and Fish and Wildlife Service biologists.

Table 289. Alternative 2 Potential Activities in Gunnison Sage-grouse Critical Habitat: Dominated by Trees.

Geographic Area & Proposed Activity	SBEADMR Activity Type	Total Acres
Gunnison Basin North		**3,962**
	Hazard Trees Outside PTAs	**112**
	Aspen Mix	102
	Aspen Spruce Mix	8
	Spruce Mix	2
	Priority Treatment Areas	**3,849**
	Commercial	72
	Aspen	0
	Aspen Spruce Mix	71
	Noncommercial	3,778
	Aspen	2,654
	Other Tree Species	1,120
	Spruce	4
Gunnison Basin South		**1,310**
	Hazard Trees Outside PTAs	**203**
	Aspen Mix	137
	Aspen Spruce Mix	57
	Spruce Mix	9
	Priority Treatment Areas	**1,107**
	Noncommercial	1,107
	Aspen	495
	Aspen Spruce Mix	58
	Other Tree Species	552
	Spruce	1
North Fork Valley		**92**
	Hazard Trees Outside PTAs	**36**
	Aspen Mix	29
	Spruce Mix	7
	Priority Treatment Areas	**56**
	Commercial	56
	Aspen Spruce Mix	29
	Spruce	27
Uncompahgre Plateau		**2,001**
	Hazard Trees Outside PTAs	**26**
	Aspen Mix	12

Geographic Area & Proposed Activity	SBEADMR Activity Type	Total Acres
	Spruce Mix	14
	Priority Treatment Areas	**1,975**
	Noncommercial	1,975
	Aspen	1,711
	Other Tree Species	261
	Spruce	3
Grand Total		**7,365**

There are several haul routes to transport commercially harvested timber to the mill that have the potential to disturb Gunnison sage-grouse during the breeding season (Map G-67, Appendix G). The Range-wide Plan and listing package prepared by Fish and Wildlife Service recommends avoiding use of routes with 0.6 miles of a lek by vehicular traffic between March 15 and May15 (Gunnison Sage-grouse Range-wide Steering Committee, 2005). Road segments in blue on Map G-63 are those that pass within 0.6 miles of an active lek. All of these routes are State Highways on which the Forest Service has no jurisdiction to require a seasonal closure. The estimated 20 trucks per day could result in increased traffic noise which could displace birds. The degree of increased traffic noise over ambient levels from passenger traffic will vary by route. High use routes like Highway 50 will see minor increases over ambient while other routes like Hwy 114 may have slightly higher levels. If inactive leks become active or if new leks are discovered along USFS or County Roads, design feature WFRP-16 (Appendix B) will be applied. WFRP 16 is consistent with current seasonal road closures applied in the Gunnison Basin on County, BLM, and USFS roads in Gunnison sage- grouse habitat to protect birds during the lek season.

Alternative 2 - Cumulative Effects

Cumulative effects include the environmental baseline plus the additive effect of reasonably future State, private and tribal activities. Within the Gunnison Basin State, private and tribal lands management actions are guided by CCAA, which was developed as a conservation measure for grouse. Other sub-populations of grouse of grouse do not have signed CCAA in place so management actions on State, private and Tribal will continue how they have in the past. Most of the actions are considered on-going, occurring over long periods of time.

Alternative 3, WUI Focus - Direct and Indirect Effects

Species and Critical Habitat

There are 6,926 acres of various vegetation types included in commercial and non-commercial PTA within Gunnison sage-grouse designated critical habitat (Table 290). Aspen, piñon-juniper, and mixed aspen-conifer stands will be the focus of treatment. During treatment planning areas of ***sagebrush, grass and forb meadows will be identified and avoided***. Approximately 10,955 acres of non-target (sagebrush, habitat types also fall within commercial and non-commercial PTA. As with Alternative 2, treatments focus on moving vegetation toward habitat objectives identified in the Range-wide plan (Gunnison Sage-grouse Range-wide Steering Committee, 2005).

While acres of target vegetation types are less than Alternative 2, direct and indirect effects will be similar in scope and scale.

Under Alternative 3, commercial acres on which spruce-fir or aspen could be harvested are less than under alternative 2 (approximately 45,000 acres). While acres are fewer, major haul routes that could affect sage-grouse leks remain the same and therefore effects from the use of these routes are the same (Map G-67, Appendix G). The use of WFRP-16 will be applied anytime hauling occurs on USFS roads that could affect sage-grouse between March 15 and May 15.

Table 290. Alternative 3 Potential Activities in Gunnison Sage-grouse Critical Habitat: Dominated by Trees

Geographic Area	SBEADMR Activity Type	Total Acres
Gunnison Basin North		**3,639**
	Hazard Trees Outside PTAs	**154**
	Aspen Mix	144
	Aspen Spruce Mix	8
	Spruce Mix	2
	Priority Treatment Areas	**3,485**
	Commercial	72
	Aspen	0
	Aspen Spruce Mix	71
	Noncommercial	3,413
	Aspen	2,331
	Other Tree Species	1,078
	Spruce	4
Gunnison Basin South		**1,194**
	Hazard Trees Outside PTAs	**203**
	Aspen Mix	137
	Aspen Spruce Mix	57
	Spruce Mix	9
	Priority Treatment Areas	**991**
	Noncommercial	991
	Aspen	382
	Aspen Spruce Mix	58
	Other Tree Species	550
North Fork Valley		**92**
	Hazard Trees Outside PTAs	**36**
	Aspen Mix	29
	Spruce Mix	7
	Priority Treatment Areas	**56**
	Commercial	56
	Aspen Spruce Mix	29
	Spruce	27
Uncompahgre Plateau		**2,001**
	Hazard Trees Outside PTAs	**26**
	Aspen Mix	12

Geographic Area	SBEADMR Activity Type	Total Acres
	Spruce Mix	14
	Priority Treatment Areas	**1,975**
	Noncommercial	1,975
	Aspen	1,711
	Other Tree Species	261
	Spruce	3
Grand Total		**6,926**

Alternative 3 -Cumulative Effects

Cumulative effects include the environmental baseline plus the additive effect of reasonably future State, private and tribal activities. Within the Gunnison Basin State, private and tribal lands management actions are guided by CCAA, which was developed as a conservation measure for grouse. Other sub-populations of grouse do not have signed CCAA in place so management actions on State, private and Tribal will continue how they have in the past. Most of the actions are considered on-going, occurring over long periods of time.

Greenback Cutthroat Trout

Environmental Baseline

There are at least 40 Conservation Populations of Greenback Cutthroat Trout (GBCT) on the GMUG. Greenback Cutthroat Trout populations on the GMUG are generally confined to mid- to high-elevation streams (> 2,500 m) with associated high gradients. Conservation Populations tend to occupy relatively pristine streams, although the surrounding watersheds may contain a substantial human footprint. Large-scale patterns of habitat occupancy observed today are most likely the result of incursion of non-native fish species along with water development in downstream portions of occupied watersheds. Seven streams supporting greenback cutthroat lineage fish are known to occur in the SBEADMR project area (Table 291).

Table 291. Cutthroat Trout Conservation Populations Associated with Priority Treatment Areas.

CRCT Population	Lineage	SBEADMR Geographic Area
Dyke Creek	GBCT	Grand Mesa
Cunningham Creek	GBCT	North Fork Valley
East Fork Terror Creek	GBCT	North Fork Valley
West Fork Terror Creek	GBCT	North Fork Valley
Beaver Dams Creek	GBCT	Uncompahgre Plateau
East Fork Dry Creek	GBCT	Uncompahgre Plateau
Pryor Creek	GBCT	Uncompahgre Plateau

Alternative 1 - No Action Alternative — Direct and Indirect Effects

Under the No Action alternative, there would be no direct, indirect effects to Greenback cutthroat trout, as no management activities are proposed. However, most spruce affected by spruce beetle and aspen affected by SAD would be untreated, unless authorized by other ongoing and future decisions. There would be more dead trees left in the riparian areas, which are a source of large, woody debris to stream channels.

Alternative 2 – Agency Preferred Alternative - Direct and Indirect Effects

Design features incumbent to the SBEADMR project preclude harvest-related activities in and very near to stream channels (Table 292). Therefore, impacts to greenback from the effects described above would not occur as SBEADMR is implemented. The following table defines potential effects and lists specific design features that render analysis of the potential impacts moot.

Table 292. SBEADMR Design Features for Stream Habitat and Resident Aquatic Populations.

Effect	Design Feature(s)	Comments
Direct mortality of CRCT	WQSP-2A	See Section 10
Habitat destruction	WQSP-2A	See Section 10
Stream network fragmentation	WQSP-3A; WQSA-3B; WQSP-8A(B)	WQSP-3A states that aquatic biologists will participate in the design of road-stream crossings. WQSP-3B states temporary crossings will be removed from streams upon completion.
Erosion from surrounding watershed	TSHR-1; TSHR-2; WQSP-5A; WQSP-6; WQSP-7A; WQSP-8B; MNTG-1	At least one member of the Aquatics Team will participate in the planning and implementation of treatment-level harvest activities.
Increased stream temperature from riparian harvest	WQSP-2A; MNTG-1	The Aquatics Team has the ability to perform long-term stream temperature monitoring to quantify the effect (if any) of harvest near streams on stream temperature.
Additive erosion in watersheds with existing dense road network	TSHR-1; WQSP-6; WQSP-7A; WQSP-8A; WQSP-8B; MNTG-1	At least one member of the Aquatics Team will participate in the planning and implementation of treatment-level harvest
Additive stream temperature increase due to riparian harvest and climate change	WQSP-2A	See below

Climate change has the potential to affect aquatic populations by reducing the amount of suitable habitat within their range. If stream temperatures rise such that they are outside the suitable range for growth and reproduction, aquatic biota would be forced to respond by moving to suitable areas (typically upstream in Rocky Mountain watersheds) or potentially be extirpated from previously occupied areas. Research in the Pacific Northwest suggests that climate change is contributing to stream temperature changes that are negatively impacting the suitability of historically occupied stream habitat. In the Rocky Mountains, changes to stream habitat are not as well studied or defined.

The GMUG Aquatics Team has been monitoring stream temperature across the Forest since 2010. We use a combination of permanent and seasonally deployed stream temperatures sensors at sites across the Forest. The objective of the monitoring program is to develop predictive stream temperature models for the Forest.

There are two ways stream temperature changes could affect habitat suitability for aquatic biota: elevated short-term (1-7 day) stream temperatures that cause mortality and elevated long-term (30 day) stream temperatures that affect growth, feeding, reproduction, and recruitment. The temperature data we have collected since 2010 allows us to evaluate the potential for climate change to alter the suitability of stream habitat over the next 20-75 years.

There are a several potential direct effects of forest management activities on fishes and aquatic stream habitat. These include mortality due to the operation of equipment in or around stream channels, modification of stream habitat due to the operation of equipment in a stream channel, and fragmentation of stream habitat due to the installation of a road-stream crossing that prevents organism passage. GBCT populations could experience indirect effects as a result of SBEADMR.

Potential indirect effects to streams of forest management practices in a watershed include erosion from roads and timber harvest in the riparian area or on surrounding hillslopes, as well as increased stream temperature due to harvest of riparian vegetation. However, the identified design features, including avoidance of streamside areas, would avoid or minimize these potential impacts.

Alternative 2 – Cumulative Effects

Cumulative effects that could be manifested as SBEADMR is implemented include additive sedimentation from new roads and harvest activities that occur in watersheds with existing road networks, additive fragmentation of stream networks by improperly designed road-stream crossings, and stream temperature increases that occur because of the combined effects of riparian vegetation harvest and regional climate change. With proper used of prescribed design features impacts to GBCT will be minimized.

Determinations of Effect and Rationale

Canada Lynx

Based on this analysis, we determine that the SBEADMR project is ***"Likely to Adversely Affect"*** the Canada lynx. This conclusion applies to both action alternatives. The rationale for this conclusion is based on:

- The scale and complexity of the proposed project.
- Stand conditions that are constantly changing as bark beetles and SAD continue to spread to spruce-fir and aspen stands respectively, across the landscape. These landscape-level changes will continue to influence lynx habitat conditions, both positively and negatively.
- The project is in compliance with all SRLA Vegetation Standards, objectives and guidelines (Table 293). Estimates of impact based upon best available data at the scope and scale of the project have been used. As treatment are designed and implemented

annual tracking and reporting which will help validated predicted impacts and ensure no acre caps will be exceeded.

- Levels of predicted impact as defined by VEG S1 and VEG S2 will occur in 49 out of 51 LAU on the GMUG NF. In a few cases and depending on current and adapted (future) stand conditions these thresholds could be approached of the life of the project.
- Project design criteria will be applied at the treatment design phase. Design criteria will help avoid or minimize effects to Canada lynx and their prey. However, measureable impacts will occur.
- Impacts from all action alternatives are not discountable, insignificant or wholly beneficial.
- Monitoring will be required:

Annual Treatment Reviews

- One treatment will be reviewed annually to ensure that Design Features identified in the treatment design checklist were implemented and effective. A findings report from these reviews will be completed annually. The report will include a summary of corrective actions or improvements in design features.
- In areas with <90% over-story mortality where DHC surveys were completed, re-do 5% of the DHC plots within harvest units to determine how DHC changed as a result of logging activities. Results will be used to adjust projected impacts and reported to FWS annually.
- Track acres of treatment and acres of road construction occurring in affected LAU (VEG S1 and VEG S2 standards).

Annual Reporting Requirements to FWS

- SRLA reporting will continue using Forms 1-4 as required under SRLA ROD Attachment 1-9. The SBEADMR decision will be reported the year the decision is signed. Other vegetation management projects that affect lynx habitat will also be reported as they occur over the life of the amendment.
- SBEADMR Treatment-level reporting - Annual
    - Treatment reviews – to confirm compliance with Design Features from the Record of Decision and to ensure compliance with management objectives for lynx as described in the SRLA. The Pre-Treatment Design Checklist and Annual Review will be the primary methods used to document adherence to SRLA.
    - Summary of acres by LAU of management induced changes to lynx habitat up to 15% (VEG S2).
    - Summary of acres by LAU of management induced and natural changes to lynx habitat up to 30% (VEG S1).
    - Other project findings related to the BO

(This page intentionally blank)

Table 293. Summary of Effects to Canada lynx and SRLA Compliance Documentation by Action Alternative

Analysis Metric	Alternative 2	Alternative 3	Explanation
Magnitude of potential effects at Geographic Area (GA) and Lynx Analysis Units (LAU) Scales	Commercial and non-commercial treatments are capped at 60,000 acres each for a total of 120,000 acres.		
	Commercial - a total of 107,425 acres of treatment in lynx habitat are identified. With the commercial treatment cap at 60,000 acres, a maximum of approximately 56% of the overlapping lynx habitat could be actively treated. However for analysis purposes, it was assumed all 107,425 acres could receive active management through the life of the project; this assumption enabled maximum treatments by LAU to be identified and analyzed, even though the cumulative total commercial treatment across all LAUs would sum to no more than 60,000 acres. The analysis revealed that the maximum total affected habitat by Geographic Area ranges from a high of 51% on the Uncompahgre Plateau to a low of 4% in Gunnison Basin North. At the LAU scale, percent of habitat potentially affected range from 57% in the Spring Creek LAU to a low of less than 1% on several LAUs across multiple GAs. **Non-commercial** – a total of 27,103 acres of lynx habitat could be managed non-commercially mechanically or with the use of prescribed fire. With the noncommercial treatment cap at 60,000 acres, all of these acres could be potentially managed but it is unlikely since non-commercial Priority Treatment Areas (PTA) total 77,246 acres with most (66%) of the acreage outside lynx habitat. When non-commercial treatments occur in lynx habitat, it will be for the specific purpose of regenerating aspen stands affected by aspen decline.	**Commercial -** a total of 44,908 acres of treatment in lynx habitat are identified. With the commercial treatment cap at 60,000 acres, it is probable that all acres receive active management. However, it is estimated at least 25% of a treatment area would be excluded due to steep slopes, water influence zones, and other factors related to design features. The analysis revealed that the maximum total affected habitat by Geographic Area ranges from a high of 31% on the Uncompahgre Plateau Geographic Area to a low of 1% in the Gunnison Basin North Geographic Area. Five out of six GA have less than 10% of lynx habitat potentially affected. At the LAU scale, percent of habitat potentially affected range from 49% of the Spring Creek LAU to a low of less than 1% on several LAU across multiple GA. **Non-commercial** – a total of 24,945 acres of lynx habitat could be managed non-commercially mechanically or with the use of prescribed fire. With the noncommercial treatment cap at 60,000 acres, all of these acres could be potentially managed. When non-commercial treatments occur in lynx habitat, it will be for the specific purpose of regenerating aspen stands affected by aspen decline.	See notes in Alt 2 and Alt 3.

Hazard Tree removal and non-commercial mechanical and prescribed fire treatments	Hazard Trees – Maximum 8,043 acres of lynx habitat affected. Non-commercial –Maximum 27,103 acres of lynx habitat affected. Maximum 49 LAUs and 3 Lynx Linkage Areas affected	Hazard Trees - Maximum 7,987 acres of lynx habitat affected. Non-commercial – Maximum 24,945 acres of lynx habitat affected. Maximum 46 LAU and 4 Lynx Linkage Area (LLA) affected	Impacts related to hazard trees and non-commercial mechanical treatments in lynx habitat are summarized below in association with various objectives, standards and guidelines.

Objective ALL O1 Maintain or restore connectivity in and between LAUs and in linkage areas. **Standard ALL S1** New or expanded permanent developments and vegetation management projects must maintain habitat connectivity in an LAU and/or linkage zone.	**Between LAUs - Potential Natural Vegetation Analysis:** **Grand Mesa LAUs** – Project maintains or moves toward Potential Natural Vegetation but percent change less than 10%. **Gunnison Basin North LAUs -** Project maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **Gunnison Basin South LAU** – Project maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **North Fork Valley LAU** – Project maintains or moves toward Potential Natural Vegetation but percent change less than 5%. **San Juan LAU** – Project maintains or moves toward Potential Natural Vegetation but percent change less than 5%. Exception is Alpine LAU at 16% change. **Uncompahgre Plateau LAUs -** Project maintains or moves toward Potential Natural Vegetation but percent change less than 10%. **Lynx Linkage Zones:** Four lynx linkage zones are affected by the project – Poncha Pass, North Pass/Cochetopa Hills, Slumgullion/Spring Creek Pass and Battlements Mesa linkage zones. In Alternative 2, less than 2% of the Poncha Pass, North Pass/Cochetopa Hills and Battlement Mesa zones will be affected. Approximately 29% (2,298 acres) of the Slumgullion/Spring Creek Pass linkage zone could be actively managed. Even if all 2,298 acres were actively managed, lynx habitat in the linkage zone would remain in or move toward PNV. In addition, various design features would be applied to protect understory vegetation (WFRP-11 and 12); protect water influence	**Between LAU - Potential Natural Vegetation Analysis:** **Grand Mesa LAUs** – maintains or moves toward PNV but percent change less than 7 percent. **Gunnison Basin North LAUs -** – maintains or moves toward PNV but percent change less than 2 percent. **Gunnison Basin South LAU** – maintains or moves toward PNV but percent change less than 5 percent with most LAU less than 2 percent. **North Fork Valley LAU** – maintains or moves toward PNV but percent change is 2 percent with most LAU less than 1 percent. **San Juan LAU** – maintains or moves toward PNV but percent change less than 5 percent with most LAU less than 1 percent. **Uncompahgre Plateau LAUs -**maintains or moves toward PNV with the Spring Creek LAU shifting approximately 22 percent and Traver Mesa shifting 5 percent. **Lynx Linkage Areas:** Four lynx linkage zones are affected by the project – Poncha Pass, North Pass/Cochetopa Hills, Slumgullion/Spring Creek Pass and Battlements Mesa linkage areas. Under alternative 3 less than 1% of the Poncha Pass, North Pass/Cochetopa Hills, Battlement Mesa, and Slumgullion/Spring Creek Pass linkage areas will be affected. Various design features would be applied to protect understory vegetation (WFRP-11 and 12); protect water influence zones important to lynx movement (WQSP-2) and maintain connectivity in managed stands (WFRP-17).	Potential Natural Vegetation takes into account disturbance processes, soils and other factors. At a LAU-scale, management toward PNV will create or maintain a mosaic of habitat conditions ideal for lynx and their prey. Maintaining preferred habitat patches for hare and lynx within this mosaic of old and young stands that are representative of natural processes and disturbance regimes are conducive to long-term conservation (Interagency Lynx Biology Team, 2013).Use of design features to maintain areas of high quality habitat, protection of riparian areas and other water features, and application of conservation biology principles during treatment design will further maintain connectivity during implementation. While high-traffic volume on roads is not a significant

	zones important to lynx movement (WQSP-2) and maintain connectivity in managed stands (WFRP-17). **Influence of Roads and Highways:** Truck traffic associated with timber sale activities were assessed and compared to a threshold of 2,000 vehicles per day, at which the probability of a vehicle lynx collision increases. Traffic increases on most National Forest System routes will generally be less than 30% and no route will exceeds 2,000 vehicles per day. Three of the State Highways that could be used by logging trucks already exceed 2,000 vehicles per day or could by year 2025. However, the projected 20 trucks per day will increase traffic on the highways by 1% or less, which is believed to be within normal daily traffic fluctuations. There are a maximum of 64 miles of temporary road that could be constructed on ridges and saddles affecting 23 LAUs. All roads will be decommissioned and revegetated within 5 years of sale closure and none of the roads will be open to the public.	**Influence of Roads and Highways:** (See Alternative 2 for discussion of truck traffic.) There are a maximum of 30 miles of temporary road that could be constructed on ridges and saddles affecting 14 LAUs. All roads will be decommissioned and re-vegetated within 5-years of sale closure and none of the roads will be open to the public.	population-level threat to lynx, traffic volume does pose a higher risk in Colorado than elsewhere in the lynx range (Interagency Lynx Biology Team, 2013). Increased vehicular traffic associated with SBEADMR are expected to be relatively small and within acceptable limits of 2,000 vehicles per day. The lack of permanent roads will also not impede lynx movement long-term some short-term effects to lynx movement are anticipated during logging and road decommissioning operations, however lynx movement would not be impeded in the long-term (once activities cease and the temporary road is decommissioned). **Compliance with ALL O1: Yes** **Compliance with ALL S1: Yes**
Guideline ALL G1 Methods to avoid or reduce effects on lynx should be used when constructing or reconstructing highways or forest highways across federal lands.	No highways are being proposed under SBEADMR.		N/A

Objective VEG O1 Mimic or approximate natural successional and disturbance processes. This is applied at the LAU scale.	Managing towards Potential Natural Vegetation (PNV) is one mechanism to mimic natural successional and disturbance processes. Current spruce-fir and spruce-fir-aspen seral conditions were compared to PNV in all affected LAU. By its definition, Potential Natural Vegetation provides for a range of habitat structural stages and therefore provides long-term habitat for lynx and their prey. Most LAUs are dominated by late-mid and late seral spruce-fir and spruce-fir-aspen. Even if all acres of the identified Priority Treatment Areas received active management, most shifts from late-mid and late seral would be less than 5%, leaving a preponderance of old trees on the landscape at a higher level than is predicted under PNV. Existing vegetation in some LAUs approximate PNV and active management would retain seral conditions in those ranges. In LAUs with heavy overstory mortality, the loss of old trees and a shift to younger age classes of trees has already begun. Design feature WFRP-23 will be applied to retain areas/pockets of mature spruce still persisting on the landscape.		Use of modeled PNV incorporates environmental factors such as soils, aspect, slope, elevation and natural disturbance history to indicate the type and range of seral conditions expected across the landscape. PNV also incorporates the concept of Historic Range of Variability (HRV) and is useful for creating a benchmark on which to evaluate current conditions and identifying the restoration potential of a site. In regards to the SRLA, management toward PNV mimics or approximates natural successional and disturbance processes, which helps maintain habitat at the LAU scale for long-term persistence of lynx. **Compliance with VEG O1: Yes**
Objective VEG O2 Provide for a mosaic of habitat conditions through time to support dense horizontal cover, and high densities of snowshoe hare. Provide winter snowshoe hare habitat in both the stand initiation structural stage and in mature, multi-story conifer vegetation. This is applied at the LAU scale.	**PNV analysis**: See discussion above for VEG O1. Additional analysis: 15,324 acres of hare habitat and 7,641 acres of high quality hare habitat (>35% DHC) could be affected if all acres identified for commercial treatment were treated. However, the commercial treatment cap is 60,000 acres, meaning only 52% of the available acres will be treated. The corresponding assumed potential impacts to high quality hare habitat is, therefore, approximately 3,973 acres. Design features WFRP-11, 12 and 17 will further minimize potential effects to the understory during operations and layout.	**PNV analysis**: See discussion above for VEG O1. Additional analysis: There are 5,071 acres of hare habitat and 2,536 acres of high quality hare habitat (>35% DHC) could be affected if all acres identified for commercial treatment were treated. Use of WFRP-11, 12 and 17 will further minimize potential effects to the understory during operations and layout.	Currently the Forest is limited to 4,149 acres of high quality hare habitat affected by forest management activities under Standard VEG S6. The projected impact acres for both alternatives o is below this capped amount. Actual acres of high quality lynx habitat affected will be tracked annually under VEG S6 and reported to Fish and Wildlife Service. **Compliance with VEG O2: Yes**

Objective VEG O3 Conduct fire use activities to restore ecological processes and maintain or improve lynx habitat.	A maximum of 28,708 acres of lynx habitat could be managed non-commercially. The vast majority of this habitat is secondary lynx habitat (within 300 m of primary spruce-fir habitat), dominated by aspen and aspen-spruce mix. Many of these acres are affected by aspen decline. Stands that lack aspen regeneration and have less than 50% overstory mortality could be treated mechanically or with the use of prescribed fire to stimulate regeneration in the understory. Within mixed aspen-spruce stands, spruce will be retained to provide habitat for snowshoe hares (WFRP-20).	A maximum of 24,945 acres of lynx habitat could be managed non-commercially. The vast majority of this habitat is secondary lynx habitat (within 300 m of primary spruce-fir habitat), dominated by aspen and aspen-spruce mix. Many of these acres are affected by aspen decline. Stands that lack aspen regeneration and have less than 50% overstory morality could be treated mechanically or with the use of prescribed fire to stimulate regeneration in the understory. Within mixed aspen-spruce stands, spruce will be retained to provide habitat for snowshoe hares (WFRP-20).	Prescribed fires will be completed to restore ecological processes by targeting aspen stands affected by Sudden Aspen Decline. Spruce will be retained in lynx habitat where it currently exists. The use of wildland fires to achieve resource objectives for lynx will be addressed when and if it occurs and is beyond the scope of this analysis. **Compliance with VEG O3: Yes**
Objective VEG O4 Focus vegetation management in areas that have potential to improve winter snowshoe hare habitat but presently have poorly developed understories that lack dense horizontal cover.	Appendix C identifies silvicultural prescriptions that will be used on the project. In spruce-fir stands with less than 40% overstory mortality, the stand will be managed for resiliency through the use of group selections less than 2 acres (<3 tree lengths) and single tree removal. Areas lacking understory vegetation will be targeted for treatment.		Resiliency treatments in spruce-fir are considered a conservation measure for lynx and are consistent with VEG O4. **Compliance with VEG O4: Yes**
Standard VEG S1 If more than 30 percent of the lynx habitat in an LAU is currently in stand initiation structural stage that does not yet provide winter snowshoe hare habitat, no additional habitat may be generated by vegetation management projects.	Assumptions used in the analysis are described on pages 61-64 of the BA. Analysis was completed for current stand conditions based upon the level of current overstory mortality and adapted if all mature spruce in a stand were to die from beetle activity (BA – Table 51). All LAU potentially affected under SBEADMR will be tracked annually (FEIS – Table 6). **Current stand conditions** – Maximum treatment of PTA acres in Stewart Creek LAU could exceed VegS1 by 1,320 acres; Spring Creek could exceed by 1,137 acres. Reminder (47 LAU) would meet this standard. **Adapted stand conditions** – Maximum treatment of PTA acres in Stewart Creek LAU could exceed Veg S1 by 1,521 acres; Spring Creek LAU by 8,443 acres. 47 LAU would meet this standard.	**Current stand conditions** – Given maximum treatment of PTA acres in each LAU, given current stand conditions, all LAU meet this standard. **Adapted stand conditions** – Maximum treatment of PTA acres in Spring Creek LAU could exceed Veg S1 by 6,830 acres. Remainder of LAU would meet this standard.	Throughout SBEADMR implementation, the amount of lynx habitat converted to stand initiation will be annually tracked per existing protocol. This includes management induced changes as well as those resulting from natural causes. When triggers identified in Table 6 are approached, management will be reduced or stopped to ensure VEG S1 thresholds are not exceeded. **Compliance with VEG S1: Yes**

Standard VEG S2 Timber management shall not regenerate more than 15% of lynx habitat on NFS lands within an LAU over a 10-year period. This 15% includes the entire stand within an even-aged regeneration, and only patch opening within group selections. Salvage harvest within stands killed by insect epidemics, wildfire, etc. does not apply to the 15 percent unless the harvest treatment cause the lynx habitat to change to an unsuitable condition.	Assumptions used in the analysis are described on pages 61-64 of the BA. The environmental baseline for affected LAU are provide in Table 9 of the BA. Analysis was completed for current stand conditions based upon both a) the level of current overstory mortality and b) potential future condition if all mature spruce in a stand were to die from beetle activity (BA – Table 40). All LAU potentially affected under SBEADMR will be tracked annually (FEIS – Table 6). **Current stand conditions** – all LAU meet VEG S2 standard. **Potential future/Adapted stand conditions** - Maximum treatment of PTA acres in Alpine and Spring Creek LAU could result in exceedance of Veg S2.	**Current stand conditions** – Given maximum treatment of PTA acres in each LAU, given current stand conditions, all LAU meet this standard. **Adapted stand conditions** – Maximum treatment of PTA acres in Spring Creek LAU could exceed Veg S2 by 6,746 acres. Remainder of LAU would meet this standard.	Through the life of SBEADMR the amount of lynx habitat converted to stand initiation through forest management will be tracked through appropriate databases annually. When triggers identified in the FEIS, Table 6 are approached, management will be reduced or halted to ensure VEG S2 thresholds are not exceeded. **Compliance with VEG O2: Yes**
Standard VEG S5 Pre-commercial thinning practices and similar activities intended to reduce seedling/sapling density are subject to four limitations identified in the SRLA from the stand initiation structure stage until stands no longer provide winter snowshoe hare habitat. Current balance that could be applied to VEG S5 is 42,293 acres (3% of lynx habitat on the Forest).	Precommercial thinning may only occur: 1) Within 200 feet of administrative sites, dwellings and outbuildings. Generally pre-commercial thinning to reduce fuel loading adjacent to structures will not be completed for SBEADMR. If it does occur, it will be tracked with use of the treatment design checklist and reported annually to FWS. 2) For research studies. Generally beyond scope of the project. 3) For conifer removal in aspen or daylight thinning around individual aspen trees. Design feature WFRP- 20 prohibits removal of conifers in secondary lynx habitat (aspen-conifer mixed stands) to maintain habitat for hares. 4) Based upon new information that is peer reviewed and accepted by the regional/state levels of the Forest Service. Generally outside scope of the analysis. In addition to the above exceptions, pre-commercial thinning may be applied if it a) does not exceed 1% of lynx habitat in the LAU over the life of the amendment; b) is in an LAU that exceeds 30% in stand initiation structure stage (VEG S1) but do not yet provide snowshoe hare habitat; projects designed to maintain lynx connectivity and provide snowshoe hare habitat over the long-term; d) monitoring is used to document snowshoe hare response. Tracked with use of the treatment design checklist and reported annually as they occur.			Treatments completed under VEG S5 will be tracked annually and reported under required SRLA reporting. **Compliance with VEG S5: Yes**

Standard VEG S6 Vegetation management projects that reduce snowshoe hare habitat in multi-story spruce-fir mature or late successional conifer forests may occur only: 1) within 200 feet of administrative sites, outbuildings, recreation sites, etc.; 2) for research studies; 3) for incidental removal during salvage harvest; or 4) when uneven-aged management (single tree or group selection) are employed to maintain and encourage multi-story attributes.	**Hare habitat:** 15,324 acres of hare habitat and 7,641 acres of high quality hare habitat (>35% DHC) could be affected if all acres identified for commercial treatment were treated. However, the commercial treatment cap is 60,000 acres, meaning only 52% of the available acres will be treated. The corresponding assumed potential impacts to high quality hare habitat is, therefore, approximately 3,973 acres. The Forest cap for impacts to high quality hare habitat is 4,149 acres under SRLA, which does take into account present impacts/baseline condition. Incidental removal of hare habitat was determined as follows: • Resiliency treatment – 15 percent loss to the understory • Combined treatment (combination of resiliency and salvage) – 20 percent loss to the understory • Salvage treatment – 25 percent loss to the understory.	**Hare habitat:** Maximum of 5,071 acres of hare habitat affected; 2,536 acres of which are high quality (>35% DHC).	Within multi-storied spruce-fir stands, an understory less than 35% is still considered hare habitat but not high quality. Under VEG S6, the 4,149 acre cap is the allowable level of impact for high quality hare habitat. The project meets VEG S6 standard. Tracking and reporting will occur annually to validate assumptions in the FEIS and ensure project remains both within analysis assumptions and Forest-wide SRLA cap. **Compliance with VEG S6: Yes**
Guideline VEG G1 Vegetation management objectives should be planned to recruit high densities of conifers, hardwoods and shrubs where given habitat is scarce or lacking.	Non-commercial treatments will be conducted with a primary purposes of to regenerating aspen, mixed conifer and aspen-conifer stands capable of supporting aspen. Aspen stands with <50% overstory mortality and lacking regeneration in the understory will be treated mechanically or with prescribed fire to stimulate such. Commercial resiliency treatments in spruce-fir will be conducted in areas with minimal or lacking an understory with the primary purposes of simulating natural group dynamics and regenerating the understory.		**Compliance with VEG G1: Yes.**
Guideline VEG G4 Prescribed fire activities should not create permanent travel routes that facilitate snow compaction. Constructing permanent fire breaks on ridges or saddles should be avoided.	No road construction is associated with non-commercial mechanical or prescribed fire activities. Removal of hazard trees along roads or in association with administrative sites or other structures may temporarily create fire breaks but will be re-planted with trees when natural regeneration is not likely.		**Compliance with VEG G4: Yes.**

Guideline VEG G5 Habitat for alternative prey species, primarily red squirrel, should be provided in each LAU.	**PNV analysis**: See discussion above for VEG O1. At the LAU scale, management toward desired PNV will maintain a suite of habitat conditions for a variety of spruce obligates, including red squirrel. **Red squirrel analysis:** In Colorado, red squirrel have been documented to decline when overstory mortality in spruce-fir stands reach 60 percent and further decline when mortality exceeds 90 percent. When dead mature spruce that no longer produces a cone crop is removed, there is minimal additional impact. Under WFRP- 23, all live mature spruce will be retained in stands with high overstory mortality. Design Feature WFRP- 12, which is designed to protect high quality hare habitat in the understory, will also help create blocks of un-harvested retention areas in the matrix that will provide habitat for squirrels.		**Compliance with VEG G5: Yes.**
Guideline G10 – Fuel treatment projects in WUI should be designed considering VEG S1, S2, S5 and S6.	See discussion above for VEG S1, S2, S5, S6 and G4.		**Compliance with VEG G10: Yes**
Guideline G11 – Denning habitat should be distributed in each LAU in the form of pockets of large amounts of large woody debris… or piles of small wind thrown trees (jack-strawed piles)	PNV analysis: See discussion above for VEG O1. At the LAU scale, maintaining or moving vegetation toward PNV provides for a range of habitat conditions important to maintain life stages of Canada Lynx including but not limited to dispersal, denning, and foraging. Scope and scale of treatments: Commercial – most LAU will have less than a maximum of 15% of the lynx habitat potentially affected by treatment. Exceptions are Cottonwood Lakes, Kannah Creek, Chester, Los Pinos, Lone Cone, Spring Creek and Travers Mesa. Maximum treatment in no LAU would exceed 60 percent. WFRP-2, 12 and 17 will facilitate retention of denning habitat in treatment areas. Most of the Forest and LAUs will remain untreated; in those areas experiencing high overstory spruce mortality, an abundance of large wood will be available for denning habitat over time as the dead overstory eventually falls.	Commercial – most LAU will have less than a maximum of 5% of the lynx habitat potentially affected by treatment. Exceptions are Cottonwood Lakes, Kannah Creek, Mesa Lakes Whetstone, Cochetopa, Fossil Ridge, Pitkin, Chester, Lake City, Crater Lake, Iron Mountain, Little Cone, Spring Creek and Travers Mesa. Maximum treatment in no LAU would exceed 50 percent.	**Compliance with VEG G10: Yes**

Livestock Grazing Management (GRAZ) – Objective GRAZ O1, Guidelines G1-G2, G4 *(Guideline GRAZ G3 not relevant to scope of SBEAMDR project; treatments would occur outside of riparian areas due to water-quality design features.*)	Design feature RG-2 will require grazing deferment or pasture rest following treatment when needed to facilitate meeting vegetation management objectives. Aspen treatments designed to increase regeneration in stands affected by aspen decline are likely candidates for rest until stands exceed livestock grazing height.	**Compliance with Grazing Management Objectives and Guidelines: Yes**
Human Use Projects (HU) – Objective HUO2, HUO3, HU04, HUO5, HUO6, Guideline HU G1-G5.	These human use objectives and guidelines are related to management of recreation or mineral activity and therefore not applicable to the project. However, construction of temporary roads were considered for potential impacts to recreation use patterns. All temporary roads constructed under SBEADMR will be decommissioned within 5 years of sale closure. During operations, roads will be closed to the public. No change in open road density nor recreation use associated with temporary project roads is expected.	**Objective HUO2, HUO3, HU04, HUO5, HUO6, Guideline HU G1-G5: Yes**
The following table entries pertain to Human Use Projects. Note that the SRLA does not apply the objectives and guidelines related to Human Use Projects to vegetation management projects such as SBEADMR. Nevertheless, the IDT considered SBEADMR activities in relation to these objectives and guidelines to further discern potential impacts to lynx habitat.		
Human Use Projects (HU), Objective HUO1 – Maintain the lynx's natural competitive advantage over other predators in deep snow, by discouraging the expansion of snow compaction activities in lynx habitat. This standard does not apply to vegetation management projects.	Despite this objective not being applicable to vegetation management projects, an analysis of existing logging roads that could be plowed in order to implement commercial activities was completed. Approximately 90.5 miles were identified, and of these routes, 84.6 miles are already included in the snow compaction environmental baseline for the Forest. Therefore, the potential additional snow compaction from SBEADMR is minimal.	**Compliance with Objective HUO1: Yes**
Human Use Projects (HU), Guideline HUG6 – Methods to avoid or reduce lynx connectivity should be used when upgrading unpaved roads to maintenance levels 4 or 5.	No road will be upgraded to a maintenance level 4 or 5. Routes used for hauling will be managed to the identified road use objective.	**Compliance with Guideline HUG6: Yes**

Human Use Projects (HU), Guideline HUG7 – New permanent roads should not be built on ridge-tops or saddles, or in areas identified as important for lynx connectivity. New permanent roads and trails should be situated away from forested stringers.	All roads constructed will be temporary with at least 70% of constructed roads decommissioned once sale activities are complete and all roads within 5 years of sale closure. During sale layout, WFRP-17 will be applied to ensure lynx will be maintained and/or impacts minimized post-treatment. Decommissioned roads will be re-vegetated when needed and monitoring for and treatment of noxious weeds completed as needed. Approximately 64 miles of proposed road that could be constructed on roads or saddles within 23 LAU under this alternative. These constructed routes could affect lynx movement between or within LAU but the effects are expected to be short-term and would be largely due to immediate human disturbance from logging activity and/or road decommissioning.	Approximately 30 miles of proposed road that could be constructed on roads or saddles within 14 LAU under this alternative. These constructed routes could affect lynx movement between or within LAU but the effects are expected to be short-term and would be largely due to human disturbance from logging activity and/or road decommissioning.	**Compliance with Guideline HUG7:** Yes. However, because some roads could exist for up to 7 years (2 years for commercial activity implementation and up to 5 years for post-sale activities), they could have at least short-term effects to lynx movement between LAU. The temporary roads would not have a measurable effect on dispersal of an animal to a new home range.
Human Use Projects (HU), Guideline HUG8 – Cutting brush along low-speed, low traffic volume roads should be done to minimum level necessary to provide for public safety.	Brush cutting along roads will not occur. Removal of hazard trees will occur and be conducted in accordance with WFRP- 11 and 12 which are designed to maintain understory vegetation.		**Compliance with Guideline HUG8: Yes**
Human Use Projects (HU), Guideline HU G9 – If project analysis determines that new roads adversely affect lynx, then public motorized use should be restricted. Upon project completion, these roads should be reclaimed or decommissioned, if not needed for other management objectives.	At least 70% of constructed temporary roads will be decommissioned by the purchaser following commercial harvest. The remainder of the roads will be decommissioned, and when needed revegetated, within 5 year of sale closure. If a constructed road is needed to achieve future management objectives, additional NEPA and consultation will be required. None of the temporary roads will be open to public use.		**Compliance with Guideline HU G9: Yes**

Human Use Projects (HU), Guideline HU G10 - Designated over-the snow routes or designed play areas should not expand outside baseline areas of consistent snow compaction.	The plowing of roads to facilitate logging was previously discussed under VEG G4. No designed over-the-snow routes or play areas are proposed.	**Compliance with Guideline HU G10: Yes**
Human Use Projects (HU), Guideline HU G11 – When developing or expanding ski areas and trails, consider locating access roads and lift termini outside lynx habitat	Not applicable to SBEADMR	NA
Human Use Projects (HU), Guideline HU G12 – Winter access for non-recreation uses and mineral and energy exploration should be limited to designated snow routes or designated over-the-snow routes.	The plowing of roads to facilitate logging was previously discussed under VEG G4.	**Compliance with Guideline HU G12: Yes**
Linkage Areas (LINK), Objective LINK O1 – In areas of intermingled ownership, work with landowners to pursue conservation easements, habitat conservation plans, land exchanges, or other solutions to reduce potential adverse impacts on lynx and lynx habitat.	Not applicable to SBEADMR	NA
Linkage Areas (LINK), Standard LINK S1 – When highways or forest highways constructed or reconstructed is proposed in linkage areas, identify potential highway crossings.	Not applicable to SBEADMR	NA

Linkage Areas (LINK), Guideline LINK G1 – National Forest System lands should be retained in public ownership.	Not applicable to SBEADMR	NA
Linkage Areas (LINK), Guideline LINK G2 – Livestock grazing in shrub-steppe habitats should be managed to contribute to maintaining or achieving a preponderance of mid-or late-seral stages similar to conditions that would have occurred under historic disturbance regimes.	While shrub-steppe habitats are not targeted vegetation types for non-commercial treatment, some could be affected incidental to prescribed fire in target cover types. Under design feature RG-2, coordination with range staff will occur prior to treatment to determine if grazing needs to be deferred or the area rested from grazing to accomplish resource objectives.	**Compliance with Guideline LINK G2: Yes**

Gunnison Sage-grouse

Based on this analysis, the SBEADMR project "***may effect but is not likely to adversely affect***" Gunnison sage grouse nor result in "***adverse modification***" of designated critical habitat. The rationale for this conclusion is based on:

- The closure of roads within 0.6 miles of a lek during the breeding and brooding period is a conservation measure implemented consistent with other efforts being implemented in the Gunnison Basin for protection of the bird. However, on State Highways increase haul truck traffic, while very small, may disturb some birds particularly during the breeding season. These effects are believed to be discountable.

- The use of non-commercial mechanical and prescribed fire to eliminate conifer encroachment into sage-brush is considered a conservation measure for sage-grouse. However, some short-term negative effect could occur from human presence and use of mechanized equipment. Avoidance the breeding and brooding period will minimize these effects making them discountable.

- The use of non-commercial mechanical and prescribed fire to regenerate aspen stands adjacent to sage-brush is also considered a conservation measure for sage-grouse. However, some short-term negative effect could occur from human presence and use of mechanized equipment. Avoidance the breeding and brooding period will minimize these effects making them discountable.

Greenback Cutthroat Trout

Rationale: 1) design features provide for basic protection of perennial streams and aquatic populations; 2) additional site-specific design features will be imposed around perennial streams supporting aquatic populations of recreational or conservation significance; 3) the Aquatics Team will participate in the planning, implementation, and post-treatment monitoring to insure mistakes that may occur are not repeated throughout project implementation; and 4) stream temperature monitoring and the best available science of stream temperature preferences of native Greenback Cutthroat Trout suggest the magnitude of changes to stream temperature across the GMUG is unlikely to affect negatively Conservation Populations for foreseeable future. Following the rationale outlined in above, SBEADMR ***may effect, but is not likely to adversely affect*** Greenback Cutthroat Trout.

Sensitive Species, Management Indicator Species, Migratory Birds and General Wildlife

Summary of Changes between Draft and Final

- The Rocky Mountain Region Regional Forester's Sensitive Species List was updated on October 13, 2015. The updated list was reviewed and used in the final version of the

Biological Evaluation for Sensitive species. Two new additions to the list were considered: Western bumblebee and Monarch butterfly. These species were excluded from detailed analysis because the species and their habitat do not occur within or would not be affected by the SBEADMR project.

- Incorporated additional information and data to analyze and quantify potentially affected habitat under each alternative to American marten, red-naped sapsucker, northern goshawk, and Rocky Mountain elk at the Geographic Area and GMUG National Forest-level scales. Incorporated habitat modeling for elk, marten, red-naped sapsucker and goshawk that was used and described in the 2005 Management Indicator Species Assessments (available: www.fs.usda.gov/goto/gmug/wildlife). Incorporated Colorado Parks and Wildlife Species Activity Mapping data for elk.
- Used the Priority Treatment Areas for commercial and noncommercial activities to examine effects of treatments to species, and to quantify habitat acres affected by treatment type for American marten, red-naped sapsucker, northern goshawk, and Rocky Mountain elk.
- Elk habitat effectiveness, as influenced from road densities, was assessed for all alternatives in accordance with Forest Plan direction.
- Incorporated additional cumulative effects analysis by summarizing past, present and reasonably foreseeable future actions and the additive effects of SBEADMR.
- Analyzed effects of SBEADMR on migratory birds and general wildlife species.
- Design features were clarified and additional design features added to avoid or minimize negative impacts.
- Additional peer-reviewed scientific literature sources were reviewed, relevant information added to the analysis, and cited.
- Various revisions and edits to clarify information.

The scope of this analysis discusses several categories of wildlife: 1) USFS Region 2 Designated Sensitive Species; 2) GMUG National Forest Management Indicator Species (MIS); 3) Migratory Birds - Bird Conservation Area 16; and 4) General Wildlife.

The analysis was conducted at the following scales:

a) MIS – The Forest Level – Grand Mesa, Uncompahgre and Gunnison National Forests

b) All other species – Within the SBEADMR Priority Treatment Areas (PTAs), which are the maximum extent of geographic area analyzed for potential treatments. Where appropriate, the analysis is further assessed by PTAs in individual Geographic Areas. The action area also includes non-target vegetation within PTAs due to impacts that extend beyond the footprint of disturbance; as such acres described in this section for PTAs are greater than described in the description of alternatives. The scale of analysis ranges from 176,663 acres for alternative 3, to 275,423 acres* for alternative 2. Where habitat mapping was available for sensitive and MIS, affected acres were quantified by alternative and compared to available habitat Forest-wide.

*Note that the quantitative analysis for impacts to MIS and sensitive species is an overestimate, as the analysis included non-target vegetation types in the non-commercial PTAs that will not be affected by the proposed action or action alternatives.

Existing Condition

The existing condition in the action area has been affected by past and ongoing activities and natural processes, including forestry activities such as timber harvests, grazing, various recreational activities, wildlife use, and wildfire and associated suppression activities. Forested stands have been affected by bark beetle infestation resulting in mortality of trees that can be seen across the landscape.

The SBEADMR project will primarily treat Engelmann spruce-subalpine fir (*Picea engelmannii-Abies bifolia*) and aspen (*Populus tremuloides*) vegetation types. Both spruce-fir and aspen occur as or within a matrix of other vegetation types. Most spruce-fir stands in the project area range from 100 to 200+ year old and aspen range from 80 to 120 years old. Spruce-fir stands provide high quality denning, foraging and dispersal habitat for Canada lynx. Other species that utilize spruce-fir are boreal owl, olive-sided flycatcher, American three-toed woodpecker, hairy woodpecker, northern goshawk and a variety of Neotropical migratory and resident songbirds and woodpeckers, and mammal species such as Rocky Mountain elk, American marten and pygmy shrews. Treatments in the planning area include opportunities to promote/maintain multi-storied, mature stand structures for denning and dispersal habitat that exist within the spruce-fir in the project area.

Aspen is also a common constituent in the primary vegetation type of the subalpine zone in the Southern Rocky Mountains, and can also form homogeneous stands. Aspen can also occur in the lower-elevation montane zone (Johnston and others 2001). Some of the aspen stands are those in which conifers are unlikely to succeed them. These stands are mature and are near the end of the physiological life span. Due to past heavy browse pressure on aspen sprouts by ungulates and livestock in some areas, the successful establishment of new aspen stands is reduced. The species considered in this document are specialists for aspen habitats during one or more life history periods. Aspen forests support high biodiversity, providing habitat for a variety of mammal and birds species including but not limited to deer, elk, small mammals (e.g. chipmunks, gophers, squirrels and voles), red-naped sapsucker, northern flicker, downy woodpecker, black-capped chickadee, house wren, warbling vireo, yellow-rumped warbler, dark eyed junco and northern goshawk.

The spruce-fir zone, or subalpine zone, is the highest forested zone on the GMUG NF, occurring from around 9,500 ft (2,900 m) elevation to the upper treeline, often called timberline. Upper treeline occurs around 11,500 – 12,000 ft (3,500 – 3,650 m), somewhat higher in the south part of the forests and on north-facing slopes (Johnston and others 2001). The subalpine zone is dominated by large, continuous stands of Engelmann spruce (*Picea engelmannii*) and subalpine

fir (*Abies bifolia*); sometimes lodgepole pine (*Pinus contorta*) or aspen (*Populus tremuloides*) will be dominant, but slowly seral to fir and spruce. There are openings and parks within this zone, a few large parks, with big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) or fescue grasses (*Festuca thurberi* or *F. idahoensis*). Riparian areas in relatively undisturbed condition are dominated by one of the smaller willows (*Salix planifolia, S. wolfii, S. brachycarpa*, etc.) and sedges (*Carex aquatilis* etc.). Most of the fens are in the subalpine zone (Johnston and others 2012).

The subalpine zone for the last few decades has seen a great deal of tree mortality. Various root and butt-rot diseases have affected subalpine fir, and beetles, budworms, and dwarf-mistletoe the Engelmann spruce. Almost all stands in this zone are at least partially dead; a trail through the subalpine is often blocked by fallen trees, even a few days after a trail crew cleared it. Then in the last decade, spruce bark beetle populations increased dramatically, killing whole stands of Engelmann spruce within a few years.

The montane zone on the GMUG NF occurs between about 8,700 ft. (2,650 m) and 10,500 ft. (3,200 m). The montane zone is partially forested, with the forested portion dominated by lodgepole pine, aspen, ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*). There are occasional stands of blue spruce (*Picea pungens*). The rest of the montane zone is dominated by big sagebrush, Gambel oak (*Quercus gambelii*), and various other shrublands and grasslands. Riparian areas in relatively undisturbed condition have narrowleaf cottonwood (*Populus angustifolia*), blue spruce, various tall willows (*Salix monticola, S. geyeriana, S. drummondiana*, etc.) and sedges (*Carex utriculata*, etc.).

Many aspen stands in the montane zone experienced significant mortality from sudden aspen decline after a deep drought early in this century (Worrall and others 2008-2010-2013), especially aspen stands that had not been treated previously. Aspen decline is projected to continue in tandem with climate change, especially following future droughts (Worrall 2010). The severe epidemic by mountain pine beetle in lodgepole pine that decimated northern Colorado forests during that same period has yet to be seen on these national forests, although mountain pine beetle is present here, mostly in endemic quantities.

Human uses within the action area include hunting, fishing, dispersed camping, OHV riding, driving for pleasure/sight-seeing, wildlife viewing, hiking, horseback riding, picnicking, firewood gathering, snow shoeing, cross-country skiing, snowmobiling, use of all-terrain vehicles on roads, public and private land livestock grazing, special use permits and easements (includes road access permits for private land inholdings, irrigation ditches, spring developments, outfitter/guide permits, etc.) and vegetation management. Existing developments include developed campgrounds, picnic or day use areas, restrooms, trailheads, historic buildings, signs, roads, utility lines and modern houses (developed on private land). These activities and their effects are described in detail in the cumulative effects section.

Direct, Indirect, and Cumulative Effects - USFS Region 2 Designated Sensitive Species, MIS, Migratory Birds, and General Wildlife

Methodology

The following analysis is based upon professional knowledge, the best available science, and existing best available information. Due to the size of the project, and the lack of specificity of when and where treatments may occur, and the current lack of field reconnaissance, at this time, the "worst case scenario" will be presented within the range of potential outcomes. Effects are analyzed for known occurrences and for potential habitats which will be discussed in the context of occupied habitats. As the main difference between the alternatives is the spatial area that they could occur in, a comparison of Priority Treatment Areas, hazard tree treatments, and new roads that are outside PTA's (all three activities together will be referred to as "potential affected areas") will be a proxy for magnitude of impacts. Commercial and/or non-commercial treatments will be applied within identified treatment areas only. Commercial treatments include; resiliency (<40 percent overstory mortality), recovery and resiliency (>40 percent and <90 percent overstory mortality), and recovery (>90 percent overstory mortality). Non-commercial treatments include; burn/mechanical and burning). Road construction and re-construction are only associated with commercial treatments.

Scope of Analysis

This project uses the potential affected areas to indicate areas on the GMUG where these activities could occur. The potential affected areas are assessed spatially by Geographic Area of occurrence (Grand Mesa, Gunnison Basin North, Gunnison Basin South, North Fork Valley, San Juan, and Uncompahgre Plateau). Treatment types have been identified along with estimated acres associated with each action in each treatment area. Based on current stand conditions and alternatives we expect 7-15 percent salvage, 47-49 percent variable retention regeneration (combination), and 38-44 percent resiliency treatments. As the level of spruce-beetle induced mortality changes, acres of anticipated resiliency and variable retention treatments would shift towards salvage treatment. This latter scenario is also analyzed and is referred to as "adapted treatment type".

Analysis of impacts to Forest Service sensitive and GMUG NF Management Indicator Species were completed by comparing treatment outcomes based upon the vegetative indicators within the silvicultural and prescribed fire prescription matrix (Appendix A) and the use of design features (Appendix B) to minimize impacts or achieve a desired outcome. Treatment type and resulting post-treatment vegetative conditions were compared to the biological needs of affected species. Through the analysis process, recommendations to further minimize effects were made to refine treatment methods or design features as needed. The wildlife design features are products of this analysis process and public input received on the Draft EIS.

For Forest Service sensitive species and GMUG NF management indicator species, design features will avoid or minimize negative impacts. This includes limited operating periods to minimize impacts during the breeding season, the retention of snags and coarse woody debris including large diameter logs across the landscape, and maintaining vegetation for habitat connectivity and cover, consistent with GMUG Forest Plan direction.

Sensitive Species

Species having no suitable habitat within the analysis area, or with suitable habitat and populations present but occurring in Wilderness or Roadless Areas where no impacts will occur, are not analyzed in further detail. Please refer to the Biological Evaluation and Management Indicator Species report for the rationale for species that were not carried forward in analysis, and for information on species life history and habitat requirements for those carried forward in analysis. The Biological Evaluation determined that suitable habitat and/or individuals may be impacted for the species described in Table 294, below. These species are further analyzed for each alternative.

Table 294. Summary of Findings USFS Region 2 Sensitive Species that may be impacted by the SBEADMR Project.

Species	General Habitat	ALTERNATIVES		
		1 – No Action	2	3
AMPHIBIANS				
Boreal toad *Anaxyrus boreas boreas*	Wetlands/Riparian	NI	MI	MI
Northern leopard frog *Lithobates pipiens*	Wetlands/Riparian	NI	MI	MI
Colorado River Cutthroat Trout	Cold water rivers/streams	NI	MI	MI
BIRDS				
Northern goshawk *Accipiter gentiles*	Forests	NI	MI	MI
Boreal owl *Aegolius funereus*	Montane and subalpine forests	NI	MI	MI
Olive-sided flycatcher *Contopus borealis*	Snag, coniferous forests, forest-meadow edges	NI	MI	MI
Flammulated owl *Otus flammeolus*	Montane forests – aspen/conifer mixes; mixed conifer	NI	MI	MI
Purple Martin *Progne subis*	Mature aspen near water	NI	MI	MI
MAMMALS				
American Marten *Martes Americana*	Montane and subalpine coniferous forests	NI	MI	MI

Species	General Habitat	ALTERNATIVES		
		1 – No Action	2	3
Pygmy Shrew *Sorex hoyi*	Wet meadows, wetlands, riparian areas in sub-alpine Spruce-fir forests	NI	MI	MI
Hoary Bat *Lasiurus cinereus*	Low elevation forests (1,900 – 9,100 feet)	NI	MI	MI

NI = No Impact; MI = May Impact Individuals, but is not likely to cause a trend towards Federal listing or result in loss of viability in the planning area.

Effects of the No Action Alternative – Alternative 1

Direct and Indirect

There will be no human-induced direct and indirect effects as a result of Alternative 1. There would be no treatments under this alternative and terrestrial wildlife species and their habitats would continue to be influenced by natural ecosystem processes.

Cumulative

Under the no action alternative there would be no increase in cumulative effects because no federal actions would occur to add to activities occurring in the past, present or in the future. Natural processes would continue to affect wildlife resources, with the spruce beetle epidemic causing dynamic changes across the landscape throughout all Geographic Areas. Large-scale natural disturbance processes are an important part of ecosystem function and contribute to biodiversity.

Direct and Indirect Effects of Alternative 2 (Agency Preferred Alternative) and Alternative 3 (WUI Focus)

Northern Goshawk

In general, direct effects to northern goshawks from treatment activities include noise due to the presence of heavy equipment operations, chainsaws, the presence of personnel and smoke associated with prescribed fire activities. Noise disturbance and smoke may result in the temporary displacement of goshawks during treatment activities. Design features included in the proposed action and in compliance with Forest Plan direction will restrict activities during the breeding season and will also require raptor surveys to determine the locations of individuals (particularly active nest sites) or populations each year. These design features will minimize impacts to active goshawk nest sites and provide protection to these sites during implementation

of the proposed action. Disturbance to foraging goshawks from noise created by treatment activities could cause the birds to abandon the area temporarily.

On the GMUG NF, goshawks have been primarily documented to nest in mature aspen-dominated stands mixed with conifers, including Engelmann spruce and lodgepole pine. A low percentage of known nests are in mature lodgepole pine or ponderosa pine stands. It is unlikely that treatments to spruce-fir will affect nesting habitat for goshawks. It may, however affect foraging habitat and may indirectly affect prey species. Table 295 through Table 299 quantify acres of potential goshawk nesting that may be affected from Alternatives 2 and 3.

Table 295. Activities Proposed under Alternative 2 - Overlap with Goshawk Nesting Habitat (Acres and % of Total) within each Geographic Area

Geographic Area	Goshawk Nesting Habitat?	Hazard Trees	New Roads Outside PTA	Priority Treatment Area (PTA)					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Goshawk Nesting Habitat	17	1	11,241	475	1,243	2,299	56	15,314	**15,332 (38%)**
	Not Goshawk Nesting Habitat	1,058	18	10,680	969	7,565	3,865	429	23,508	**24,584 (62%)**
	Total	**1,075**	**19**	**21,920**	**1,445**	**8,808**	**6,163**	**486**	**38,822**	**39,916**
Gunnison Basin North	Goshawk Nesting Habitat	113	1	8,557	-	1,178	1,526	103	11,363	**11,478 (17%)**
	Not Goshawk Nesting Habitat	3,583	48	39,829	-	5,719	5,137	1,722	52,408	**56,038 (83%)**
	Total	**3,696**	**49**	**48,386**	**-**	**6,897**	**6,663**	**1,825**	**63,771**	**67,516**
Gunnison Basin South	Goshawk Nesting Habitat	215	1	5,272	-	1,938	714	627	8,551	**8,767 (17%)**
	Not Goshawk Nesting Habitat	4,579	43	13,228	-	9,396	3,705	11,434	37,764	**42,385 (83%)**
	Total	**4,794**	**44**	**18,500**	**-**	**11,334**	**4,419**	**12,061**	**46,315**	**51,152**
North Fork Valley	Goshawk Nesting Habitat	91	0	1,120	-	841	928	78	2,967	**3,058 (13%)**
	Not Goshawk Nesting Habitat	2,167	25	11,104	920	2,516	4,097	466	19,103	**21,294 (87%)**
	Total	**2,258**	**25**	**12,225**	**920**	**3,356**	**5,025**	**544**	**22,070**	**24,352**
San Juans	Goshawk Nesting Habitat	56	3	323	-	1,631	1,082	205	3,242	**3,301 (22%)**
	Not Goshawk Nesting Habitat	1,967	39	107	-	6,141	1,513	1,625	9,386	**11,392 (78%)**
	Total	**2,023**	**42**	**430**	**-**	**7,773**	**2,595**	**1,830**	**12,628**	**14,692**
Uncompahgre Plateau	Goshawk Nesting Habitat	51	6	15,964	-	8,387	9,756	238	34,345	**34,402 (44%)**
	Not Goshawk Nesting Habitat	3,490	28	25,266	-	6,610	7,878	119	39,873	**43,392 (56%)**
	Total	**3,541**	**34**	**41,231**	**-**	**14,997**	**17,634**	**357**	**74,219**	**77,795**
	Grand Total	**17,387**	**213**	**142,691**	**2,365**	**53,166**	**42,499**	**17,103**	**257,823**	**275,424**

[1]There are a total of 275,424 acres where proposed activities under Alternative 2 could occur. Of those acres, 76,338 (28%) are in mapped goshawk nesting habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to protect nest sites and manage nesting habitat based on best available science. This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 12% of the total nesting habitat on the GMUG National Forests.

Table 296. Activities Proposed under Alternative 3 - Overlap with Goshawk Nesting Habitat (Acres and % of Total) within each Geographic Area.

Geographic Area	Goshawk Nesting Habitat?	Hazard Trees	New Roads Outside PTA	Priority Treatment Area (PTA)					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Goshawk Nesting Habitat	33	4	8,905	475	738	1,745	54	11,917	**11,955 (40%)**
	Not Goshawk Nesting Habitat	1,483	24	8,405	969	4,545	1,859	322	16,101	**17,608 (60%)**
	Total	**1,516**	**28**	**17,310**	**1,445**	**5,283**	**3,605**	**376**	**28,018**	**29,563**
Gunnison Basin North	Goshawk Nesting Habitat	158	2	5,812	-	398	961	38	7,209	**7,369 (16%)**
	Not Goshawk Nesting Habitat	5,083	42	29,769	-	1,588	1,284	694	33,335	**38,460 (84%)**
	Total	**5,241**	**45**	**35,581**	**-**	**1,986**	**2,245**	**732**	**40,544**	**45,829**
Gunnison Basin South	Goshawk Nesting Habitat	300	3	2,243	-	374	270	31	2,918	**3,220 (17%)**
	Not Goshawk Nesting Habitat	7,113	17	5,048	-	1,263	730	1,228	8,269	**15,399 (83%)**
	Total	**7,413**	**20**	**7,291**	**-**	**1,637**	**999**	**1,259**	**11,187**	**18,619**
North Fork Valley	Goshawk Nesting Habitat	102	1	450	-	559	860	56	1,925	**2,028 (10%)**
	Not Goshawk Nesting Habitat	2,714	20	9,027	897	1,202	3,434		14,560	**17,294 (90%)**
	Total	**2,816**	**20**	**9,477**	**897**	**1,761**	**4,293**	**56**	**16,485**	**19,322**
San Juans	Goshawk Nesting Habitat	56	3	323	-	1,395	370	162	2,249	**2,308 (29%)**
	Not Goshawk Nesting Habitat	2,460	20	107	-	1,742	706	490	3,045	**5,525 (71%)**
	Total	**2,516**	**22**	**430**	**-**	**3,137**	**1,076**	**652**	**5,294**	**7,833**
Uncompahgre Plateau	Goshawk Nesting Habitat	66	7	13,209	-	4,773	4,103	144	22,230	**22,303 (40%)**
	Not Goshawk Nesting Habitat	5,125	27	20,193	-	3,992	3,783	73	28,042	**33,194 (60%)**
	Total	**5,192**	**34**	**33,403**	**-**	**8,766**	**7,886**	**218**	**50,272**	**55,497**
	Grand Total	**24,694**	**169**	**103,491**	**2,342**	**22,571**	**20,103**	**3,293**	**151,800**	**176,662**

[1]There are a total of 176,662 acres where proposed activities under Alternative 3 could occur. Of those acres, 49,183 (28%) are in mapped goshawk nesting habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to protect nest sites and manage nesting habitat based on best available science. This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 7.8% of the total nesting habitat on the GMUG National Forests.

Table 297. Comparison of Alternatives (Acres and % of Total)

Geographic Area (GA)	Alt. 2 Potentially Affected Areas[1]	Alt. 3 Potentially Affected Areas	Goshawk Nesting Habitat (Baseline)[2]	Goshawk Nesting Habitat Potentially Affected by Alt. 2 (% of Total Nesting Habitat)	Goshawk Nesting Habitat Potentially Affected by Alt. 3 (% of Total Nesting Habitat)
Grand Mesa	39,916	29,563	94,816	15,332 (16)	11,955 (13)
Gunnison Basin North	67,516	45,829	140,467	11,478 (8)	7,369 (5)
Gunnison Basin South	51,152	18,619	85,172	8,767 (10)	3,220 (4)
North Fork Valley	24,352	19,322	108,477	3,058 (3)	2,028 (2)
San Juans	14,692	7,833	73,180	3,301 (5)	2,308 (3)
Uncompahgre Plateau	77,795	55,497	126,939	34,402 (27)	22,303 (18)
Grand Total	**275,423**	**176,663**	**629,051**	**76,338 (12)**	**49,183 (8)**

[1]Potentially affected areas: includes all commercial and noncommercial activities in Priority Treatment Areas, hazard tree removal areas, and area affected by new roads outside PTAs.

[2]This is all modeled goshawk nesting habitat for the GMUG National Forests based on the GMUG 2005 MIS Assessment (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5199933.pdf)

The proposed action will reduce ground and surface fuels by removing dead and dying trees. Prescribed fire treatments such as pile burning will also reduce fuels generated by treatment activities. Fuel treatments may benefit northern goshawks and their habitat in the long term by improving the health of forested stands if they are successful in increasing age-class diversity and promoting aspen regeneration. In addition, resiliency treatments would increase age class diversity and tree species composition which would increase the diversity of habitats for goshawks. This could benefit foraging habitat and their prey species in the long-term.

Table 298 is a summary of effects to goshawks in spruce stands as a result of treatment activities based on stand mortality and Table 299 is a summary of effects to goshawks, flammulated owls and purple martins in aspen stands.

Table 298. Effects of Silvicultural Treatments to Goshawks in Spruce – Fir Stands

Stand Condition	Overstory Mortality Level	Treatment	Effects to Goshawk Habitat
Single Storied	<40%	• Individual tree selection. • Removal focused on pockets of dead and dying spruce-fir. • Harvest 15-25% of stand. • May require mechanical site prep.	Spruce fir stands are not preferred by goshawk as nesting/roosting habitat on the GMUG but goshawks will utilize these stands for foraging. Treatments will remove individual or pockets of trees with the majority of the area remaining as it exists. Habitat for prey species will be affected in patches due to decreases in canopy cover, stand density and coarse woody debris. Design features will ensure maintenance of down woody debris and protection of habitat directly around nest sites and within Post Fledging Areas from disturbance when nests are active. Overall, foraging habitat will remain across the landscape.
	Between 40-90%	• Remove all dead and dying spruce-fir in areas where adequate seed source exists. • Group selection where mortality is patchy. • Clear cut where mortality is extensive. • Create small openings in areas where <40% mortality occurs. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”. • May require mechanical site prep.	These stands may be used by goshawks as foraging habitat. Treatments may degrade habitat for prey species because of a decrease in canopy cover, stand density and coarse woody debris. As a result foraging habitat may also be degraded. Design features will ensure maintenance of snags and retention of down woody debris and protection of habitat directly around occupied nest sites from disturbance during operations, and maintaining uncut areas important for foraging habitat. Overall, foraging habitat will remain across the landscape. Stands will also have lower canopy cover across the landscape as a result of proposed treatments. Goshawks require canopy cover over 40% and it is likely the majority of stands will fall below that level as trees die and fall or as a result of treatment. In areas where canopy cover is low, goshawks are unlikely to use those areas. However patches of habitat may be available after treatments are completed and may be used by goshawks depending on the size and proximity of suitable habitat. Goshawks may also hunt along edges of openings and within small meadows during the breeding season, thus treatments are not anticipated to render habitat unsuitable.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Goshawk Habitat
Single Storied	>90%	• Remove all dead and dying spruce-fir where there is no adequate natural seed source. • Clear cut where mortality is extensive. • May require mechanical site prep.	Due to the lack of overstory canopy cover, goshawks are not expected to use these areas where treatment units are large. Stands may be too open after treatments with decreased canopy cover, stand density, coarse woody debris as well as the incidental reduction in understory vegetation components. When nest sites are discovered in the planning area, design features will be applied providing protection of habitat directly around occupied nest sites from disturbance during operations, protections to the Post Fledging Area, and maintaining uncut areas important for foraging habitat.
Two Storied	<40% and ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Although spruce fir has been found not to be a preferred nesting habitat type for goshawks on the GMUG, these stands could provide suitable nesting/roosting habitat if the stand contains large trees and high canopy cover. Otherwise the area is suitable foraging habitat. Treatments will have a minimal effect to goshawk habitat. Only pockets of trees or individual trees will be removed. Habitat for prey species will be affected in patches, but is not expected to result in changes in overall population abundance. Foraging habitat will be maintained across the landscape. Treatments are intended to create multiple age classes of trees and increase. Increased habitat diversity will benefit goshawks in the long term.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Remove dead and dying spruce-fir.	These stands may provide nesting/roosting and foraging habitat as long as there is a dense canopy cover. Treatments will affect habitat in these areas with the removal of individual or groups of trees, leaving small openings that goshawks could potentially use for hunting. When nest sites are discovered in the planning area, design features will be applied providing protection of habitat directly around occupied nest sites from disturbance during operations, protections to the Post Fledging Area, and maintaining uncut areas important for foraging habitat.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Goshawk Habitat
Two Storied	Between 40-90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Treatments are expected to further decrease canopy cover, stand density and coarse woody debris which are important habitat elements for prey species. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.
	Between 40% and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Treatments will decrease canopy cover, stand density and coarse woody debris which may also degrade habitat for prey species (particularly birds). Goshawks are not likely to use areas where treatments significantly reduce canopy cover. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.
	>90% and ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• Stand no longer two storied due to dead overstory. • Salvage of dead and dying spruce-fir.	These stands may not be used by goshawks due to the lack of canopy cover, live trees, and prey species because of high mortality in the stands. Treatments will not affect nesting goshawks. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Goshawk Habitat
Multiple Canopies	<40% ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Spruce fir is not a preferred habitat type for goshawks for nesting/roosting however these stands may provide suitable habitat if canopy cover is >40% and large trees occur in the stand. They can be used as foraging habitat for goshawks and treatments may have beneficial effects to prey species in the long term by increasing vegetation diversity. At a landscape level, these stands are expected to continue to support foraging habitat and possibly nesting/roosting habitat.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	These stands are suitable foraging habitat and treatments may degrade habitat with the removal of individual or groups of trees resulting in decreases in canopy cover, stand density and coarse woody debris which are important habitat elements for prey species. Small openings may benefit some small mammal species.
	Between 40 and 90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”.	Large portions of these stands may be low quality foraging habitat due to the low canopy cover and stand density as a result of mortality within stands. High mortality and lack of live overstory trees may result in low prey species availability (birds). Patches of suitable foraging habitat may exist and treatments will reduce canopy cover, stand density, coarse woody debris and understory vegetation components which may degrade prey species habitat and decrease the amount of available prey. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Goshawk Habitat
Multiple Canopies	Between 40 and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Canopy cover is likely to average less than 40% because of mortality levels, but pockets of suitable habitat may be present. Treatments may degrade habitat with the removal of trees and decreases in canopy cover, stand density, coarse woody debris and understory habitat components. Prey species may decrease which affect forage availability for goshawks. Overall, these areas will not support high quality habitat. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.
	>90% ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• If two canopies still alive, it is a multi-storied stand. • Salvage of dead and dying.	These stands are unlikely to be used by goshawks due to the lack of canopy cover and live trees as a result of the high mortality in the stands. Treatments will not affect nesting goshawks. Design features will help ensure maintenance of snags and retention of down woody debris and maintenance of a suitable understory for various prey species across the landscape.

Flammulated Owl

Direct effects to owls include noise disturbance and smoke associated with prescribed fire activities. Noise disturbance resulting from the use of heavy equipment, chainsaws and personnel implementing the project as well as smoke may cause the temporary displacement of roosting owls. Project activities will also remove suitable habitat which could result in the permanent displacement of owls if they are using areas where pockets of trees are removed.

Flammulated owls do not typically nest in spruce-fir forests, but they have been documented in mixed conifer and aspen-Douglas fir mixed stands on the GMUG. Treatments in spruce-fir forest stands are not expected to affect flammulated owl nesting habitat. Noncommercial prescribed fire and mechanical treatments could cause reductions in nesting habitat or cause nest abandonment and chick mortality if implemented during the nesting season in occupied areas. Indirect effects to flammulated owls and their habitat are described in Table 299.

Purple Martin

The purple martin prefers mature aspen with nearby water sources as their primary habitat. Direct effects to purple martins include noise disturbance associated with the use of heavy equipment and chainsaws and the presence of personnel during treatment activities. All of these effects may cause individuals in the area to temporarily displace to adjacent areas. Displacement of individuals during the breeding season may result in nest abandonment. It may also affect nest success if birds are spending more time avoiding activities rather than foraging and delivering food to chicks.

Table 299 includes effects of aspen treatments to martin habitat based on suckering potential and treatment prescriptions. All treatments will result in a temporary loss of habitat, unless areas with known martin occurrences can be avoided as described in design feature WFRP-22. Aspen will regenerate over time and habitat will be restored in the long term. Mixed conifer-aspen stands that are not treated to remove conifer encroachment will become conifer-dominated, resulting in a loss of aspen habitat. Resiliency treatments in mixed conifer-aspen stands, where appropriate to achieve desired future conditions, have the primary objective of conifer removal to maintain the aspen component. All action alternatives for aspen will help maintain aspen habitat in the long-term for martins.

Table 299. Effects of Silvicultural Treatments to Northern Goshawks, Flammulated Owls, Purple Martin in Aspen Stands.

Aspen Stand Condition	Suckering Potential	Treatment	Effects
No SAD or <50% SAD in stands	High	• Coppice (clear cut) treatments of aspen if tree defect is low to high. • Prescribed burn feasible if there is a moderate fine fuel component.	Coppice treatments in stands will result in short-term loss of habitat for goshawks, flammulated owls and purple martin. Where prescribed burning is applied, fuel loads will be reduced including downed logs, grasses, shrubs, snags and live mature trees. Breeding habitat would initially be lost but in the long term treatments are intended to stimulate aspen regeneration and persist on the landscape, maintaining habitat for all species utilizing this tree type.
	Low	• No treatment	No treatment, therefore no effect.
>50% SAD in stands	High	• Site specific prescriptions to be determined based on site conditions.	Habitat may be degraded or lost if stands are thinned or if coppice treatments are used. Typically, these are low priority treatment areas since regeneration of the stand has shown to have low success.
	Low	• Allow continued succession of stand. • Plant site adapted conifer species as an option.	Stands will not support suitable habitat if conifers become the dominant species.
Aspen Overstory with Spruce Fir Understory	High	• Defer aspen cut and allow stand to succeed as a spruce-fir dominated stand.	Coppice treatments will temporarily result in a loss of habitat. Over time, aspen are expected to regenerate and will support aspen dependent species.
	Low	• Coppice (clear cut) treatments of aspen if tree defect is low to high. • Prescribed burn to stimulate aspen where appropriate. • Remove fir and aspen to stimulate additional aspen.	Stands will continue to support aspen and provide habitat for goshawks, flammulated owls and martins.

Aspen Stand Condition	Suckering Potential	Treatment	Effects
Mixed Conifer with Aspen	High	• Remove spruce-fir and allow stand to succeed as an aspen dominated stand. • Use prescribed fire as needed to reduce fuels and regenerate aspen.	Treatments in stands will include coppice cuts in patches across entire stands. This will result in a temporary loss of habitat. Aspen will regenerate over time and once stands are re-established, will provide suitable habitat for goshawk, flammulated owl and martins.
	Low	• Coppice (clear cut) treatments in patches within the entire stand. • Pile burn as needed. • Use prescribed fire as needed to reduce fuels and regenerate aspen	The removal of spruce-fir in stands will allow aspen to become the dominant tree species in these stands. This will also improve habitat conditions for species using pure or aspen-dominated stands as habitat.

Boreal Owl

Individuals may temporarily avoid impacted areas during project implementation due to the presence of humans, equipment, smoke and increased noise. This could cause nest abandonment if they are using these areas as nesting habitat, or could affect nest success if birds spend more time avoiding these disturbances rather than foraging and delivering food to chicks.

Noise disturbance resulting from the use of heavy equipment, chainsaws and personnel implementing the project as well as smoke may cause the temporary displacement of roosting owls. Project activities will also remove suitable habitat which could result in the permanent displacement of owls if they are using areas where pockets of trees are removed.

The proposed action will reduce ground and surface fuels through the removal of dead and dying trees. Prescribed fire treatments such as pile burning will also reduce fuels generated by treatment activities. These activities could cause reductions in prey availability for boreal owls.

Indirect effects to spruce fir habitat for boreal owl are included in Table 300. Treatments proposed in aspen stands are not expected to affect boreal owls.

Olive-sided Flycatcher

Individuals may temporarily avoid impacted areas during project implementation due to the presence of humans, equipment, smoke and increased noise. This could cause nest abandonment if they are using these areas as nesting habitat, or could affect nest success if birds spend more time avoiding these disturbances rather than foraging and delivering food to chicks.

Indirect effects include changes in habitat structure and composition within all treatment units. Salvage logging, by reducing snag densities, may diminish site quality particularly if larger snags, which olive-sided flycatchers prefer (Altman and Sallabanks 2000, Brandy 2001), are selectively removed. However, this species has been found to nest in logged forests, but not in clear cuts (Kotliar 2007). There are studies that have found that logged areas provide nesting habitat, however there is conflicting evidence as to the relative suitability of these areas (Kotliar and Melcher 1998, Hutto and Young 1999). In studies comparing burned forests with logged forests, results have shown both higher and lower nesting success in burned areas (Smucker and Smucker 2001, Meehan and George 2003). Studies have also shown that logged areas likely provide better forage than burned areas based on higher feeding rates (Meehan and George 2003). This was even found in studies where burned areas had higher nesting success than logged areas (Meehan and George 2003). Based on all of this information, disturbance events including logging activities do not necessarily result in negative impacts to olive sided flycatchers. What isn't known is whether it's the type of disturbance, the scale, severity, or elapsed time since the disturbance occurred that affects habitat suitability (Kotliar 2007). Maintaining clumps of trees and snags are important to maintaining nesting habitat for flycatchers. The proposed project includes design features that will maintain these elements in areas where salvage activities occur. This will help to minimize adverse effects to flycatchers. A description of indirect effects to habitat due to silvicultural treatments is described in Table 300.

The proposed action will also reduce ground and surface fuels through the removal of dead and dying trees. Prescribed fire treatments such as pile burning will also reduce fuels generated by treatment activities. Olive sided flycatchers do utilize burned areas and have been found to be more abundant in moderate to high severity burned areas than in low severity burned areas. Therefore, the reduction of fuels prior to a fire occurring may result in habitat that is of lower quality. However, if a stand replacing fire occurs, it is unlikely flycatchers would use the area especially in the absence of any live trees in or near these areas. Initially, portions of crown fire patches much greater than 200 m from live forest may not be readily used by olive-sided flycatchers, due to lack of nearby trees that retain needles (Kotliar 2007). Over longer time frames, delayed forest regeneration within the interior of severely burned patches may prolong occupancy of the burn by olive-sided flycatchers (Kotliar 2007).

Pygmy Shrew

Direct effects to pygmy shrews could potentially include trampling and crushing due to the use of heavy equipment and the increases presence of humans. There are no recorded observations of individuals in areas available for treatment however this species is small and not easily detected due to their small size (they are the smallest North American mammal and one of the smallest mammals in the world) and they spend a lot of time digging through soil and leaf litter searching for food. Indirect effects to habitat are described in more detail in Table 300. Pygmy shrews do not use aspen as habitat and treatments to aspen stands will have no effect to them.

The proposed action will reduce ground and surface fuels through the removal of dead and dying trees. Prescribed fire treatments such as pile burning will also reduce fuels generated by treatment activities. Although recorded to live in areas with both wet and dry soil, the pygmy shrew requires moist soils and a moist leaf litter layer when foraging for insects (*Index for Mammalian Species*. *www.science.smith.edu. Retrieved 2016-01-16*). Though small, they have an extremely large appetite for their size and due to a fast metabolism, they need to eat constantly. Treatments that reduce woody material on the ground and that reduce shade from overstory tree removal are likely to result in dryer conditions that could negatively impact pygmy shrew foraging habitat.

Table 300. Effects of Silvicultural Treatments in Spruce Fir to Boreal Owl, Olive sided Flycatcher, and Pygmy Shrew.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Single Storied	<40%	• Individual tree selection. • Removal focused on pockets of dead and dying spruce-fir. • Harvest 15-25% of stand. • May require mechanical site prep.	Treatments will slightly alter habitat conditions for the boreal owl, olive sided flycatcher and pygmy shrew. Open pockets will occur within stands and stand density will slightly decrease in some areas which may improve foraging habitat for flycatchers. Overall stands will continue to provide suitable habitat across the landscape.
	Between 40-90%	• Remove all dead and dying spruce-fir in areas where adequate seed source exists. • Group selection where mortality is patchy. • Clear cut where mortality is extensive. • Create small openings in areas where <40% mortality occurs. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”. • May require mechanical site prep.	Habitat for all of these species may be degraded or lost as a result of treatment activities. There will be a decrease in canopy cover, stand density, and coarse woody debris with group selection treatments. This may degrade habitat for the pygmy shrew as well as habitat for boreal owl prey species resulting in a decrease in prey availability. Design features will minimize effects to coarse woody debris levels which will retain some habitat components for small mammal species. Decrease or loss of canopy cover and stand density may degrade the quality of habitat for all species. Flycatchers may continue to utilize the area if there are snags and patches of live trees remaining. A design feature that requires retaining 90-225 snags per 100 acres across the landscape will maintain habitat for the owl and flycatcher. Design features will retain live trees in salvaged areas and patches of high quality lynx foraging habitat in blocks greater than 0.3 acres or larger should provide standing snags and understory habitats for birds. Maintaining understory vegetation should provide thermal cover for shrews.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Single Storied	>90%	• Remove all dead and dying spruce-fir where there is no adequate natural seed source. • Clear cut where mortality is extensive. • May require mechanical site prep.	These stands provide low quality to marginal habitat for all of the species analyzed in this table. Treatments will decrease or remove canopy cover, stand density and coarse woody debris as well as an incidental reduction in understory vegetation within treated areas. Treatments will be designed to maintain patches of habitat greater than 0.3 acres to support high quality lynx foraging habitat, which will also provide habitat for pygmy shrew (will help maintain moist conditions through retention of leaf litter associated with these patches) and boreal owl prey species but they will have limited use due to their small size. Within treatment areas, these stands will no longer support suitable habitat for any of the species and it will take years (decades) for suitable habitat to regenerate. Design features will maintain suitable habitat for boreal owls, flycatchers and shrews across the broader landscape where treatments are proposed.
Two Storied	<40% and ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Treatments will slightly alter habitat conditions for the boreal owl, olive sided flycatcher and pygmy shrew. Open pockets will occur within stands and stand density will slightly decrease in some areas which will improve foraging habitat for flycatchers. Stands will continue to provide suitable habitat for all species across the landscape. Habitat quality for small mammal prey species is expected to improve due to increased diversity that these treatment types will achieve in the long term. Distribution of prey for boreal owls may be affected, but small mammal populations will not result in any significant change. Treatments are intended to make stands more resilient to future bark beetle attacks which will decrease the chances of habitat loss in the future.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Two Storied	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Remove dead and dying spruce-fir.	Treatments will slightly alter habitat conditions for boreal owl, olive-sided flycatcher and pygmy shrew. Open pockets will occur within stands and stand density will slightly decrease in some areas which will continue to provide suitable foraging habitat for flycatchers. Habitat for small mammal species is marginal quality due to relatively low vegetation structural diversity. Treatments may further degrade habitat for these species with a decrease and loss of canopy cover and stand density. These changes would result in loss or degradation of habitat for shrews and other small mammals that are prey for boreal owls. Design features for coarse woody debris and snag retention will retain some of those features maintaining some habitat in stands after treatments. Small patches of habitat within the forest matrix would be lost or degraded with the group selection prescription, reducing habitat availability for boreal owl and pygmy shrew. Treatments are intended to increase age class diversity and tree species composition making stands more resilient to future bark beetle attacks which will decrease the chances of habitat loss in the future.
	Between 40-90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”.	Habitat for all of these species may be degraded or lost as a result of treatment activities. There will be a decrease in canopy cover, stand density, and coarse woody debris with group selection treatments. This may degrade habitat for the pygmy shrew as well as habitat for boreal owl prey species resulting in a decrease in prey availability. Design features will minimize effects to coarse woody debris levels which will retain some habitat components for small mammals. Decreases in canopy cover and stand density may degrade the quality of habitat for all species. A design feature that requires retaining 90-225 snags per 100 acres across the landscape will maintain this habitat component for the owl and flycatcher. Thermal cover may be affected by treatment activities for the shrew, but it will depend on the remaining understory. However, design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Two Storied	Between 40% and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Habitat for all of these species is low quality and may be degraded further with salvage activities. All activities will lower the amount of coarse woody debris in stands which will affect shrews and small mammals that are prey for boreal owls. Design features will minimize effects to coarse woody debris levels and retain snags across the landscape which will maintain some habitat. Changes and loss of canopy cover and stand density may degrade the quality of habitat for all species. Because mortality is between 40% and 90%, untreated stands will likely be left with patches of low quality habitat in the matrix that may not be of sufficient size to support high densities of boreal owl across the broader landscape. However, Design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality and removal from salvage harvests.
	>90% and ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• Stand no longer two storied due to dead overstory. • Salvage of dead and dying spruce-fir.	These stands are unlikely to support suitable habitat for the boreal owl or flycatchers. Due to the amount of mortality in the stand, canopy cover and stand density would already be absent or low and highly degraded. Habitat for shrews may still occur if there is a developed understory that can provide cover, shelter and food. Treatments may further degrade any suitable habitat that remains and it is likely treatment areas will not support these species until forest cover regenerates and reaches adequate sizes and densities. However, design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality and removal from salvage harvests.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Multiple Canopies	<40% ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Treatments will slightly alter habitat conditions for the boreal owl, olive sided flycatcher and pygmy shrew. Open pockets will remain after treatments within stands and stand density will slightly decrease in some areas and may improve foraging habitat for flycatchers. Stands will continue to provide suitable habitat across the landscape for all species especially in areas where more than one story remains. Habitat for small mammal species will also be affected in patches, but populations for shrews and prey species for the boreal owl are not expected to result in any significant change to populations. Treatments are intended to increase age class diversity and tree species composition making stands more resilient to future bark beetle attacks which will decrease the chances of more habitat loss in the future.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Treatments will slightly alter habitat conditions for boreal owl, olive-sided flycatcher and pygmy shrew. Open pockets will occur within stands and stand density will slightly decrease in some areas which may improve foraging habitat for flycatchers. Habitat for small mammal species is moderate quality due to less understory cover. Treatments may further degrade habitat for these species, however existing DHC will be retained as much as possible. Coarse woody debris would also be decreased which will impact the pygmy shrew and other small mammal species by reducing important habitat components for these species. This may also affect the prey base for boreal owls by changing the distribution across the landscape. Design features require the retention of coarse woody debris which will maintain that habitat component in stands after treatments. There will be a decrease in canopy cover and stand density but some areas may still maintain more than one story. Patches of habitat may be lost or degraded with the group selection prescription. Treatments are intended to increase age class diversity and tree species composition making stands more resilient to future bark beetle attacks which may benefit these species in the long term.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Multiple Canopies	Between 40 and 90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Habitat for all of these species may be degraded or lost as a result of treatment activities. There will be a decrease in canopy cover, stand density, and coarse woody debris with group selection treatments. This may degrade habitat for the pygmy shrew as well as habitat for boreal owl prey species resulting in a decrease in prey availability. Design features will minimize effects to coarse woody debris levels and retain snags across the landscape which will maintain some habitat components for all species. Salvage treatments will likely cause losses of habitat with the removal of canopy cover and stand density. Thermal cover may be affected by treatment activities for the shrew, but it will depend on the remaining understory and retention of course woody debris. Design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality and removal from salvage harvest.
	Between 40 and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Habitat for all of these species is low quality and may be degraded or lost as a result of treatment activities. Salvage harvest will remove canopy cover and stand density in treatment units while other prescriptions will cause reduce habitat quality but not cause complete removal. All activities will lower the amount of coarse woody debris in stands which will affect shrews and small mammals that are prey for boreal owls. Design features will minimize effects to coarse woody debris levels which will maintain some habitat. Decreases and loss of canopy cover and stand density may degrade the quality of habitat for all species and because mortality is between 40% and 90%, stands will likely be left with patches of low quality habitat that may not be large enough to support boreal owls within treatment areas. However, design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality and removal from salvage harvest.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Habitat
Multiple Canopies	>90% ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• If two canopies still alive, it is a multi-storied stand. • Salvage of dead and dying.	These stands are unlikely to support suitable habitat for the boreal owl and nesting habitat for flycatchers except in cases where more than one story exists. Under those conditions, habitat would be low quality due to the amount of mortality in the stand. Canopy cover and stand density would already be low and highly degraded due to the extensive mortality. Flycatcher habitat may be available but it would be marginal at best and likely in patches. Habitat for shrews may still occur if there is a developed understory that can provide food, cover, and shelter. Treatments may further degrade any suitable habitat that remains. We expect that remaining stands would be marginal habitat patches; it is likely treatment areas will not support these species until forest cover regenerates and reaches adequate sizes and densities. However, design features will help ensure retention of habitat for boreal owls, flycatchers and shrews across the broader landscape even though it may be of lower quality due to high overstory tree mortality and removal from salvage harvest.

Hoary Bat

Direct effects to hoary bat include the potential for removal of occupied roost trees which could result in injury, death or displacement of individuals. If individuals are roosting in the immediate vicinity of the project area they may be disturbed by the noise or vibration caused by heavy equipment, the use of chainsaws and smoke resulting from project activities. This could result in temporary displacement of individuals. Impacts resulting from displacement or potential for mortality would be greatest during the maternity and the winter roosting seasons. Roosting habitat will be degraded in the salvage of spruce-fir stands and the proposed project does include a design feature that maintains 90-225 snags/100 acres across the landscape. This design feature will retain some snags, thus maintaining roosting habitat for bats. The largest diameter snags will be maintained and they will be in clumps where possible.

There may be an increased risk of predation if individuals are displaced and unable to locate suitable alternate roosting habitat. Also, vegetation treatments will modify foraging habitat, however it will not remove or decrease the amount of available foraging habitat. The proposed project may benefit hoary bats and their habitat in the long term by restoring and improving resiliency of spruce-fir stands against future bark beetle infestations, and promoting regeneration. This will occur through a combination of removing dead and dying trees (salvage harvest), retaining existing live, healthy trees and planting seedlings (reforestation) in areas where stocking levels are not adequate. Retained live trees that reproduce will hopefully result in trees that are more resilient to future bark beetle attacks.

American Marten

Direct effects to American marten are likely to occur primarily where treatments are impacting spruce-fir and spruce-aspen mixed stands. Individuals may abandon the area temporarily during project implementation due to the presence of humans, equipment and increased noise. Project activities will also remove suitable habitat or reduce habitat quality. Table 301 through Table 303 quantify suitable marten habitat on the GMUG NF that may be affected by the action alternatives.

Table 301. Activities Proposed Under Alternative 2 – Overlap with American Marten Habitat (Acres) within each Geographic Area.

Geographic Area	American Marten Habitat?	Hazard Trees	New Roads Outside PTA	Priority Treatment Area (PTA)					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Denning and Resting	267	2	1,043		5,602	2,898	261	9,804	**10,072**
	Foraging	60	2	1,448		2,263	1,582	188	5,481	**5,543**
	Not Marten Habitat	748	15	19,430	1,445	943	1,683	36	23,537	**24,301**
	Total	**1,075**	**19**	**21,920**	**1,445**	**8,808**	**6,163**	**486**	**38,822**	**39,916**
Gunnison Basin North	Denning and Resting	817	8	5,990		3,263	1,392	1,026	11,671	**12,497**
	Foraging	151	2	659		1,359	657	361	3,037	**3,191**
	Not Marten Habitat	2,727	39	41,736		2,275	4,615	437	49,063	**51,828**
	Total	**3,696**	**49**	**48,386**		**6,897**	**6,663**	**1,825**	**63,771**	**67,516**
Gunnison Basin South	Denning and Resting	552	5	2,943		2,580	548	1,904	7,976	**8,533**
	Foraging	150	3	1,238		2,363	290	2,475	6,366	**6,519**
	Not Marten Habitat	4,091	37	14,319		6,391	3,580	7,683	31,973	**36,101**
	Total	**4,794**	**44**	**18,500**		**11,334**	**4,419**	**12,061**	**46,315**	**51,152**
North Fork Valley	Denning and Resting	296	2	7		1,326	880	203	2,415	**2,713**
	Foraging	76	2	0		484	339	195	1,018	**1,096**
	Not Marten Habitat	1,885	21	12,218	920	1,547	3,806	146	18,636	**20,542**
	Total	**2,258**	**25**	**12,225**	**920**	**3,356**	**5,025**	**544**	**22,070**	**24,352**
San Juans	Denning and Resting	635	11	79		2,830	88	683	3,681	**4,326**
	Foraging	68	8	204		2,494	75	1,052	3,825	**3,902**
	Not Marten Habitat	1,320	23	147		2,448	2,431	95	5,122	**6,464**
	Total	**2,023**	**42**	**430**		**7,773**	**2,595**	**1,830**	**12,628**	**14,692**
Uncompahgre Plateau	Denning and Resting	171	1	1,163		6,417	2,334	165	10,078	**10,250**
	Foraging	50	1	215		4,491	1,669	107	6,482	**6,533**
	Not Marten Habitat	3,321	33	39,853		4,089	13,631	85	57,658	**61,011**
	Total	**3,542**	**34**	**41,231**		**14,997**	**17,634**	**357**	**74,219**	**77,795**
	Grand Total	**17,387**	**213**	**142,691**	**2,365**	**53,166**	**42,499**	**17,103**	**257,823**	**275,424**

[1]There are a total of 275,424 acres where proposed activities under Alternative 2 could occur. Of those acres, 48,392 acres (17.6%) are in marten denning/resting habitat, and 26,784 acres (9.7%) are in marten foraging habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to protect occupied areas and manage marten habitat based on best available science (USFS 2015). This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 12.7% of the total denning/resting habitat and up to 13% of the total foraging habitat on the GMUG National Forests.

Table 302. Activities Proposed Under Alternative 3 – Overlap with American Marten Habitat (Acres) within each Geographic Area.

Geographic Area	American Marten Habitat?	Hazard Trees	New Roads Outside PTA	Priority Treatment Area (PTA)					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Denning and Resting	467	6	752		3,474	1,722	188	6,135	**6,608 (22%)**
	Foraging	163	9	1,121		1,252	761	169	3,303	**3,475 (12%)**
	Not Marten Habitat	887	14	15,437	1,445	558	1,122	18	18,580	**19,481 (66%)**
	Total	**1,516**	**28**	**17,310**	**1,445**	**5,283**	**3,605**	**376**	**28,018**	**29,563**
Gunnison Basin North	Denning and Resting	1,110	8	4,602		1,017	566	521	6,707	**7,825 (17%)**
	Foraging	285	3	334		427	188	175	1,124	**1,412 (3%)**
	Not Marten Habitat	3,846	34	30,645		542	1,490	35	32,712	**36,592 (80%)**
	Total	**5,241**	**45**	**35,581**		**1,986**	**2,245**	**732**	**40,544**	**45,829**
Gunnison Basin South	Denning and Resting	979	3	1,209		792	240	392	2,633	**3,615 (19%)**
	Foraging	398	2	170		310	130	524	1,134	**1,534 (8%)**
	Not Marten Habitat	6,036	14	5,912		535	629	344	7,419	**13,469 (72%)**
	Total	**7,413**	**20**	**7,291**		**1,637**	**999**	**1,259**	**11,187**	**18,619**
North Fork Valley	Denning and Resting	364	2	5		721	683	46	1,455	**1,821 (9%)**
	Foraging	125	1			194	301	10	505	**632 (3%)**
	Not Marten Habitat	2,327	17	9,472	897	846	3,309		14,525	**16,869 (87%)**
	Total	**2,816**	**20**	**9,477**	**897**	**1,761**	**4,293**	**56**	**16,485**	**19,322**
San Juans	Denning and Resting	698	8	79		1,520	77	306	1,981	**2,687 (34%)**
	Foraging	143	10	204		819	40	345	1,408	**1,561 (20%)**
	Not Marten Habitat	1,676	5	147		798	959	0	1,905	**3,585 (46%)**
	Total	**2,516**	**22**	**430**		**3,137**	**1,076**	**652**	**5,294**	**7,833**
Uncompahgre Plateau	Denning and Resting	454	4	886		4,216	850	128	6,080	**6,537 (12%)**
	Foraging	271	3	170		2,914	978	53	4,114	**4,389 (8%)**
	Not Marten Habitat	4,467	27	32,347		1,636	6,057	37	40,077	**44,571 (80%)**
	Total	**5,192**	**34**	**33,403**		**8,766**	**7,886**	**218**	**50,272**	**55,497**
	Grand Total	**24,694**	**169**	**103,491**	**2,342**	**22,571**	**20,103**	**3,293**	**151,800**	**176,662**

[1]There are a total of 176,662 acres where proposed activities under Alternative 3 could occur. Of those acres, 29,093 acres (16.5%) are in marten denning/resting habitat, and 13,002 acres (7.4%) are in marten foraging habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to protect occupied areas and manage marten habitat based on best available science (USFS 2015). This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 7.6% of the total denning/resting habitat and up to 6.3% of the total foraging habitat on the GMUG National Forests.

Table 303. Comparison of Alternatives 2 and 3 to the Baseline – Potentially Affected American Marten Habitat (acres) within each Geographic Area.

Geographic Area	Alt. 2 Potentially Affected Areas[1]	Alt. 3 Potentially Affected Areas	Marten Habitat (Baseline)[2]			Marten Habitat Potentially Affected by Alt. 2 (% of Total Habitat)						Marten Habitat Potentially Affected by Alt. 3 (% of Total Habitat)					
			Denning/Resting	Foraging	Grand Total	Denning/Resting		Foraging		Grand Total		Denning/Resting		Foraging		Grand Total	
Grand Mesa	39,916	29,563	47,930	28,282	76,212	10,072	(21)	5,543	(20)	15,615	(20)	6,608	(14)	3,475	(12)	10,083	(13)
Gunnison Basin North	67,516	45,829	144,948	49,919	194,867	12,497	(9)	3,191	(6)	15,688	(8)	7,825	(5)	1,412	(3)	9,237	(5)
Gunnison Basin South	51,152	18,619	72,962	34,343	107,305	8,533	(12)	6,519	(19)	15,052	(14)	3,615	(5)	1,534	(4)	5,149	(5)
North Fork Valley	24,352	19,322	39,729	30,681	70,410	2,713	(7)	1,096	(4)	3,809	(5)	1,821	(5)	632	(2)	2,453	(3)
San Juans	14,692	7,833	50,685	51,304	101,989	4,326	(9)	3,902	(8)	8,228	(8)	2,687	(5)	1,561	(3)	4,248	(4)
Uncompahgre Plateau	77,795	55,497	24,513	10,321	34,834	10,250	(42)	6,533	(63)	16,783	(48)	6,537	(27)	4,389	(43)	10,926	(31)
Grand Total	**275,423**	**176,663**	**380,767**	**204,850**	**585,617**	**48,391**	**(13)**	**26,784**	**(13)**	**75,175**	**(13)**	**29,093**	**(8)**	**13,003**	**(6)**	**42,096**	**(7)**

[1]Potentially affected areas: includes all commercial and noncommercial activities in Priority Treatment Areas, hazard tree removal areas, and area affected by new roads outside PTAs.

[2]This is all modeled American marten denning/resting and foraging habitat for the GMUG National Forests based on the GMUG 2005 MIS Assessment (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5199823.pdf)

Snags and large woody debris, especially in the form of large-diameter boles, is an important feature of marten habitat. Logs are most useful to martens for gaining access to subnivean areas and for resting. Removal of large (coarse) woody debris from forests or interfering with processes that make it available in suitable sizes and stages of decay by removing standing trees and snags may indirectly affect martens by reducing habitat quality. While reductions of this important component of marten habitat may reduce habitat quality directly within the units, the project design features will help to maintain suitable marten habitat components consistent with Forest Plan direction. Indirect effects based on silvicultural treatments in spruce-fir stands are summarized in Table 304. Marten are not found in aspen-dominated stands so aspen treatments will not affect martens or their habitat except where treatments occur in mixed conifer-aspen stands.

Table 304. Effects of Silvicultural Treatments to American Marten in Spruce - Fir Stands.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Martens
Single Storied	<40%	• Individual tree selection. • Removal focused on pockets of dead and dying spruce-fir. • Harvest 15-25% of stand. • May require mechanical site prep.	Treatments will slightly alter habitat conditions with decreases to canopy cover, stand density, stand structure, coarse woody debris and understory vegetation. Open pockets will occur within stands but overall, suitable habitat will continue to exist across the landscape. Through single tree and group selection, regeneration of a spruce understory is likely to occur which will improve long-term habitat conditions for marten.
	Between 40-90%	• Remove all dead and dying spruce-fir in areas where adequate seed source exists. • Group selection where mortality is patchy. • Clear cut where mortality is extensive. • Create small openings in areas where <40% mortality occurs. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness". • May require mechanical site prep.	Suitable habitat for marten may be degraded or lost as the level of sanitation and salvage treatments increase with increasing overstory mortality. The use of single tree and group selections in stands with relatively low overstory mortality will result in a slight decrease in canopy cover, stand density, coarse woody debris and snags. This may degrade both denning and foraging habitat. As the level of salvage increases with increasing overstory mortality, marten habitat in treated stands will experience increasing levels of impact. Design features will help retain denning and foraging habitat and habitat connectivity for marten across the broader landscape.
	>90%	• Remove all dead and dying spruce-fir where there is no adequate natural seed source. • Clear cut where mortality is extensive. • May require mechanical site prep.	These stands provide low quality to marginal habitat and treatment activities will further reduce the quality of habitat. Canopy cover, stand density, and coarse woody debris will decrease in treated stands. Due to the lack of an understory and incidental loss of the understory where it does occur, habitat will be lacking in treated stands. These stands will no longer support suitable habitat and it will take many years (decades) for suitable habitat to regenerate even with planting activities. Design features will help retain some denning and foraging habitat and habitat connectivity for marten across the broader landscape where understory components and down wood exists to support marten.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Martens
Two Storied	<40% and ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Stands currently provide suitable habitat for martens. Treatments will result in open pockets within stands and stand density and canopy cover will decrease in these areas. Stands will continue to provide suitable habitat across the landscape. The availability of forage may change, but mainly in distribution with group selection treatments due to incidental reduction in understory vegetation in these patches. Through single tree and group selection, regeneration of a spruce understory is likely to occur which will improve long-term habitat conditions for marten.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Remove dead and dying spruce-fir.	Treatments will alter habitat conditions with open pockets occurring in stands as a result of group selection tree removal. Canopy cover, stand density and snags will decrease in these patches, but overall, suitable habitat will remain. Foraging habitat is not high quality due to the low percent of DHC currently in the stands. Treatments may further degrade habitat for marten prey with incidental loss of understory vegetation and decrease in coarse woody debris. Design features for coarse woody debris and snag retention will retain some habitat features maintaining these habitat components in stands after treatments. Through single tree and group selection, regeneration of a spruce understory is likely to occur which will improve long-term habitat conditions for marten.
	Between 40-90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”.	Suitable habitat for marten may be degraded or lost as the level of sanitation and salvage treatments increase with increasing overstory mortality. The use of single tree and group selections in stands with relatively low overstory mortality will result in a slight decrease in canopy cover, stand density, coarse woody debris and snags. This may degrade both denning and foraging habitat. As the level of salvage increases with increasing overstory mortality, marten habitat in treated stands will experience increasing levels of impact. Design features will help retain denning and foraging habitat and habitat connectivity for marten across the broader landscape.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Martens
Two Storied	Between 40% and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Habitat for martens in these stands would already be low to marginal quality due to a lack of understory cover and structural diversity and may be further degraded or lost as a result of treatment activities. As the level of sanitation and salvage treatments increase with increasing overstory mortality marten habitat in treated stands will experience increasing levels of impact. The use of single tree and group selections in stands with relatively low overstory mortality will result in a slight decrease in canopy cover, stand density, coarse woody debris and snags. This may degrade both denning and foraging habitat. As the level of salvage increases with increasing overstory mortality, marten habitat in treated stands will experience increasing levels of impact. Design features will help avoid or minimize these impacts and maintain important habitat components for marten.
	>90% and ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• Stand no longer two storied due to dead overstory. • Salvage of dead and dying spruce-fir.	Where dead stands contain >35% DHC, habitat is likely to support martens. Where dead stands contain no understory and there are no live trees, they are unlikely to support suitable habitat for martens because of the amount of mortality in the stand. This is likely to affect prey species availability for martens (red squirrel populations are likely to be severely reduced due to lack of cone-producing trees which is a food source for squirrels). Canopy cover, stand density, and coarse woody debris will decrease in treated stands. Due to the lack of an understory and incidental loss of the understory where it does occur, habitat will be lacking in treated stands. These stands will no longer support suitable habitat and it will take years (decades) for suitable habitat to regenerate even with planting activities. Design features will help retain habitat connectivity and some denning and foraging habitat for marten across the broader landscape where understory components and down wood exists to support marten.

Stand Condition	Overstory Mortality Level	Treatment	Effects to Martens
Multiple Canopies	<40% ≥35% DHC and advanced regeneration above mean snow depth	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Treatments will slightly alter habitat conditions for martens and will result in open pockets within stands. Stand density will slightly decrease in some areas, but they will continue to provide suitable habitat across the landscape especially in areas where more than one story remains. Habitat for marten prey will also be affected in patches, but populations are not expected to result in any significant change. Through single tree and group selection, regeneration of a spruce understory is likely to occur which will improve long-term habitat conditions for marten.
	<40% and <35%DHC	• Individual tree selection or group selection in 0.25 to 2 acre openings. • Removal focused on pockets of dead and dying spruce-fir.	Treatments will slightly alter habitat conditions. Open pockets will occur as a result of treatments in stands and stand density will slightly decrease. Habitat for marten prey is moderate quality with the low percent of DHC in the stands. Treatments may degrade DHC and decrease coarse woody debris which will affect small mammal habitat. However existing DHC will be retained as much as possible and a design feature will maintain coarse woody debris levels minimizing habitat loss for marten prey. Prey is expected to remain available in stands. There will be a decrease in canopy cover and stand density but some areas may still maintain more than one story. Snags will also be retained at 90-225 per 100 acres. Patches of habitat may be degraded with the group selection prescription. Through single tree and group selection, regeneration of a spruce understory is likely to occur which will improve long-term habitat conditions for marten.
	Between 40 and 90% and ≥35% DHC and advanced regeneration above mean snow depth	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind “firmness”.	Suitable habitat for marten may be degraded or lost as the level of sanitation and salvage treatments increase with increasing overstory mortality. The use of single tree and group selections in stands with relatively low overstory mortality will result in a slight decrease in canopy cover, stand density, coarse woody debris and snags. This may degrade both denning and foraging habitat. Habitat for marten prey may also be lost or degraded resulting in a decrease in prey availability As the level of salvage increases with increasing overstory mortality, marten habitat in treated stands may experience increasing levels of impact. Design features should retain habitat

Stand Condition	Overstory Mortality Level	Treatment	Effects to Martens
			connectivity and denning and foraging habitat for marten across the broader landscape.
Multiple Canopies	Between 40 and 90% and <35%DHC	• Salvage of dead and dying. • Follow uneven aged management prescriptions in areas where mortality is lower. • Remove live trees that pose a blow down risk. • Maximum removal is 40% of present stocking within residual stand to maintain wind "firmness".	Habitat for marten is low to moderate quality and may be degraded or lost as a result of treatment activities. Salvage treatments will remove canopy cover and stand density while other prescriptions will decrease these elements. All activities will lower the amount of coarse woody debris in stands which may degrade habitat for marten prey and may limit marten access to the subnivean layer during winter, thus reducing prey availability. Design features will minimize effects to coarse woody debris levels and impacts to DHC will be avoided where possible which will maintain some prey habitat and maintain habitat connections for marten. Marten individuals will be affected with changes in distribution and abundance of prey in stands.
	>90% ≥35% DHC and advanced regeneration above mean snow depth or >90% and <35%DHC	• If two canopies still alive, it is a multi-storied stand. • Salvage of dead and dying.	These stands are unlikely to support suitable habitat for martens, likely due to reduced prey (red squirrel populations are likely to be severely reduced due to lack of cone-producing trees which is a food source for squirrels). In cases where more than one story remains, habitat would be marginal quality because of the amount of mortality but would still provide habitat connections and support some prey species for marten (snowshoe hare, voles, birds). Canopy cover and stand density would already be absent or low and highly degraded. Habitat for marten prey may still occur if there is a developed understory that can provide food, cover, and shelter, thus prey may still remain after treatments. However, treatments may degrade any denning habitat in treatment units and it is expected only patches of marginal habitat would remain and would not support martens in the immediate future. Design features will help retain suitable denning and foraging habitat for marten across the broader landscape.

Treatments that reduce overstory forest cover and course woody debris in spruce-fir forests negatively impacts species such as marten that are specialists for mature or old growth interior forest conditions. Studies have shown that martens largely avoid burned over areas due to the lack of overstory cover and course woody debris on the ground (USDA 2005). These effects would similarly occur under the commercial and non-commercial treatment scenarios proposed under SBEADMR, with salvage harvest being the most impactful to the American marten. Design features to protect and promote multi-storied spruce-fir forests, protect live trees, promote habitat connectivity, and retain snag and course woody debris will help avoid or lessen these negative effects. Resiliency treatments would negatively affect the marten in the short-term, but could have beneficial effects to habitat in the long-term if they are successful in increasing vegetation composition and structural diversity.

Alternative 3, WUI Focus

Direct and Indirect

Effects for all terrestrial sensitive species analyzed will be the same as described for the Agency Preferred Alternative, except that alternative 3 will affect fewer acres, with activities and affects largely within the WUI areas. Although alternative 3 has fewer PTA acres for treatment, the maximum amount of acres treated annually and over the life of the project is the same. Treatments would be limited to the WUI and alongside roads (public safety areas), and therefore the extent of potential treatment impacts across the landscape would be more concentrated than and not as widespread as Alternative 2. There are fewer miles of road construction associated with implementing this alternative. With fewer constructed roads, there would be less associated direct loss of habitat and fewer direct disturbances to wildlife when compared to Alternative 2. Treatments would be focused in the WUI to protect adjacent communities and developed areas. Species may inhabit these areas, but likely at lower densities due to existing disturbances associated with roads and other types of infrastructure, and more concentrated human activity. Generally, salvage treatments would have negative effects to species analyzed as described in alternative 2. Resiliency treatments may have short-term negative effects but may benefit multiple species in the long-term. Resiliency treatments however will not be as widespread as in Alternative 2. Alternative 3 will include a lower amount of acres to be treated and fewer miles of temporary roads compared to Alternative 2. Therefore, Alternative 3 is likely to be less impactful to species analyzed in this document. Since there will be fewer acres affected across the landscape, there will be more snags and course woody debris and less incidental effects to live vegetation.

Colorado River Cutthroat Trout

Direct and Indirect

A detailed description of the biology, ecology, and status of Colorado River cutthroat trout on the GMUG is available on the internet at:
http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199668.
We identified CRCT populations that could be affected by SBEADMR's Alternatives 2 and 3. The populations listed below either occur in areas slated for treatment or have priority treatment areas in at least 20 percent of their contributing watershed. There are one known Conservation Populations in priority treatment areas located in East Fork Big Creek located in the Grand Mesa GA. With respect to population size and density, the population in East Fork is not particularly large. There are a several potential direct effects of forest management activities on fishes and aquatic stream habitat. These include mortality due to the operation of equipment in stream channels during placement of culverts or low water-fords during road construction and potential fragmentation of stream habitat from road-stream crossing if not properly installed to allow organism passage. Potential indirect effects to streams of forest management practices in a watershed include erosion from roads and timber harvest in the riparian area or on surrounding hillslopes, as well as increased stream temperature due to harvest of riparian vegetation.

Design features incumbent to the SBEADMR project preclude harvest-related activities in and very near to stream channels except when installing stream crossings. Therefore, impacts to CRCT from the effects described above will be minimized as SBEADMR is implemented. Table 305 defines potential effects and lists specific design features that minimizes or avoids potential effects.

Table 305. SBEADMR Design Features for Stream Habitat and Resident Aquatic Populations.

Effect	Design Feature(s)	Comments
Direct mortality of CRCT	WQSP-2A	See Section 10
Habitat destruction	WQSP-2A	See Section 10
Stream network fragmentation	WQSP-3A; WQSA-3B; WQSP-8A(B)	WQSP-3A states that aquatic biologists will participate in the design of road-stream crossings. WQSP-3B states temporary crossings will be removed from streams upon completion.
Erosion from surrounding watershed	TSHR-1; TSHR-2; WQSP-5A; WQSP-6; WQSP-7A; WQSP-8B; MNTG-1	At least one member of the Aquatics Team will participate in the planning and implementation of project-level harvest activities.
Increased stream temperature from riparian harvest	WQSP-2A; MNTG-1	The Aquatics Team has the ability to perform long-term stream temperature monitoring to quantify the effect (if any) of harvest near streams on stream temperature.
Additive erosion in watersheds with existing dense road network	TSHR-1; WQSP-6; WQSP-7A; WQSP-8A; WQSP-8B; MNTG-1	At least one member of the Aquatics Team will participate in the planning and implementation of project-level harvest
Additive stream temperature increase due to riparian harvest and climate change	WQSP-2A	See below
Spread of Amphibian Chytrid Fungus	WFRP - 24	At least one member of the Aquatics Team will participate in the planning and implementation of project-level operations
Mortality of Boreal Toad and Reduction of Hibernaculum Habitat	WFRP - 25; WFRP - 26	Timing limitation for ground based activities in areas within 1.6 miles of documented breeding ponds limited between July thru October.

Cumulative Effects

Cumulative effects that could be manifested as SBEADMR is implemented include additive sedimentation from new roads and harvest activities that occur in watersheds with existing road networks, additive fragmentation of stream networks by improperly designed road-stream crossings. Since riparian vegetation will not be affected due to adherence to defined buffers (Water Influence Zone), stream temperature increases that could occur because of impacts to riparian vegetation will not occur. Climate change may continue to influence stream temperatures across the GMUG which may render some streams less suitable to support cutthroat in the future.

Boreal Toad

Direct and Indirect

There are a several potential direct effects of forest management activities on amphibians and aquatic stream habitat. These include mortality due to the operation of equipment in or around stream channels when installing stream crossings and fragmentation of stream habitat due

improper installation of a road-stream crossing that prevents organism passage. Additionally, because Boreal Toad has such a wide home range relative to its size, foraging in upland areas, direct mortality could be caused by ground based vegetative management activities. Only two watersheds having PTA supporting boreal toad breeding ponds (Cement Creek near Crested Butte and Buzzard Creek on the Grand Mesa). These include noncommercial activities such as mastication and fuels reduction.

Transport and use of logging equipment (both commercial and non-commercial) between hydrologic catchments could result in the spread of the amphibian chytrid fungus. Furthermore, movement and operation of vegetative management equipment can reduce or destroy hibernation locations by crushing woody debris and soil compaction.

The use of design features WFRP-24, WFRP-25 and WFRP-26 will avoid or minimize potential effects to boreal toad.

Cumulative Effects

Cumulative effects that could be manifested as SBEADMR is implemented include additive sedimentation from new roads and harvest activities that occur in watersheds with existing road networks, additive fragmentation of stream networks by improperly designed road-stream crossings. Since riparian vegetation will not be affected due to adherence to defined buffers (Water Influence Zone), stream temperature increases that could occur because of impacts to riparian vegetation will not occur.

Northern Leopard Frogs

Direct and Indirect

Although a USFS Region 2 Sensitive Species, unlike the Boreal Toad, the leopard frog is only classified by CPW as a Species of Concern. As such CPW has not conducted extensive presence and local distribution data for Northern Leopard Frog. Therefore presence of specific populations of NLF within project areas is yet to be determined. Analysis and design criteria discussed below take into consideration the possible presence of Northern Leopard Frog.

There are a several potential direct effects of forest management activities on amphibians and aquatic stream habitat. These include mortality due to the operation of equipment in or around stream channels when installing stream crossings and fragmentation of stream habitat due improper installation of a road-stream crossing that prevents organism passage.

Cumulative Effects

Cumulative effects that could be manifested as SBEADMR is implemented include additive sedimentation from new roads and harvest activities that occur in watersheds with existing road networks, additive fragmentation of stream networks by improperly designed road-stream crossings. Since riparian vegetation will not be affected due to adherence to defined buffers

(Water Influence Zone), stream temperature increases that could occur because of impacts to riparian vegetation will not occur.

Management Indicator Species

A detailed description of the biology, ecology, and status of terrestrial and aquatic species (Common Trout) classified as Management Indicator Species on the GMUG is available on the internet at:
http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199668.

Species or Species Groups Identification

This section analyzes impacts and describes how the action alternatives are consistent with Forest Plan direction as it relates to management indicator species. Management Indicator Species (MIS) for the GMUG National Forests are identified in the Forest Plan on Table II-15 and II-16, pages II-42 and II-43. A MIS Forest Plan Amendment in 2005 reduced the number of MIS from 17 to 12 (http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199918). The GMUG National Forests completed Management Indicator Species Assessments for all twelve MIS identified in the MIS Forest Plan Amendment (May 2005) and can be found at:

- http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199668

Up-dated assessments for common trout and cutthroat trout are provided at:

- http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199668
- http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199668

These Forest-wide assessments include the rationale for the selection of MIS, information on biology, occurrence and distribution, habitat relationships, suitable habitat on the GMUG, monitoring results, available information on population trend and source references. This SBEADMR MIS assessment tiers to the Forest-wide assessments. Table 306 displays the Forest list of MIS and their relationship to the SBEADMR Project Area.
MIS potentially affected by the no action and the two action alternatives include: Rocky Mountain Elk, Northern goshawk, American Marten, Red-naped sapsucker and common trout since the terrestrial species all use spruce and/or aspen habitat types during some period of their life history and the common trout occur in many perennial streams throughout the action area.

Table 306. Management Indicator Species (MIS) in the SBEADMR Project Area.

GMUG National Forests MIS Species List			
Common Name	**Scientific Name**	**Habitat Association**	**Habitat or species Present Within the Project Analysis Area?**
Rocky Mountain elk	*Cervus elephus*	Early succession spruce-fir, Douglas-fir, lodgepole, aspen, mountain shrub. Also MIS for travel mgmt.	Y
Abert's squirrel	*Sciurus aberti*	Late-succession ponderosa pine	N
American marten	*Martes Americana*	Late-succession spruce-fir, lodgepole pine	Y
Northern goshawk	*Accipiter gentillis*	Late-succession aspen and mixed conifer	Y
Red-naped sapsucker	*Sphyrapicus nuchalis*	Pure Aspen	Y
Merriam's turkey	*Meleagris gallopavo*	Gamble oak, ponderosa pine, and Pinion-Juniper	N
Colorado river cutthroat trout	*Oncorhynchus clarki pleuriticus*	Aquatic and riparian habitats	Y
Rainbow trout	*Oncorhynchus mykiss*	Aquatic and riparian habitats	Y
Brown trout	*Oncorhynchus trutta*	Aquatic and riparian habitats	Y
Brook trout	*Salvelinus fontinalis*	Aquatic and riparian habitats	Y

Common Trout

Direct, Indirect and Cumulative Effects of Alternatives 2 and 3

As demonstrated in the Species Assessment, populations of Common Trout on the Grand Mesa, Uncompahgre, and Gunnison National Forests are widely distributed, abundant with multiple age classes represented. While timber harvest and non-commercial and prescribed fire associated with the SBEADMR project may occur near fish-bearing streams, design criteria included in the SBEADMR project will minimize the possibility of stream reach, population, or watershed-scale effects to these species. Forest Plan standards, guidelines and objectives for Common Trout will continue to be met.

Rocky Mountain Elk

Direct, Indirect and Cumulative Effects of Alternatives 2 and 3

Direct effects to elk include noise and audible disturbances from equipment and the presence of personnel for all treatment types, causing a temporary displacement of elk from treatment areas. Smoke associated with prescribed fire treatments may also displace elk.

All action alternatives will affect summer and fall habitat and areas used in transition during spring and fall as a result of changes in the structure and composition of vegetation. In forested areas, treatments will remove trees which will reduce the amount of thermal and hiding cover, and in some cases browse (due to aspen coppice treatments) available for elk. Forage may increase in treatment areas due to the understory being released as a result of reductions in overstory cover. Resiliency and prescribed fire treatments under Alternatives 2 and 3 may also improve habitat conditions if treatments are successful in restoring and improving resiliency of spruce fir stands against future bark beetle infestations, promoting regeneration in both aspen and spruce-fir stands, and increasing forage quality and quantity. Prescribed fire treatments will temporarily decrease the amount of forage available (perhaps for one or two growing seasons), however over time, we anticipate that forage quality and quantity will improve as grasses and shrubs sprout in response to fire activities.

Alternatives 2 and 3 are not likely to negatively affect population trends of Rocky Mountain elk. The action alternatives may affect elk distribution throughout treatment areas during project implementation. Changes in habitat that affect forage and thermal or hiding cover will also influence how elk use the landscape. Alternative 2 and 3 differ in the spatial extent of treatments and the focus of treatments (outside or inside WUI; prescribed fire and mechanical treatments, resiliency, or salvage). New temporary road construction under Alternative 2 is greater than Alternative 3; as such Alternative 2 will have greater impacts on elk distribution due to increased human disturbances along roads. Use of haul routes for winter logging activities has the potential to displace elk from winter concentration areas. Depending on winter severity, range conditions and animal health going into winter, this could result in adverse impacts to individuals in terms of increased stress that could contribute to mortality. Table 307 identifies haul routes for Alternatives 2 and 3 that go through areas currently identified by Colorado Parks and Wildlife as

winter concentration areas. Map G-68 (Appendix G) identifies the overlap of haul routes with winter concentration areas. Design feature WFRP-15 (Appendix B), a timing restriction, will help to avoid or minimize impacts to big game on winter range.

Table 307. Length (Miles) of Haul Routes within Elk Winter Concentration Areas (as Mapped by Colorado Parks and Wildlife Species Activity Mapping Data).

Geographic Area	Haul Route ID	System Road/Jurisdiction				Grand Total
		COUNTY	NATIONAL FOREST SYSTEM ROAD	STATE HIGHWAY	US HIGHWAY	
Grand Mesa	121.0		3.54			3.54
	DELCO-SURFACE CREEK	1.78				1.78
	MESCO-64.6	2.44				2.44
	SH 65			3.45		3.45
	Total	**4.22**	**3.54**	**3.45**		**11.20**
Gunnison Basin North	7723.0		5.19			5.19
	7724.0		4.26			4.26
	7726.0	1.82	8.61			10.44
	7742.0	1.88				1.88
	SH 135			7.68		7.68
	SH 149			0.01		0.01
	US 50				11.09	11.09
	Total	**3.71**	**18.06**	**7.69**	**11.09**	**40.55**
Gunnison Basin South	SH 149			6.05		6.05
	US 50				1.43	1.43
	Total			**6.05**	**1.43**	**7.48**
North Fork Valley	265.0	0.53				0.53
	701.0	1.85				1.85
	851.0		1.84			1.84
	851.1B		1.53			1.53
	SH 133			18.05		18.05
	SH 92			1.19		1.19
	Total	**2.38**	**3.37**	**19.24**		**24.99**
San Juans	864.0		0.19			0.19
	SH 62			3.31		3.31
	SNMGCO-57P	0.09				0.09
	US 50				5.32	5.32
	US 550				11.02	11.02
	Total	**0.09**	**0.19**	**3.31**	**16.34**	**19.93**

Geographic Area	Haul Route ID	System Road/Jurisdiction				Grand Total
		COUNTY	NATIONAL FOREST SYSTEM ROAD	STATE HIGHWAY	US HIGHWAY	
Uncompahgre Plateau	503.0	5.58	0.00			5.58
	536.0		1.28			1.28
	540.0	0.37				0.37
	SH 141			13.78		13.78
	US 550				4.09	4.09
	Total	**5.95**	**1.28**	**13.78**	**4.09**	**25.10**
	Grand Total	**16.35**	**26.44**	**53.53**	**32.94**	**129.26**

The action alternatives are expected to treat the same amount of acres both annually and over the life of the project, with Alternative 3 concentrated in the WUI and Alternative 2 more widespread on the Forest. With Alternative 2 affecting a larger spatial extent, we anticipate Alternative 2 to directly and indirectly affect more habitat than Alternative 3 (Table 308 and Table 309).

Table 308. Activities Proposed Under Alternative 2 - Overlap with Elk Foraging and Cover Habitat (Acres) within each Geographic Area.

Geographic Area	Elk Habitat ?	Hazard Trees Total	New Roads Total	Priority Treatment Area (PTA)					PTA Total	Grand Total
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Not Elk Habitat	0.80	3.43	1,023.94	10.28	1.15	3.74	0.08	1,039.19	1,043.42
	Elk Habitat	1,074.42	15.39	20,896.48	1,434.31	8,807.03	6,159.58	485.46	37,782.85	38,872.66
	Total	**1,075.22**	**18.82**	**21,920.42**	**1,444.59**	**8,808.17**	**6,163.32**	**485.54**	**38,822.04**	**39,916.08**
Gunnison Basin North	Not Elk Habitat	0.62	12.18	1,634.22			4.44		1,638.66	1,651.46
	Elk Habitat	3,695.17	36.93	46,751.36		6,897.30	6,658.59	1,824.98	62,132.22	65,864.32
	Total	**3,695.79**	**49.11**	**48,385.57**		**6,897.30**	**6,663.03**	**1,824.98**	**63,770.88**	**67,515.79**
Gunnison Basin South	Not Elk Habitat	17.84	2.97	714.16		1.61	5.00	1.46	722.23	743.05
	Elk Habitat	4,775.93	41.04	17,785.72		11,332.88	4,413.93	12,059.93	45,592.47	50,409.44
	Total	**4,793.78**	**44.01**	**18,499.88**		**11,334.49**	**4,418.93**	**12,061.39**	**46,314.70**	**51,152.49**
North Fork Valley	Not Elk Habitat	6.00	1.66	525.44	4.32		12.65		542.40	550.07
	Elk Habitat	2,251.59	23.38	11,699.07	915.66	3,356.33	5,011.87	544.35	21,527.28	23,802.26
	Total	**2,257.60**	**25.05**	**12,224.51**	**919.97**	**3,356.33**	**5,024.52**	**544.35**	**22,069.69**	**24,352.33**

Geographic Area	Elk Habitat ?	Hazard Trees Total	New Roads Total	Priority Treatment Area (PTA)					PTA Total	Grand Total
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
San Juans	Not Elk Habitat	2.21	9.30	50.93		1.27	9.60	0.01	61.81	73.31
	Elk Habitat	2,020.67	32.77	378.89		7,771.26	2,585.33	1,830.25	12,565.72	14,619.15
	Total	**2,022.87**	**42.07**	**429.81**		**7,772.53**	**2,594.93**	**1,830.25**	**12,627.52**	**14,692.47**
Uncompahgre Plateau	Not Elk Habitat	14.14	0.92	2,261.22		8.46	85.68	5.23	2,360.59	2,375.65
	Elk Habitat	3,527.57	33.45	38,969.28		14,988.39	17,548.62	351.72	71,858.01	75,419.03
	Total	**3,541.71**	**34.37**	**41,230.51**		**14,996.85**	**17,634.30**	**356.94**	**74,218.60**	**77,794.68**
	Grand Total	**17,386.98**	**213.43**	**142,690.71**	**2,364.57**	**53,165.67**	**42,499.03**	**17,103.46**	**257,823.43**	**275,423.84**

Table 309. Activities Proposed Under Alternative 3 - Overlap with Elk Foraging and Cover Habitat (Acres) within each Geographic Area

Geographic Area	Elk Habitat ?	Hazard Trees Total	New Roads Total	Priority Treatment Area (PTA)					PTA Total	Grand Total
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Not Elk Habitat	0.90	2.86	747.28	10.28	0.52	1.17		759.24	763.01
	Elk Habitat	1,515.45	25.28	16,562.67	1,434.31	5,282.66	3,603.46	376.13	27,259.22	28,799.96
	Total	**1,516.36**	**28.14**	**17,309.94**	**1,444.59**	**5,283.17**	**3,604.63**	**376.13**	**28,018.47**	**29,562.97**
Gunnison Basin North	Not Elk Habitat	0.62	0.25	966.22			1.36		967.58	968.45
	Elk Habitat	5,240.15	31.39	34,614.78		1,729.93	1,867.04	729.50	38,941.27	44,212.80
	Total	**5,240.77**	**31.64**	**35,581.00**		**1,729.93**	**1,868.41**	**729.50**	**39,908.85**	**45,181.26**
Gunnison Basin South	Not Elk Habitat	19.91	0.76	502.36		0.64	0.04	0.12	503.15	523.82
	Elk Habitat	7,392.76	18.71	6,788.50		1,636.75	999.27	1,258.92	10,683.45	18,094.92
	Total	**7,412.67**	**19.47**	**7,290.86**		**1,637.38**	**999.31**	**1,259.05**	**11,186.60**	**18,618.74**
North Fork Valley	Not Elk Habitat	21.34	1.66	300.49	4.26		12.65		317.39	340.39
	Elk Habitat	2,795.07	18.65	9,176.35	893.08	1,761.47	4,280.64	55.96	16,167.51	18,981.23
	Total	**2,816.42**	**20.31**	**9,476.84**	**897.34**	**1,761.47**	**4,293.28**	**55.96**	**16,484.89**	**19,321.62**

Geographic Area	Elk Habitat ?	Hazard Trees Total	New Roads Total	Priority Treatment Area (PTA)					PTA Total	Grand Total
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
San Juans	Not Elk Habitat	2.88		50.93		1.24	6.53	0.00	58.70	61.58
	Elk Habitat	2,513.04	22.16	378.89		3,135.64	1,069.20	651.80	5,235.53	7,770.73
	Total	**2,515.92**	**22.16**	**429.81**		**3,136.89**	**1,075.72**	**651.80**	**5,294.23**	**7,832.31**
Uncompahgre Plateau	Not Elk Habitat	26.58	0.90	1,921.76		0.35	4.99		1,927.11	1,954.58
	Elk Habitat	5,165.19	32.44	31,480.81		8,765.48	7,880.51	217.88	48,344.69	53,542.31
	Total	**5,191.77**	**33.34**	**33,402.58**		**8,765.83**	**7,885.51**	**217.88**	**50,271.79**	**55,496.90**
	Grand Total	**24,693.90**	**155.06**	**103,491.03**	**2,341.93**	**22,314.68**	**19,726.86**	**3,290.33**	**151,164.83**	**176,013.80**

Colorado Parks and Wildlife Species Activity Mapping identifies elk production (calving) areas. There is overlap of production areas with proposed treatment areas. However, elk are not limited to calving in the mapped production areas and calving could occur nearly anywhere in suitable elk habitat ranging from low elevation sagebrush or meadow areas with adequate cover to high elevation alpine. Design feature WFRP-6 (Appendix B) will avoid impacts to elk in known calving areas. Colorado Parks and Wildlife mapped production areas will be used to help prioritize and identify key areas that may provide high quality calving areas where this design feature may need to be applied. Map G-65 identifies the overlap of mapped production areas with treatment areas.

Direct and indirect effects would most likely result in temporary displacement or cause shifts in elk behavioral patterns and habitat use. This displacement is expected to be short term with elk use returning to the same level or possibly greater level in treatment areas due to an increase in forage quality and quantity. There will be minor increases in temporary road density; fewer disturbances would occur in Alternative 3 due to fewer miles of roads utilized compared to Alternative 2. Commercial treatments, particularly hazard tree removal along roads, will reduce cover for elk. Design feature WFRP-5 (Appendix B) is intended to ensure that adequate cover is maintained.

SBEADMR Habitat Effectiveness Results

Summary

In accordance with Forest Plan requirements, a baseline habitat effectiveness (HE) as influenced by road densities was analyzed in all 6th order watersheds in which commercial activities are planned. HE was also calculated for the difference in road densities resulting from Alternative 2 and Alternative 3.

All of the habitat effectiveness calculations for the 6th order watersheds were found to be in compliance with the forest standard of 40 percent. HE was then analyzed per management area within their respective watershed; several areas were identified which did not meet the HE standards described in the Forest Plan. HE is designed to measure habitat quality for big game species.

Habitat Effectiveness By Management Area

Management areas which had a HE standard, per the Forest Plan (1991) were first identified. These included: 3A Semi-primitive non-motorized recreation experience, 4B optimize habitat capability for all management indicator species, 4D aspen management, 5A optimize habitat capability for big game on non-forested winter-range, and 5B optimize habitat capability for big game on forested winter-range. Only management areas which fell within the affected commercial 6th order watersheds and those which had new road proposals were analyzed. Management areas 3A, 5A, and 5B were excluded from analysis as these either did not fall within the affected watersheds and/or there were no new road proposals (Alt 2 and Alt3) that would affect them. Forest Plan Standards for the 4B and 4D management areas include the following:

- 4B - Work towards a maximum level of 80 percent habitat effectiveness for elk.
- 4D - Work toward a minimum level of 60 percent habitat effectiveness for elk.

Habitat effectiveness values were then calculated and evaluated for the 4B and 4D management areas by watershed for the baseline, Alternative 2, and Alternative 3. All watersheds analyzed currently meet Forest Plan Standards and continued to meet the standards in the action alternatives, with the exception of those noted in the following tables. Eight watersheds do not meet the Forest Plan Standards for Management Area 4D or 4B (Table 310). Upper Roubideau Creek does not currently meet HE for either 4D or 4B. Table 310 through Table 312 compare the baseline to Alternatives 2 and 3. Considering the maximum proposed roads for Alternative 2, HE for each of these watersheds is slightly decreased. One additional watershed, Upper Spring Creek, would drop below the 60% threshold established in the Forest Plan for MA 4D, and another – Headwaters Naturita Creek – would drop below the 80% threshold established for MA 4B. Considering the maximum proposed roads for Alternative 3, the effects are similar but impact HE to a lesser degree. Maps G-70 and G-71 (Appendix G) compare the baseline with Alternatives 2 and 3, identifying the watersheds where Forest Plan Standards for habitat effectiveness are not met.

However, under both action alternatives, all of the newly constructed roads would be temporary, likely existing for less than seven years prior to being decommissioned. Furthermore, as HE is a measure of open road density, and none of these roads would be open to the public, this is an overestimate of the potential impact.

Table 310. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data.

Watershed ID	Watershed Name	Management Area	Acres Affected	Weighted Road Density*	Habitat Effectiveness
140200050305	Dry Fork Escalante Creek	4D >60% HE	104.53	3.0642	38
140200050204	Cottonwood Creek	4D >60% HE	137.338	3.1285	38
140200050201	Upper Roubideau Creek	4D >60% HE	4,327.99	1.1224	57
140300030302	Headwaters Beaver Creek	4B >80% HE	1137.862	0.8394	64
140300030202	Middle Horsefly Creek	4B >80% HE	452.138	1.8402	50
140200060501	Headwaters Dry Creek	4B >80% HE	2598.522	1.1578	57
140200050201	Upper Roubideau Creek	4B >80% HE	3420.993	1.4649	54
140200040406	Terror Creek	4B >80% HE	5413.661	0.7182	68

Table 311. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data in combination with Alternative 2.

Watershed ID	Watershed Name	Management Area	Acres Affected	Weighted Road Density*	Habitat Effectiveness %
140200050305	Dry Fork Escalante Creek	4D >60% HE	104.53	3.2112	37
140200050204	Cottonwood Creek	4D >60% HE	137.338	3.2326	37
140200050201	Upper Roubideau Creek	4D >60% HE	4,327.99	1.163	57
140200060601	Upper Spring Creek[1]	4D >60% HE	2520.609	1.0652	59
140300030401	Headwaters Naturita Creek[1]	4B >80% HE	893	0.4297	78
140300030302	Headwaters Beaver Creek	4B >80% HE	1137.862	0.9006	63
140300030202	Middle Horsefly Creek	4B >80% HE	452.138	1.8581	50
140200060501	Headwaters Dry Creek	4B >80% HE	2598.522	1.1925	57
140200050201	Upper Roubideau Creek	4B >80% HE	3420.993	1.4753	54
140200040406	Terror Creek	4B >80% HE	5413.661	0.7269	68

[1]The 4D and 4B Management Areas within these two watersheds met Forest Plan Standards under the existing condition, but Alternative 2 would reduce habitat effectiveness values slightly below Standards by 1.6% in the 4D Management Area, and by 2.5% in the 4B Management Area.
The remaining watersheds in this table contain Management Areas that already did not meet Forest Plan Standards in the existing baseline.

Table 312. Watersheds which overlap a Management Area not meeting Forest Plan Standards for habitat effectiveness, baseline data in combination with Alternative 3.

Watershed ID	Watershed Name	Management Area	Acres Affected	Weighted Road Density*	Habitat Effectiveness
140200050305	Dry Fork Escalante Creek	4D >60% HE	104.53	3.0642	38
140200050204	Cottonwood Creek	4D >60% HE	137.338	3.1285	38
140200050201	Upper Roubideau Creek	4D >60% HE	4,327.99	1.1224	57
140200060601	**Upper Spring Creek[1]**	4D >60% HE	2520.609	1.0652	59

Watershed ID	Watershed Name	Management Area	Acres Affected	Weighted Road Density*	Habitat Effectiveness
140300030401	Headwaters Naturita Creek	4B >80% HE	893	0.3877	80
140300030302	Headwaters Beaver Creek	4B >80% HE	1137.862	0.8394	64
140300030202	Middle Horsefly Creek	4B >80% HE	452.138	1.8402	50
140200060501	Headwaters Dry Creek	4B >80% HE	2598.522	1.1898	57
140200050201	Upper Roubideau Creek	4B >80% HE	3420.993	1.4649	54
140200040406	Terror Creek	4B >80% HE	5413.661	0.7242	68

[1]The 4D Management Area in the Upper Spring Creek watershed met Forest Plan Standards under the existing condition, but Alternative 3 would reduce habitat effectiveness values slightly below Standards by 1.6%.

This watershed failed Forest Plan Standards for Alternative 2, but would meet habitat capability requirements for Alternative 3.

The remaining watersheds in this table contain Management Areas that already did not meet Forest Plan Standards in the existing baseline.

*

Road Density = road mileage / (acreage of analysis area/640) = miles of roads/square mile

Weighted Road Density = road density X WRD co-efficient

Habitat Effectiveness is related to weighted road density WRD (WRD is called average adjusted miles of open roads/trails in the Forest Plan) (see pg III-77 Forest Plan 1991)

Coefficients are outlined in the Forest Plan (III-77) and are based on the Road Type

Road Types	Coefficient
Primary	1.0
Secondary	0.7
Primitive	0.05
None (CLOSED)	0.7

Temporary Roads proposed for Alternative 2 and Alternative 3 were considered as primitive
Roads fall into their respective type based on the Maintenance Level for roads and the Allowed Terra Use for trails

Road Type	Maintenance Level
Primary	3-5
Secondary	1-2 (Includes Jeep Trails and non-system roads)
Primitive	Motorized Trails (ATV and Motorcycle)
None (CLOSED)	Non-System**

**I considered non-system roads as secondary roads due to the fact that it is likely full-sized vehicles that are using them

Cumulative Effects

In terms of affected acres, cumulative effects are expected to be similar for both action alternatives since the maximum total acres that could be treated is the same (maximum 120,000 acres), although they differ in their spatial distribution on the landscape. There is approximately 2,812,400 acres of habitat supporting elk on the GMUG through their various seasonal life history periods. Of this amount, potentially affected areas include 268,987 acres (9.5 percent) under Alternative 2 and 171,402 acres (6.1 percent) under alternative 3 as shown above. Maximum treatment areas under both action alternatives are 60,000 acres commercial mechanical and 60,000 acres non-commercial mechanical and prescribed fire. This is approximately 4 percent of the total elk habitat on the GMUG. Treatments in aspen are designed

to increase stand resiliency which has been found successful in stands with less than 50 percent overstory mortality (Shepperd et al 2015). Therefore, resiliency treatments may have short-term negative effects from removal of mature aspen and disturbance during implementation, but we anticipate long-term beneficial effects if treatments are successful in stimulating aspen regeneration on the landscape. Resiliency treatments in spruce will increase tree age-class diversity potentially increasing foraging habitat, hiding cover, and thermal cover as stand density and tree height increases. Salvage treatments may increase forbs and grasses in some areas. Design features would avoid or lessen impacts to elk and all MIS and in some cases, helps achieve habitat management objectives for those species. Increased age-class diversity in spruce and aspen would contribute to reduced vulnerability of the stands to insect and disease, as well as other stressors.

Due to the relatively limited extent of acres potentially treated across the GMUG National Forests, no discernible changes in population trends are anticipated at the DAU or Forest level.

Effects of Alternative 1 (No Action Alternative)

There will be no human-induced effects as a result of the No Action alternative. No treatments will occur and vegetation in the area would continue to be affected naturally by ecosystem patterns and processes. Decreases in canopy cover due to dead trees may result in more forage being available and could influence elk distribution. If there are large areas that experience windthrow events resulting in large volumes of coarse woody debris accumulating, elk movement patterns and distribution could also be affected. There would be no human-influenced or additive impacts since harvest and vegetation manipulation would not occur. No discernible change in population trends at the DAU or Forest levels are expected.

Rocky Mountain Elk rely on both spruce-fir and aspen habitat types on the GMUG. Spruce-fir is primarily used in the summer for foraging and cover and aspen is used during all seasons. The total amount of area of aspen stands affected by sudden aspen decline on the GMUG is currently at 229,000 acres with no further increase expected. The total amount of spruce-fir forest affected by spruce beetle is currently estimated at 223,000 acres, with additional increases in affected acres anticipated. The loss of mature spruce and aspen will reduce cover for elk but increases in under-story vegetation will result in increased summer foraging habitat. In stands affected by sudden aspen decline where regeneration is lacking or poor, the amount of young aspen may decline without active management (Shepperd et al. 2015). However, we anticipate increases in aspen within Engelmann spruce-aspen mixed stands as overstory Engelmann spruce trees succumb to spruce beetle.

American Marten

Effects of Alternatives 2 and 3

This species is addressed in this document as a Forest Service Sensitive species in the Sensitive Species section above. Please refer to the Sensitive species section for a more detailed analysis.

Effects to American marten populations as a result of Alternatives 2 and 3 include displacement due to direct disturbance from treatment activities and associated habitat effects as described above in the Sensitive Species section.

Both alternatives will affect marten habitat due to changes in the structure and composition of forested areas. Treatments will alter stand structure and remove large areas of dead trees which will reduce habitat quality and cause avoidance of created openings. Some habitat elements will be retained, but at decreased levels compared to the existing condition. Abundant course woody debris is an important habitat requirement of martens. Project design features require maintaining snags and large diameter downed logs of various decay composition within harvest units. Design features will help maintain suitable habitat on the landscape and habitat connectivity in terms of maintaining connections between large blocks of undisturbed habitat. Denning and winter habitat would be degraded because project activities would result in stands that are more open leaving less cover for martens important for their prey, denning habitat, and subnivean access beneath snow during winter for hunting. Resiliency treatments are intended to improve the health of forested stands by promoting multi-age classes and regeneration which, if successful in achieving these desired conditions could benefit martens in the long-term.

Effects of Alternative 1 (No Action Alternative)

There will be no human-induced effects as a result of the No Action alternative. No treatments will occur and vegetation in the area would continue to naturally develop as influenced by ecosystem patterns and processes. In the short-term, martens may benefit from the spruce beetle outbreak as increases in large course woody debris accumulate. Over time, decreases in overstory canopy cover and reductions in red squirrels due to the loss of mature cone-producing spruce trees will reduce habitat quality and prey for marten. There would be no human-influenced or additive impacts since harvest and vegetation manipulation would not occur. Due to the rapid spruce beetle outbreak and landscape-scale disturbance, there is the possibility of discernible change in population trends at the Forest level.

Northern Goshawk

Effects of Alternatives 2 and 3

This species is also addressed in this document as a Forest Service Sensitive species. Please refer to the Sensitive species section above for a more detailed analysis.

Effects to northern goshawk populations as a result of Alternatives 2 and 3 include noise disturbance due to treatment activities, and the presence of personnel and smoke associated with prescribed fire treatments. Activities may cause goshawks to temporarily displace from the project area. A design feature included in the proposed action requires surveys to be completed for raptors in the project area each year. If an active nest site is found within a treatment unit, avoidance measures will be taken.

All action alternatives will result in changes in habitat structure and habitat quality. Treatments are not expected to affect goshawk nest sites. Treatments will reduce canopy cover but goshawks use a large diversity of forest structure, edge habitat, and openings for hunting. Prescribed fire treatments may improve foraging habitat for goshawks because they would open up the understory, but are not likely to reduce canopy cover. The proposed action also includes design features which will minimize effects to important habitat elements for some goshawk prey species such as snags and coarse woody debris. Alternatives 2 and 3 may improve habitat conditions in the long term by restoring and improving resiliency of spruce fir stands against future bark beetle infestations, and promoting regeneration in both aspen and spruce-fir stands.

Aspen treatments would cause reductions in high quality habitat by removing mature trees, but would also stimulate aspen regeneration that would be anticipated to benefit goshawk habitat in the long-term. The action alternatives may temporarily displace individuals through habitat alteration and/or disturbance, but these effects will not result in a change in population numbers or trends at the Forest scale.

Effects of Alternative 1 (No Action Alternative)

There will be no human-induced effects as a result of the No Action alternative. No treatments will occur and vegetation in the area would continue to naturally develop. Mature aspen and aspen/mixed conifer stands within the analysis area would continue to persist. Mature, aspen-dominated closed canopy forests would continue to provide suitable nesting habitat. The spruce beetle outbreak may be beneficial to goshawks in terms of increasing foraging opportunities (e.g., increased woodpecker prey species due to the beetles). Reductions in overstory canopy from dead trees may reduce habitat quality in some areas. There would be no human-influenced or additive impacts since harvest and vegetation manipulation would not occur. No discernible change in population trends are anticipated at the Forest level.

Red-Naped Sapsucker

Effects of Alternatives 2 and 3

Effects to red-naped sapsucker as a result of Alternatives 2 and 3 include noise disturbance due to treatment activities and the presence of personnel and equipment as well as smoke associated with prescribed fire treatments. Treatment activities may cause temporary displacement of individuals. Prolonged disturbances at or near nest sites could cause nest abandonment or prevent adults from delivering food to chicks, thus there is a slight chance of mortality of individuals.

All alternatives will affect sapsucker habitat due to changes in the structure and composition of aspen stands. Of the approximately 900,000 acres of habitat (primarily aspen cover type) supporting sapsuckers across the GMUG, treatment acres within aspen is negligible compared to the amount of available habitat Forest-wide. All treatments are intended to promote regeneration and improve resiliency of stands to sudden aspen decline. This should help maintain aspen on the landscape and promote the future development of habitat for the red-naped sapsucker.

Commercial mechanical, non-commercial mechanical and prescribed fire treatments could impact aspen forests but due to a limited commercial market for aspen most treatments are expected to be non-commercial primarily using prescribed fire. Treatments in aspen are designed to increase stand resiliency which has proven to be very success in stands with less than 50 percent overstory mortality (Shepperd et al. 2015). Therefore resiliency treatments may have short-term negative effects since mature aspen will be reduced but a long-term beneficial effect as aspen is regenerated on the landscape. Table 313 through Table 315 quantify suitable red-naped sapsucker habitat on the GMUG NF that may be affected by the action alternatives.

Table 313. Activities Proposed Under Alternative 2 – Overlap with Red-Naped Sapsucker Habitat (Acres) within Each Geographic Area.

Geographic Area	Red-naped Sapsucker Habitat?	Hazard Trees	New Roads Outside PTA	Priority Treatment Areas					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Not Red-Naped Sapsucker Habitat	636	17	8,086	595	8,783	5,611	486	23,561	24,215
	Red-naped Sapsucker Habitat	439	1	13,834	850	25	552		15,261	15,702
	Total	**1,075**	**19**	**21,920**	**1,445**	**8,808**	**6,163**	**486**	**38,822**	**39,916**
Gunnison Basin North	Not Red-Naped Sapsucker Habitat	2,012	46	21,332		6,895	5,175	1,825	35,227	37,285
	Red-naped Sapsucker Habitat	1,683	3	27,054		2	1,488		28,544	30,231
	Total	**3,696**	**49**	**48,386**		**6,897**	**6,663**	**1,825**	**63,771**	**67,516**
Gunnison Basin South	Not Red-Naped Sapsucker Habitat	2,132	39	10,724		10,097	3,090	11,772	35,683	37,854
	Red-naped Sapsucker Habitat	2,661	5	7,776		1,238	1,329	289	10,632	13,298
	Total	**4,794**	**44**	**18,500**		**11,334**	**4,419**	**12,061**	**46,315**	**51,152**
North Fork Valley	Not Red-Naped Sapsucker Habitat	732	18	5,552	54	3,277	2,413	544	11,841	12,591
	Red-naped Sapsucker Habitat	1,526	7	6,673	866	79	2,611		10,229	11,762
	Total	**2,258**	**25**	**12,225**	**920**	**3,356**	**5,025**	**544**	**22,070**	**24,352**
San Juans	Not Red-Naped Sapsucker Habitat	1,271	36	333		7,553	955	1,794	10,636	11,944
	Red-naped Sapsucker Habitat	752	6	96		219	1,640	36	1,991	2,749
	Total	**2,023**	**42**	**430**		**7,773**	**2,595**	**1,830**	**12,628**	**14,692**
Uncompahgre Plateau	Not Red-Naped Sapsucker Habitat	353	15	15,167		12,653	5,500	282	33,602	33,970
	Red-naped Sapsucker Habitat	3,189	19	26,063		2,344	12,135	75	40,616	43,824
	Total	**3,542**	**34**	**41,231**		**14,997**	**17,634**	**357**	**74,219**	**77,795**
	Grand Total	**17,387**	**213**	**142,691**	**2,365**	**53,166**	**42,499**	**17,103**	**257,823**	**275,424**

[1]There are a total of 275,424 acres where proposed activities under Alternative 2 could occur. Of those acres, 117,566 acres (42.7%) are in red-naped sapsucker cover/foraging habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to manage habitat based on best available science (USFS 2014). This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 12.4% of the total cover/forage habitat on the GMUG National Forests.

Table 314. Activities Proposed Under Alternative 3 – Overlap with Red-Naped Sapsucker Habitat (Acres) Within Each Geographic Area.

Geographic Areas	Red-naped Sapsucker Habitat?	Hazard Trees	New Roads	Priority Treatment Areas					PTA Total	Grand Total[1]
				Noncommercial		Commercial				
				Burn and Mechanical	Mechanical	Combination	Resiliency	Salvage		
Grand Mesa	Not Red-naped Sapsucker Habitat	1,023	27	6,142	595	5,269	3,102	376	15,483	16,533 (56%)
	Red-naped Sapsucker Habitat	493	1	11,168	850	14	503		12,535	13,030 (44%)
	Total	**1,516**	**28**	**17,310**	**1,445**	**5,283**	**3,605**	**376**	**28,018**	**29,563**
Gunnison Basin North	Not Red-naped Sapsucker Habitat	2,929	43	16,154		1,985	1,309	732	20,181	23,153 (50.5%)
	Red-naped Sapsucker Habitat	2,312	1	19,427		1	935		20,363	22,676 (49.5%)
	Total	**5,241**	**45**	**35,581**		**1,986**	**2,245**	**732**	**40,544**	**45,829**
Gunnison Basin South	Not Red-naped Sapsucker Habitat	4,229	19	4,093		1,404	692	1,198	7,388	11,636 (62.5%)
	Red-naped Sapsucker Habitat	3,183	1	3,197		233	307	61	3,799	6,983 (37.5%)
	Total	**7,413**	**20**	**7,291**		**1,637**	**999**	**1,259**	**11,187**	**18,619**
North Fork Valley	Not Red-naped Sapsucker Habitat	1,047	13	4,604	54	1,683	1,755	56	8,151	9,210 (47.7%)
	Red-naped Sapsucker Habitat	1,770	7	4,873	844	79	2,539		8,334	10,111 (52.3%)
	Total	**2,816**	**20**	**9,477**	**897**	**1,761**	**4,293**	**56**	**16,485**	**19,322**
San Juans	Not Red-naped Sapsucker Habitat	1,669	20	333		3,019	428	652	4,433	6,122 (78%)
	Red-naped Sapsucker Habitat	847	3	96		117	647		861	1,711 (22%)
	Total	**2,516**	**22**	**430**		**3,137**	**1,076**	**652**	**5,294**	**7,833**
Uncompahgre Plateau	Not Red-naped Sapsucker Habitat	1,101	20	12,405		7,555	2,193	176	22,329	23,450 (42%)
	Red-naped Sapsucker Habitat	4,091	14	20,997		1,211	5,693	42	27,943	32,047 (58%)
	Total	**5,192**	**34**	**33,403**		**8,766**	**7,886**	**218**	**50,272**	**55,497**
	Grand Total	**24,694**	**169**	**103,491**	**2,342**	**22,571**	**20,103**	**3,293**	**151,800**	**176,662**

[1]There are a total of 176,662 acres where proposed activities under Alternative 3 could occur. Of those acres, 86,558 acres (49%) are in red-naped sapsucker cover/foraging habitat. Prior to implementation, field surveys would verify where suitable habitat occurs in project areas and appropriate design features would be applied to manage habitat based on best available science (USFS 2014). This analysis represents the maximum area where activities could potentially occur spatially and temporally during the life of the project (8 - 12 years). During the life of the project, these proposed activities have the potential to affect up to 9% of the total cover/forage habitat on the GMUG National Forests.

Table 315. Comparison of Alternatives 2 and 3 to the Baseline – Potentially Affected Red-Naped Sapsucker Habitat (Acres) within each Geographic Area.

Geographic Area	Alt. 2 Potentially Affected Areas[1]	Alt. 3 Potentially Affected Areas	Red-naped Sapsucker Summer Cover and Foraging Habitat (Baseline)[2]	Red-naped Sapsucker Habitat Potentially Affected by Alt. 2 (% of Total Habitat)	Red-naped Sapsucker Habitat Potentially Affected by Alt. 3 (% of Total Habitat)
Grand Mesa	39,916	29,563	96,831	15,702	13,030
Gunnison Basin North	67,516	45,829	209,269	30,231	22,676
Gunnison Basin South	51,152	18,619	139,296	13,298	6,983
North Fork Valley	24,352	19,322	221,451	11,762	10,111
San Juans	14,692	7,833	82,260	2,749	1,711
Uncompahgre Plateau	77,795	55,497	196,626	43,824	32,047
Grand Total	**275,423**	**176,663**	**945,732**	**117,566**	**86,558**

[1]Potentially affected areas: includes all commercial and noncommercial activities in Priority Treatment Areas, hazard tree removal areas, and area affected by new roads outside PTAs.

[2]This is all modeled Red-naped Sapsucker summer cover and foraging habitat for the GMUG National Forests based on the GMUG 2014 MIS Assessment (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3837155.pdf)

The action alternatives may temporarily displace individuals through habitat alteration and/or disturbance, but these effects will not result in a change in population numbers or trends at the Forest scale. Over time, aspen stands are expected to regenerate which will provide healthier aspen stands that are more resilient to sudden aspen decline in the future.

Other ongoing actions occurring in aspen will continue to have some negative effect to sapsuckers but these effects are expected to be minimal unless they directly affect mature aspen. Design features would minimize impacts to MIS, and in some cases, help achieve management objectives for those species. Increased age-class diversity in spruce and aspen would contribute to reduced vulnerability of the stands to insect and disease, as well as other stressors. Due to the relatively limited extent of acres potentially treated across the GMUG National Forests, no discernible changes to population levels are expected under any action alternative.

Effects of Alternative 1 (No Action Alternative)

There will be no human-induced effects as a result of the No Action alternative. No treatments will occur and vegetation in the area would continue to be influenced by natural processes. Areas of aspen and willow vegetation are not affected by the spruce beetle epidemic. There would be no human-influenced or additive impacts since harvest and vegetation manipulation would not occur. No discernible change in population trends at the Forest level.

Aspen decline has stabilized at approximately 229,000 aces on the GMUG but affected stands continue to die with older, mature stands being most affected. Regeneration in affected aspen stands is much lower than what would be expected in healthy stands (Shepperd et al 2015). The lack of active management could reduce the amount of young aspen on the landscape which could affect sapsucker populations over time. However, the loss of overstory spruce due to beetle mortality in stands that also support aspen is expected to increase the amount of aspen in some areas. Active small scale treatment in aspen would continue, authorized by other decisions, but at a much lower level relative to the action alternatives.

Cumulative Effects to All Species – Alternatives 2 and 3

The list and description of cumulative effects for MIS is the same as described in detail in the Cumulative Effects section below for terrestrial species. All action alternatives are expected to cumulatively increase direct and indirect effects to habitat for all MIS analyzed. Over time, these effects will decrease in magnitude as vegetation management activities implemented as part of SBEADMR are completed, and as forests regenerate and recover over time.

Cumulative Effects to All Species – Alternative 1 (No Action Alternative)

There will be no cumulative effects as a result of Alternative 1 because there are no treatments proposed to add to activities occurring in the past, present or future.

Migratory Birds

Neotropical migratory landbirds (NTMB) are birds that breed in the U.S. and winter in Mexico, Central and South America. Resident landbirds include those that remain during the winter period, or move to winter habitats that occur primarily within the U.S. border.

There are 37 Bird Conservation Regions (BCRs) in North America with four of these occurring at least partially in Colorado. The GMUG National Forests occurs within the Southern Rockies Colorado-Plateau Bird Conservation Region (BCR 16), Southern Rockies Physiographic Region 62. BCR 16 encompasses portions of Colorado, New Mexico, Arizona, Utah and Wyoming. Information from BCR 16 was synthesized for use in Colorado through the development of the Birds of Conservation Concern list (U.S. Fish and Wildlife Service 2008B) and the Colorado Landbird Conservation Plan (Beidleman 2000).

Potential influences on migratory birds were tiered to conservation objectives at the Forest-Wide scale and BCR 16 (additional information on BCR 16 is available online at: http://www.nabci-us.org/bcrs.htm). Table 316 lists Birds of Conservation Concern for BCR 16, their status within the project area, and projected influence from the SBEADMR project. The Bird Conservancy of the Rockies (http://www.birdconservancy.org/) monitors many of these species to acquire population information. These migratory birds will continue to be tracked through the Bird Conservancy of the Rockies Integrated Monitoring in Bird Conservation Regions (IMBCR) Program, which includes monitoring units on the Forest, to determine population trends over time.

Table 316. FWS Birds of Conservation Concern for BCR 16 and Anticipated Influence of Alternatives

Species	General Habitat	Occurrence in Analysis Area	Effect of Alternatives
Northern Harrier	Grasslands	No	Evaluated as an R2 sensitive species; No Effect (No habitat present).
Swainson's Hawk	Grasslands	No	No Effect (No habitat present)
Ferruginous Hawk	Prairie	No	Evaluated as an R2 sensitive species; No Effect (No habitat present)
Golden Eagle	Cliffs/grasslands	No	No Effect; No known nests.
Peregrine Falcon	Cliffs	No	Evaluated as an R2 sensitive species; No Effect.
Prairie Falcon	Cliffs	No	No Effect. (No known nests near project areas).
Gunnison sage-grouse	Sagebrush	Yes	Evaluated as a threatened species in the Biological Assessment for ESA compliance. The Biological Assessment made a May Affect, not likely to adversely affect, determination since there will be some noncommercial treatments occurring in designated critical habitat where critical habitat overlaps forested areas near forest-sagebrush interfaces. Treatments will be implemented to achieve objectives from the Gunnison Sage-Grouse Rangewide Conservation Plan. Treatments will also avoid areas of sagebrush habitat.
Snowy Plover	Shorelines	No	No Effect (No habitat present)
Mountain Plover	Prairie	No	No Effect. (No habitat present).
Solitary Sandpiper	Shorelines	No	No Effect (No habitat present).
Marbled Godwit	Wetlands	No	No Effect (No habitat present).
Wilson's Phalarope	Waterbodies/ Shorelines	No	No Effect (No habitat present).
Yellow-billed Cuckoo	Deciduous Riparian	No	No Effect. (No habitat present).
Flammulated Owl	Aspen/Conifer mixed forest; Ponderosa pine/snags	Yes	Evaluated as an R2 sensitive species; May impact, due to direct disturbance and habitat effects.
Burrowing Owl	Plains/grasslands	No	Evaluated as an R2 sensitive species; No Effect. (No habitat present)
Short-eared Owl	Parks/grasslands	No	No Effect. (No habitat present).
Black Swift	Waterfalls/wet cliffs	No	Evaluated as an R2 sensitive species; No Effect. (No habitat present)
Lewis's Woodpecker	Riparian Cottonwood	No	Evaluated as an R2 sensitive species; No Effect (No known occurrences or suitable habitat in affected areas).

Species	General Habitat	Occurrence in Analysis Area	Effect of Alternatives
Williamson's Sapsucker	Montane forests/ snags	Yes	May impact, due to direct disturbance and habitat effects.
Gray Vireo	Oak woodlands/scrub	No	No Effect. (No habitat present).
Pinyon Jay	Pinyon/Juniper	No	No Effect. (No habitat present).
Bendire's Thrasher	Rare species of arid areas	No	No Effect. (No habitat present).
Crissal Thrasher	No records in CO.	No	No Effect. (No habitat present).
Sprague's pipit	No records in CO.	No	No Effect. (No habitat present).
Virginia's warbler	Riparian shrub	No	No Effect. No impact upon this habitat type.
Black-throated gray warbler	Oak scrub/riparian	No	No Effect. (No habitat present).
Grace's warbler	Ponderosa pine	No	No Effect. (No habitat present).
Sage sparrow	Sagebrush	No	No Effect. (No habitat present).
Chestnut-collared longspur	Plains	No	No Effect. (No habitat present).

The Colorado Landbird Conservation Plan (Beidleman 2000) identified priority species and habitats for each physiographic area in the state, based on the Partners-In-Flight Species Prioritization Process. Priority habitats identified for the Southern Rocky Mountains Physiographic Area include: alpine tundra, aspen, cliff/rock, high elevation riparian, lowland riparian, mixed-conifer, mountain shrubland, ponderosa pine, sagebrush shrubland, spruce-fir, and wetlands. Table 317 shows the habitat types that occur within the SBEADMR project action area.

Table 317. Priority Habitats and Species of the Southern Rocky Mountains Province and their Relationship to Assessment for the SBEADMR Action Area.

Priority Habitat Type	BCP Priority Species	BCP Potential Issues(s)	Potential Influence from Project Activities	Effect of Alternatives
Aspen	Red-naped sapsucker Purple martin Violet-green swallow	Grazing, snag habitat, Altered disturbance regimes	Yes	Red-naped sapsucker evaluated as GMUG MIS; Decrease in mature aspen from coppice treatments; decrease in snags and potential for direct mortality.
High Elevation Riparian	Cordilleran flycatcher American dipper MacGillivray's warbler Wilson's warbler	Grazing, Recreation impacts	Yes	Minimal influences to the species anticipated from disturbance associated with human activity/equipment use and noise effects. No habitat effects anticipated due to design criteria in place to protect riparian areas
Mixed Conifer	Dusky grouse Williamson's sapsucker Flammulated owl	Altered disturbance regimes, snags, timber mgmt.	Yes	Flammulated owl evaluated as R2 Sensitive Species: May Impact Individuals; Decrease in snags for sapsucker and Flammulated owl and potential for direct mortality.
Spruce/ Fir	Boreal owl Olive-sided flycatcher Hammond's flycatcher	Timber mgmt., snags, altered disturbance regimes	Yes	Boreal Owl and Olive-sided Flycatcher evaluated as R2 Sensitive Species: May Impact Individuals. Hammonds flycatcher = decrease in snags and potential for direct mortality.

Summary of Effects of Alternatives on Migratory Birds

This project will comply with Forest Plan Standards and Guidelines to retain snags for nesting structures. This project will also incorporate conservation measures and principles, as appropriate, from local bird conservation plans (North American Bird Conservation Initiative) and/or other references into project design so that adverse effects are minimized (USDA Forest Service 2008B – MOU Between the USDA Forest Service and the USFWS to Promote the Conservation of Migratory Birds).

A decrease in snag habitat and potential for direct mortality mainly upon nestlings is likely for these species due to treatments proposed for the action alternatives. Project design features are in place to: retain sufficient snags consistent with Forest Plan direction; protect known active bird nests and cavities; and minimize potential mortality since project activities are unlikely to be implemented during the spring nesting period for many of the migratory birds (May – June) since this time period coincides with wet soil conditions resulting from spring snowmelt (Standard Provision BT5.12 specifies that use of system roads and temporary roads by the timber purchaser will be authorized by the Forest Service when such use will not cause damage to the roads or Forest resources; and Design Feature TSHR-4 states that timber hauling will be restricted during wet or thawed conditions when needed to protect the road surface).

Activities associated with the action alternatives - ***May Impact Individuals, but are not likely to cause a trend towards Federal listing or result in loss of viability in the planning area.***

Cumulative Effects of Alternatives 2 and 3 for All Terrestrial Species Analyzed Above

Cumulative effects are the effects on the environment, both direct and indirect, that result from the incremental effects of an action when added to other past, present, and reasonably foreseeable future actions of the agency and other agencies or private entities (Boyle et al. 1997). There are a number of Forest Service and other entity activities in the vicinity of the proposed alternatives that have the potential to result in cumulative impacts when combined with activities proposed under the SBEADMR project. Cumulatively, implementation of this project would have minor incremental effects on Region 2 designated sensitive species, management indicator species, migratory birds and general wildlife.

Table 318 displays the present and foreseeable actions that contribute cumulatively to impacts to sensitive and management indicator species and their habitat, and whether the impacts are anticipated to be similar to those described above in the effects analysis. More detail regarding specific reasonably foreseeable future actions are located in Chapter 3, Cumulative Impacts – Actions Considered & Analysis Approach.

Table 318. Present and Future Projects and Activities in the Cumulative Impacts Analysis Area.

Agency	District	Foreseeable Future Project	Impacts within the range of those described in direct and indirect impact (Yes/No) and effects analysis and additional comments.
USDA Forest Service, USDI Bureau of Land Management, Counties	Forestwide	Ongoing Grazing Activities	No, see below
	Forestwide	Fuels & Timber Projects	Yes
	Forestwide	Road maintenance	Yes
	Forestwide, multiple locations	Trail Management	Yes
	Forestwide, multiple locations	Minerals activities	Yes
Private landowners	N/A	Grazing	No, see below

The following describes the potential range of impacts anticipated from the SBEADMR action alternatives when incrementally added to the activities mentioned in the above table. These descriptions summarize the general potential indirect impacts of changes to environmental conditions.

Vegetation Management and Fuels Reduction Projects

Vegetative treatments using silvicultural prescriptions and prescribed burning have occurred over the past few decades on National Forest System land within the SBEADMR project boundary. Most planned activities tend to reduce habitat suitability in the short-term with the long-term effect of achieving desired conditions consistent with the Forest Plan and the purpose and need of the projects.

The vegetation and fuels reduction projects involve vegetation treatment similar to those proposed in the action alternatives for this project, and thus direct and indirect impacts on site are similar to those assessed in this report. Conducting many projects across the landscape in close temporal and geographic proximity increases the magnitude of positive and negative effects.

Invasive Plants

Herbicide application has occurred in various locations, mainly along roads and at other areas of soil disturbance related to past management activities. Weed control is authorized under a Forest wide EA that allows the use of herbicides. The continued introduction and spread of invasive plants will act with the proposed alternatives to decrease habitat suitability and increase competition for resources where they co-occur with terrestrial wildlife species. Continued invasive plant management would be a beneficial impact for wildlife, reducing impacts from

invasive plants. Please see Chapter 3, Noxious and Invasive Weeds section and the Invasive Plant Risk Assessment located in the project record for a full discussion of the anticipated impacts.

Grazing

Livestock grazing has been occurring since the 1800s and continues today. Most grazing allotments on the GMUG NF are used by cattle, with few domestic sheep grazing allotments. Historically, cattle, horse and sheep grazing occurred in much higher numbers than today. Currently, private land is primarily composed of cattle grazing. Grazing, both on and off Forest Service lands, has the potential to add to the effects for all species. Grazing has been identified as potentially impacting purple martin, amphibians, pygmy shrew and elk. The impacts caused by grazing include trampling, browsing, competition for forage and impacts to aquatic habitats from hoof punches. This activity would interact with the proposed action alternatives by further decreasing habitat quality.

Private Land In and Around the Project Area

Development and management of private land for agricultural uses, ranching operations, water developments, residential homes (both seasonal and year-round occupancy) and other activities occurs on private land inholdings and on lands bordering the National Forests. To protect private land owner privacy, site specific data are limited and not used in this analysis. Human population growth drives private land development and management changes over time. Several large private land ranches bordering National Forest are under conservation easements, indefinitely protecting those properties from future development and maintaining the properties for agricultural and ranching uses only. This maintains open space, wildlife habitat and habitat connectivity, and provides a buffer of protection from development in some areas that is beneficial to National Forest watershed.

Recreation

Recreational activities such as hunting, fishing, hiking, biking, ATV/UTV/motorcycle riding, snowmobiling, snowshoeing, back country skiing, wood cutting and camping occur on the GMUG NF. Recreation trends have changed dramatically in the past several decades, with changes in motorized recreation largely shifting from ATVs to UTVs and in general increased recreation pressure on the National Forests. There are many popular fishing and hunting areas on the GMUG NF and adjacent BLM and state land. Use of developed recreation areas such as ski resorts and designated campgrounds have increased over the last few decades. The increase in recreation use has also contributed to increased traffic numbers.

Although not due to actions from this EIS, we can expect more pressure on roads and trails, and more demand for off-road vehicle use. As a result, more invasive plant species will become introduced. Existing infestations could get larger due to spread by recreationists further impacting

wildlife habitat. There is also the potential for habitat impacts and species displacement due to illegal off-road use.

Roads

Federal and state highways and county roads go through or are adjacent to the GMUG NF, providing multiple public access points. All managed roads are subject to routine maintenance activities as needed. County road maintenance is a potential cumulative effect for many wildlife species because road maintenance activities contribute to the spread of invasive plants.

Temporary roads will be constructed as part of the SBEADMR project, and some existing roads will be re-constructed or improved as a part of the project for implementation purposes (*i.e.*, improved to specifications to allow for haul trucks). Temporary roads will not be open to public use. Approximately 70 percent of temporary roads will be decommissioned by the timber purchaser immediately upon completion of harvest operations, and 30 percent will be decommissioned within five years of sale closure to allow for post-sale activities (tree planting, site prep, regeneration surveys, complete work using KV-funds, pile burning, etc.). In the short-term, temporary roads constructed under SBEADMR will increase road densities for the life of the project. In the long-term, roads will cause habitat fragmentation effects and loss of habitat until vegetation recovers. Species that use edge habitat to meet life history requirements for foraging, hunting, and cover may benefit once roads are decommissioned. The SBEADMR project will contribute to increased traffic volumes on highways, County roads and Forest Service roads due to log hauling (estimated 20 log trucks per day for timber sale projects implemented under SBEADMR) and pickup trucks used by timber sale contractors and Forest Service employees. There is the potential for increased risk of wildlife mortality due to vehicle collisions.

Generalized Effects to Terrestrial Wildlife

The proposed activities would have additive impacts to wildlife and their habitat (impacts may be beneficial and/or negative and vary spatially and temporally). SBEADMR may cumulatively increase impacts to various species on Forest Service lands when considered with other actions. Direct disturbance from treatment activities would be temporary and would be due to the presence of personnel and equipment during project implementation. Indirect effects from vegetation treatments would alter habitat conditions and in some cases, would reduce the amount of suitable habitat available for some species, while for others there may be no impact, and others would benefit. Due to the spruce bark beetle outbreak, natural processes are causing dynamic changes to the spruce-fir ecosystem and associated wildlife species, with some species benefitting and others negatively impacted at various temporal and spatial scales. Some species currently benefitting in the short-term during and immediately following the beetle outbreak (three-toed and hairy woodpeckers) may be negatively affected in the long-term, while others will likely be negatively affected long-term (hundreds of years) until multi-storied mature forests develop across the beetle-impacted landscape (canopy dependent song birds such as ruby-crowned kinglets, and

species dependent on mature interior forests such as American marten, brown creeper, and red squirrel). Anecdotally, Rocky Mountain elk appear to be benefitting currently in forests with dead overstory due to an increase in herbaceous production on the forest floor and are likely to benefit long-term due to increased forage production, assuming that hiding and thermal cover requirements are met.

Vegetation management activities in the past, present and future will continue to impact species and their habitats, but the magnitude of those effects are based on the type and scale of activities. Treatments that are intended to reduce fuels will address public and firefighter safety and will have both positive and negative impacts to wildlife depending on the species and seasonal life history requirements. The effects of fuels reduction from treatments may benefit foraging habitat for some species during the summer when they are more likely to use openings and edge habitat for hunting (e.g. American marten) or foraging (e.g. elk), but could negatively impact some species during the winter when overstory cover and large course woody debris is more important (e.g. American marten). Elk may also be both positively and negatively impacted during the summer due to increases in forage production and the cumulative reduction of hiding and thermal cover.

Noxious and invasive weed treatments, if effective, are likely to improve habitat conditions for wildlife and increase ecosystem diversity and resilience. Activities such as grazing, recreation use, road use and maintenance and the presence of private land around the project area will have a continued impact on wildlife in the area. Wildlife species have been disturbed by activities associated with recreation and with road maintenance on a regular basis, though recreation continues to increase. Grazing activities on NFS lands and on private lands would continue to affect vegetation, soil and water quality in the area and may impact amphibians and small mammal populations.

The proposed project would increase cumulative effects to all species analyzed when combined with the anthropogenic activities described above and the spruce bark beetle natural disturbance event. However, the cumulative actions are not likely to affect population viability resulting in a trend towards listing for any sensitive species due to the relatively limited extent of acres affected across the GMUG NF; within the context of the vegetation cover types affected on the GMUG NF landscape over a variety of spatial and temporal scales. When considering past, present, and reasonably foreseeable future actions documented across the GMUG NF and their impacts to associated subwatersheds evaluated in this analysis (150 subwatersheds), the total estimated percent cumulative impact to Forest Service lands in all subwatersheds combined is 5 percent. When considering cumulative disturbance for each individual subwatershed, the percent cumulative disturbance ranges from 0 percent (Wilderness Area subwatersheds) to 25 percent. Out of the 150 subwatersheds analyzed, 78 had a cumulative disturbance ≤ 5 percent; 141 ranged from 6-19 percent cumulative disturbance; and 9 ranged from 20-25 percent cumulative disturbance. Appendix E in the Biological Evaluation and Management Indicator Species Report

(available in the project file) provides a detailed analysis of cumulative impacts, comparing baseline disturbance to additive actions under SBEADMR and future disturbances.

In summary, cumulative effects that lead to reductions in habitat quality for some species, improvements in habitat quality for other species, and possible disturbance and/or displacement and loss of some individuals particularly nestlings, may impact individuals but would not likely contribute to a loss of species viability of any animal species addressed in this analysis. Implementation of project design features alleviates some of these potential impacts. The Agency Preferred Alternative (Alt. 2) has the potential to directly and indirectly impact more acres that are more wide-spread on the GMUG NF than Alternative 3, resulting in increased cumulative effects to wildlife. Overall, when considering the history of disturbances combined with present and future activities and magnitude of those effects on landscape habitat conditions, although speculative, these factors likely have meaningful impacts on wildlife demographic dynamics and seasonal habitat use patterns that are difficult to quantify.

Determination of Effect and Rationale

Based on this analysis, I determine that the No Action Alternative – Alternative 1 will have no effect; and the Agency Preferred Alternative - Alternative 2 and the WUI Alternative – Alternative 3 "***May adversely impact individuals, but not likely to result in a loss of viability in the Planning Area, nor cause a trend toward federal listing*** for Colorado River Cutthroat Trout, the northern goshawk, boreal owl, flammulated owl, olive sided flycatcher, purple martin, boreal toad, northern leopard frog, hoary bat, American marten and pygmy shrew. Due to project design features, the action alternatives are also consistent with Forest Plan direction as it relates to management indicator species. The rational for this conclusion is based on:

- The maximum acres that would be treated under all action alternatives are limited in extent to 120,000 acres. This represents only 4 percent of the entire land base of the GMUG National Forests. Further, treatments in spruce-fir and aspen would comprise less than 10 percent of these vegetation types across the GMUG.
- Design features, consistent with Forest Plan direction and policy standards will minimize effects to these species with timing restrictions and protective buffers for active nest sites, and the retention of important habitat elements including snags, downed logs and coarse woody debris and pockets of vegetation for habitat connectivity. Further rationale on how the design features will avoid or minimize impacts can be found in Appendix D of the Biological Evaluation and Management Indicator Species Report.

Alternatives 2 and 3 include an adaptive management scenario that takes into consideration changed conditions that result in treatment methods shifting primarily to salvage harvest of dead Engelmann spruce. The above effect determination considers current stand condition and proposed actions within SBEADMR treatment areas but also considers the effects of salvage harvest that would be applied when site conditions consist of greater than 90 percent mortality. As the level of spruce-beetle induced mortality changes, acres of resiliency and variable retention have the potential to shift towards salvage as described in the Silvicultural Prescription Matrices

(see Appendix A). If this occurs, the extent of potential direct and indirect effects to suitable habitat and potentially occupied habitat for Sensitive, MIS, migratory birds and general wildlife will be greater.

Implementation of projects in the future must adhere strictly to the proposed design features and policy standards discussed in this document to avoid or minimize adverse impacts (Appendix B – Design Features). By following the design features and policy standards, changes in treatment type should not change the effect determination for "future" (present – 10-20 years) with adapted action. Allowing for adequate planning time to analyze and develop site specific recommendations and appropriate protection measures will be critical.

Conservation measures provided within the design criteria (Appendix B) should allow the effect determination to remain unchanged for all species analyzed above. Adhering to the design features and policy standards is critical to prevent causing a trend to federal listing or a loss of species viability for Sensitive species.

Social Environment

Cultural

Compliance with Regulatory Direction

The SBEADMR project is designed to be compliant with the National Historic Preservation Act of 1966 (amended in 1976, 1980, and 1992) and all other heritage resource management laws and regulations that support, clarify, or expand on the National Historic Preservation Act. It also complies with Federal Regulations 36 CFR 800 (Protection of Historic Properties), 36 CFR 63 (Determination of Eligibility to the National Register of Historic Places, 36 CFR 296 (Protection of Archaeological Resources), and Forest Service Manual 2360 (FSM 2360) which provide the basis of specific heritage resource management practices. Several other laws address various aspects of heritage resource management, including NEPA, NFMA, Antiquities Act of 1906, Historic Sites Act of 1935, and the Archaeological Resource Protection Act of 1979 as amended in 1988 The National Historic Preservation Act calls for tribal participation in the consultation process (Section 106).

An existing programmatic agreement exists between the Colorado State Historic Preservation Office and the Forest Service. A Section 106 (National Historic Preservation Act, as Amended, [NHPA]) Notification will be initiated under the Colorado National Forests Bark Beetle Programmatic Agreement (PA)[19] for the SBEADMR Project in partial fulfillment of the

[19] Amendment Four for the Programmatic Agreement among the Advisory Council on Historic Preservation, The Colorado State Historic Preservation Office and the USDA Forest Service (Colorado National Forests) Regarding the

requirements of the National Historic Preservation Act, as amended. The Colorado State Historic Preservation Office (SHPO) and the Forest have agreed that the procedures derived from the PA would ensure that there would be no adverse effect and no significant impact to cultural resources from the SBEADMR proposed actions.

Affected Environment

Cultural Resources in this analysis consist of the significant archaeological and historical sites or structures left behind by Native American or Euro-American/other past occupation of an area. Such sites are at least 50 years old and have been determined to be significant and eligible for listing on the National Register (NR) of Historic Places as defined in 36 CFR 60. In general, these sites may be valued either for their association with history, Native American culture, or for their scientific research potential. A variety of identification methods may be used to locate sites in a project area depending on the types of sites that are expected and the field conditions. The Forest consults with the State Office of Archaeology and Historic Preservation to determine NR eligibility of any sites identified in a project area, and consults with Native American tribes to identify traditional cultural places or concerns.

SBEADMR is located on the GMUG National Forest (GMUG), which is comprised of the Gunnison, Grand Mesa, and Uncompahgre National Forests. Generally, prehistoric archaeological evidence suggests human occupation of West-Central Colorado spans at least 10,000 years (Reed and Metcalf 1999). Prehistory in this part of Colorado is subdivided into four broad periods; Paleo-Indian (10,000-7800 years Before Common Era [BCE]), Archaic-Period (ca. 10,000-7,800 BCE), Formative Period (500 BCE-1300 Common Era ([CE]), and Proto-historic Period (1300-1801 CE). The Formative period is not well represented in the upland mountainous environments. These broad temporal periods are often further subdivided but will not be addressed here.

By the time of Euro-American settlement, the Ute Indians already occupied the Area of Potential Effects (APE). The Gunnison NF was home to the Tabegauche Utes, who occupied the Los Pinos Indian Agency from 1869-1875 (O'Rourke 1980: 49-50). The Grand Mesa NF may have been used by a band known as the Grand River Utes (Dees 2004: 17). The Uncompahgre NF area lies within the aboriginal territory of the Yampatika–Uncompahgre Ute Band, which was based in the Uncompahgre River valley (Crum and Keene 2009). In 1828, Antoine Robideau established a trading post east of the Uncompahgre Plateau near the confluence of the Uncompahgre and Gunnison rivers; the fort was burned down by Utes in 1844. Significant Euro-American occupation of the area did not occur until after the Utes in this region were forcibly relocated to Utah in 1881.

Implementation of Bark Beetle Management, Hazardous Fuel and Tree Reduction Program and Management of Cultural Resource Programs within Hazardous Tree Environments, 2015.

Following the removal of the Utes to reservations, the APE historically has seen mainly mining, ranching, settlement/homesteading and logging activity. In the Gunnison NF, mining activity was focused on the Gunnison gold belt between 1870 and 1910, with a peak of activity in Taylor Park and the Tin Cup mining areas from 1870-1890. Other districts, such as Cebolla, Cochetopa and Elk Mountain(s) Mining Districts had more sporadic production in the early 20th Century (Streufert 1999: 27-34). Some of the notable existing historic mining sites and districts on the GMUG are the Colorado Boy Mine, Mountain King (Red Mountain) Mining Districts and the Dorchester Enterprise. In the Uncompahgre NF, the Ouray and Silverton Mining Districts began production in the 1870s with gold and silver finds at the Mineral Farm mining claim (Colorado Geologic Survey, N.D.). The Grand Mesa NF, while lacking precious metals, was identified as having coal deposits early in the 20th Century (United States Bureau of Mines, 1911). Coal mines were developed earlier adjacent to the Gunnison NF in the Crested Butte and the Somerset area in the 1890s.

The APE was the focus for logging in the 19th Century due to the proximity of timber stands to the growing communities located in and adjacent to what would become the GMUG NF. Initially, logging was non-industrial in scale and relied on horse teams to convey cut timber to small and sometimes portable lumber mills for processing. Industrial-scale and mechanized logging was not established until after World War II. Historic logging operations generally left only temporary sites such as camps, small trash scatters, portable sawmilling locations, and structures that are generally not eligible for the National Register. The industrial-scale lumber mills were generally located on private lands outside the boundaries of the GMUG, such as: Norwood, Sapinero, Montrose and Gunnison. Operations at these mills sites were in steep decline by the 1970s and most had ceased by 1980.

Grazing, historically heavy on the Uncompahgre NF, was also present on the Gunnison and Grand Mesa NFs. These upland environments and their forage and water resources provided valuable summer range for area ranchers and farmers. While devoid of permanent ranch settlements, summer range camps, known colloquially as “cow camps” were established in the early 20th Century in many locations throughout the APE. In addition to the remains of cow camps, one may also encounter various water impoundments, ditches and other forms of water conveyance to deliver upland derived water resources to grazing allotments and ranches just outside the forest boundaries. Certain areas in the APE were heavily homesteaded between 1895 and 1920 by individuals hoping to farm under the Homestead Act of 1862 and subsequent related acts. Many of these farms and land claims failed and the lands were returned to National Forest System land ownership; however, a limited number of historic structures and sites remain on the landscape from that era.

Recreation and tourism was not a major factor in the early historic period, with some notable exceptions, such as Taylor Park on the Gunnison NF. Tourism, now a major industry in the project area, grew slowly during the first half of the 20th Century, but with the economic and population increases following World War II, recreation activities and associated features, such as

cabins, campgrounds, roads and trails, grew exponentially. Many of the same sites associated with early recreation are still in use today.

Other cultural resource sites of interest are related to early transportation as well as resource management activities by the Forest Service and other government entities in the early 20th Century. Transportation sites include the Alpine Tunnel, a narrow-gauge railroad tunnel passing through the Continental Divide that was constructed in 1882, and the Trout Lake Trestle, used by the Rio Grande Southern Railroad to carry mail and passengers in hybrid motor vehicle-rail cars (USDA FS, N.D.). Early forest management sites of interest are the Fairview Peak Lookout originally constructed of stone in 1912 on the Gunnison NF; and Fort Peabody on the Uncompahgre NF established in 1904 and manned by the Colorado National Guard to manage labor unrest among unionized miners the San Juan and Telluride mining districts (Ibid.).

The Great Depression ushered in massive government-funded resource management programs and camps associated with the Civilian Conservation Corps (CCC). Some of their handiwork is still in use or part of the GMUG NF's interpreted and restored historic buildings and sites; these include the Cold Springs, Ward Lake on the Gunnison NF, Mesa Lakes Guard Station on Grand Mesa NF, and the Silesca Guard Station on the Uncompahgre NF (Ibid.). The CCC also built or improved many travel routes on the GUMG, such as the Divide Road, Cumberland Pass Road, Land's End Road and other "truck trails."

Expected Types of Cultural Resources

Expected types of cultural resources potentially located within the SBEADMR project area consist of archaeological sites from both the prehistoric, proto-historic and historic periods. Based on previous work in and around SBEADMR, expected prehistoric cultural resources within the project area would include lithic scatters (predominantly quartzite and chert) representing short and long term camps and limited activity sites; lithic procurement areas; and isolated flaked and ground stone materials and hunting blinds. Generally, prehistoric sites in this APE tend to be found in the lower elevation sagebrush and grassy areas, or above timberline in the high elevations; rarely are prehistoric sites found within the mid-elevation, heavily forested areas. Culturally scarred trees (CSTs), Ponderosa pine, have been found in the lower elevations of the valleys where ponderosa pine stands may be found. A great potential for Ute materials exists dating from the 1860s since the first Los Pinos Agency was located near the project area. Such materials might include, tee pee rings, wikiups or other brush structures and artifact scatters that contain Ute and historic period artifacts.

Expected historic cultural resources would include mining prospect sites; homesteads with hay meadows, structures, wells, or ditches; carved aspen trees; cabins; cow camps; refuse scatters; CCC-Era historic guard stations and linear features such as stage roads, trails; and portable sawmill sites. There are also isolated log cabin ruins in the mid-elevation forested areas of the

APE of unknown cultural association; most likely they are associated with trapping, fishing or recreation activities.

Direct and Indirect Effects Common to All Alternatives

Cultural resources may be affected in different ways by different kinds of land management actions. Impacts to sites are considered to be significant or "adverse" effects if they alter or destroy the characteristics that made the site significant. Causing damage or loss of artifacts or features, and sometimes significantly changing the setting of the area immediately surrounding a site may also produce adverse impacts. Under Section 106 (NHPA) the Forest consults with the State Office of Archaeology and Historic Preservation to determine effects to cultural resources.

Most Forest Service actions are designed so that any eligible sites are avoided by actions that could impact them; thus treatments have no effect on the sites. The following discussions address hypothetical effects to sites that *had not* been protected through treatment re-design, or to sites that may have escaped identification because of, for instance, very heavy vegetation. Field inventory is effective in identifying sites in most cases and all inventories conform to SHPO standards for site identification. However, if an area selected for treatment is likely to contain certain kinds of significant sites but has environmental conditions that limit the identification of the cultural resources, this information is considered in determining the potential impact of the treatment and the appropriate mitigation and monitoring measures.

Alternative 1 (No Action Alternative) – Direct, Indirect and Cumulative Effects

This alternative is used as a basis for comparing the effects of the Proposed Action and other alternatives. Under the No Action Alternative, cultural resources would continue to largely be subject to natural processes. Buried sites (none were found) would generally remain intact except for whatever natural erosion might be present, and for mixing of the soil due to rodent and insect activity. In mountainous areas where sites are not buried very deeply, rodents and insects can create considerable soil disturbance. In areas where people often visit, surface artifacts and features may be subject to unauthorized collection or vandalism; in this project area there is little concentrated visitor use.

Wildfire, if unchecked by fuel treatment, may burn over parts of this APE and would likely damage or kill the culturally scarred trees (CSTs) which have been determined eligible for the National Register. Such mature ponderosa pines may survive fire (and have survived past fires in the project area) but when growing in thick oak or other brush, with thick duff on their roots, or with ladder fuels introducing fire to their upper crowns, they are often killed in intense fire conditions. Even if they survived, the forest settings around them would be altered and subject to subsequent accelerated erosion and potential introduction of exotic plant species and other changes.

Although surveys conforming to state standards will be conducted during forest management activities, buried archaeological sites can be missed. Under the No Action alternative, these sites would be subjected to an unknown level risk of intensive burning from wildfires but would otherwise be subjected only to natural decomposition. This decomposition includes wikiup sites, which have a limited number of years to endure based on the fragility of the cut poles in the mountainous environment.

Ongoing management activities authorized under existing and future NEPA employ cultural resource surveys and consultation with SHPA prior to any ground and vegetation disturbing activities and, for the most part, avoid archaeological sites. These management activities include inadvertent discovery design features the same as or similar to those included in design features to minimize damage to sites that were not found during surface surveys.

Activities Common to Both Action Alternatives - Design Features

Cultural resource surveys will occur prior to treatment implementation. Locations of all known cultural resource sites needing protection will be shown on internal working maps not subject to disclosure and/or identified on the ground so that these areas are avoided and protected during all phases of treatment implementation.

If any new cultural resource sites are discovered during implementation, treatment activities would stop and the GMUG archeologist would be contacted immediately. The archeologist would evaluate the site and determine how the site would be protected.

In evaluating the cultural resource, the Forest Service would follow the procedure set forth in Amendment Four for the Programmatic Agreement among the Advisory Council on Historic Preservation, The Colorado State Historic Preservation Office and The USDA Forest Service.

Activities involving hazardous tree removal, grapple piling, mechanical treatment, skid trails and landing areas: For all cultural resource sites located during the field inventory or previously known, no mechanical treatment will occur **within the site boundary plus a 50 foot buffer around the site**. If treatment is necessary, these sites and the 50 foot buffer will be hand treated to remove hazard trees and accumulated fuel build up, per Stipulation 5.B.b.ii and Stipulation 6.a and 6.b, Standard Treatments for Historic Properties, in the 2015 Programmatic Agreement for Bark Beetle, Hazardous Fuel and Tree Reduction.

The Cultural Resources Design Features derived from the PA will be implemented for Alternatives 2 and 3 (Table 319 and Appendix B).

Table 319. Cultural Resources Design Features.

	Design Feature	Source
CR-1	Cultural resource surveys will occur prior to treatment implementation. All eligible or unevaluated cultural resource sites within a treatment area will be avoided until State Historic Preservation Office consultation may be completed.	2015 Programmatic Agreement for Bark Beetle, Hazardous Fuel and Tree Reduction Programs
CR-2	Discoveries: If any new cultural resource sites are discovered during implementation, treatment activities would stop and the Forest Service archeologist would be contacted immediately. The archaeologist will evaluate the significance of the cultural resource. If potentially significant, within 48 hours of the discovery, the SHPO will be notified of the discovery and consultation will begin to determine an appropriate mitigation measure. The discovery will be protected from further disturbance until any required mitigation is completed. Operations may resume at the discovery site upon receipt of written instructions and authorization by agency officials.	2015 Programmatic Agreement for Bark Beetle, Hazardous Fuel and Tree Reduction Programs
CR-3	For all cultural resource sites located during the field inventory or previously known, no mechanical treatment or ground disturbing activities will occur within the site boundary, including an additional 50 foot buffer around the site. If mechanical treatments are necessary, the site and the 50 foot buffer around the site will be treated by hand to remove hazard trees and accumulated fuel build up.	Stipulation 5.B.b. ii and Stipulation 6.a and6 .b, Standard Treatments for Historic Properties, in the 2015 Programmatic Agreement for Bark Beetle, Hazardous Fuel and Tree Reduction Programs
CR-4	In areas slated for prescribed fire treatment, flammable cultural resource sites or sites with components or features susceptible to heat damage with the APE will be marked on the ground by an archeologist, along with a buffer area of no less than 50 feet, sufficient to prevent fire or heat from affecting components of the site that may contribute to its eligibility to the National Register of Historic Places. In addition, treatments may include fuel-breaks, no-treatment buffers, wrapping, foaming, wetting, blackline, fire line (hand or mechanical), and clearing the cultural resource sites of flammable debris by raking and hand removal. Any fire line that will be ground disturbing will be subjected to an intensive field inventory; if any additional sites, components or features are located, the fire line will be adjusted to avoid these cultural resources.	GMUG's 2013 Prescribed Fire Programmatic Agreement
CR-5	If road construction cannot physically be relocated to avoid a site, and there is the potential for unidentified buried cultural remains, then SHPO consultation will take place and construction activities in the site boundaries would be monitored by an archaeologist.	GMUG's 2013 Prescribed Fire Programmatic Agreement
CR-6	Culturally Scarred Trees (CSTs) will be protected during mechanical treatments and to the extent possible, during underburns. Hand removal of fuels under CSTs will be conducted to the extent possible to reduce the risk of killing them during prescribed burning. However, no measures will be taken to create firelines or physically prevent burning around the CSTs.	GMUG's 2013 Prescribed Fire Programmatic Agreement
CR-7	Monitoring: For treatments where field inventories are not feasible due to visibility concerns prior to treatment implementation, monitoring in the form of a sample inventory for cultural resources will be required post implementation. This monitoring will take place within one year of treatment implementation, with results provided to SHPO. In addition, a sufficient sample of prescribed fire treated	GMUG's 2013 Prescribed Fire Programmatic Agreement

	Design Feature	Source
	areas will be monitored to assess the effectiveness of cultural resource protection measures outlined in CR-4 and CR-6 above.	
CR-8	Cultural resource sites that were required to be avoided during treatment implementation will be monitored for effectiveness of the protection measures following project completion.	GMUG's 2013 Prescribed Fire Programmatic Agreement
CR-9	Native American human remains: Any operator carrying out treatments must notify the Forest Service, by telephone, with written confirmation, immediately upon the discovery of human remains or funerary items, discovered on federal land. The Forest Service must then immediately notify appropriate tribes of the find. All treatment activities must stop in the vicinity of the discovery that could adversely affect it, until tribal consultation can be completed and a Plan of Action can be approved and implemented.	NAGRPA regulation 43 CFR 10.4(g)

Direct and Indirect Effects Common to All Action Alternatives

Following the stipulations of the Colorado National Forests Bark Beetle Programmatic Agreement (PA), areas potentially affected by project activities will be surveyed for cultural resources, such as prehistoric and historic archaeological sites and structures known or anticipated from the SBEADMR Project. These cultural resource field surveys will be conducted over the life of the project, as the annual program of work is developed for SBEADMR implementation. Design features derived in part from the PA and developed specifically for SBEADMR will be implemented to assure that cultural resources located within proposed treatments will be avoided and thus protected from direct, indirect and cumulative effects.

SBEADMR proposes a range of vegetative treatments within the APE. These include mechanical treatments, prescribed burning and chainsaw treatments where material could be piled by hand or machine. Potential effects will be addressed below for each of these broad treatment types.

Mechanical Treatment

Ground disturbance to prehistoric and archaeological sites can be caused by mechanical equipment if cultural resources are not avoided by the proposed design features. Mechanized logging equipment and fuels treatment, such as mastication, can be detrimental to surface as well as buried artifact scatters and sites. Impacts vary, but are related to types of timber harvest-yarding systems employed and use of either tractor-based or rubber tire-based equipment. The later typically produce less direct ground impacts due to reduced pressure (lbs./inch^2) on the ground. Tracked vehicles, such as bulldozers, can cause deep rutting, particularly in turning the vehicle during operations. The potential for detrimental impacts is greatest when the soil is wet, or when soil is exposed on steep slopes. The actual extent of detrimental disturbance that occurs depends not only on the inherent soil and site characteristics, but also the weather conditions during operations, as well as contract administration.

In addition, limited road reconstruction and the construction of temporary roads would be performed to access areas slated for mechanical treatment. The existing road network would primarily be used to access the proposed treatments and remove forest products, possibly supplemented with temporary road construction. The impacts to cultural resources related to primary skid trails, log landings, and temporary road construction will be of longer duration given the typical blading and repeated heavy use that they receive. Those impacts would be eliminated by application of design features, inherent to all action alternatives, to avoid cultural resource site areas.

Prescribed Burning

SBEADMR treatments rely heavily on the application of prescribed fire. The APE contains prehistoric artifacts made mainly of quartzite and chert, which sustain minimal damage from heat derived from prescribed fire applications. However, if conducted on a cultural resource site with high fuel loadings, a very large amount of hot fuel burning directly upon these rock types could shatter, pot lid-fracture, discolor, or even warp or melt them. When present, studies have shown that high damaging heat is generally limited to the upper 5-10 cm of the soil and surface; therefore, buried materials would not be impacted. However, large tree root systems burning below the ground surface can introduce high heat deeply into the soil. This mainly occurs when the roots were dead/dry prior to the burn, such as beneath standing snags or stumps. Large, piled fuels would have the greatest potential to damage artifacts and thin, dispersed fuels the least. Even when some surface artifacts are damaged from burning, many Native American or prehistoric archaeological sites retain their value since most of the deposit is buried, with the majority of significant mountain sites being between 10 and 30 cm deep, but this is not always true. Some sites contain hearths visible on the surface; such features could be physically damaged and any data obtainable from the charcoal, if present, such as carbonized seeds and macrobotanical remains, could be destroyed by reburning. This scenario would be quite rare due to previous natural fires, the weathering of surface cultural resource materials and the relatively long fire return intervals for spruce-fir and aspen stands covered by this analysis (Romme et al, 2006: 24; Sibold et al, 2006: 631-647; Shinneman et al, 2013). Overall, prehistoric sites are not avoided during prescribed burning but are treated to reduce hazard fuel buildup.

Historical and ethnographic sites contain more materials that are damaged by heat—glass, ceramic, wood and bone artifacts and features. Wooden structures, such as cabin remnants, sawmill slab piles, corrals, and wikiups (Native American habitations) would be destroyed by any level of direct burning. Wikiups are a rare and significant type of site. They are usually found in pinyon-juniper stands and mid-elevations. While unknown in the spruce-fir stands and rare in aspen stands, at least two examples of aspen pole wikiups are suspected in the GMUG NF. They are usually found today in remote areas that have not been treated with any kind of vegetation treatment. Wikiups sometimes have artifact scatters and visible hearths, as well as other cut trees, platforms and other features. These structures would be destroyed in a prescribed burn, especially a stand-replacing burn in pinyon-juniper or mountain shrub plant communities.

Concern exists for the protection of Native American/culturally scarred peeled ponderosa pine trees (CSTs). Generally, such trees are mature and do not have low-hanging limbs, but if they did, pruning would not harm them, and they are too large to be thinned pre-commercially. Sanitizing removal of insect-infested or at-risk trees, which may sometimes be part of a thinning prescription, may apply to some CSTs, in which case analysis must balance the needs of the health of the forest and the need for protecting CSTs and their setting as historical properties. This is a case-by-case consideration. CSTs may need to be identified as "special" to prevent fuel-wood gatherers from cutting them for fire wood. Because wildfire would also damage or destroy CSTs, most fuel treatments to reduce hazardous fuels are compatible with the CST sites; hand thinning/pruning brush and ladder fuels prior to prescribed burning and careful use of fellar-bunchers is an effective method of protecting these cultural properties. It is expected that the majority of such trees would survive prescribed burns and possibly some wildfires, and despite relatively long fire return intervals, most would have survived past fires already.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

All eligible or listed cultural resources will be avoided in the implementation of this alternative. In addition, any sites whose eligibility as not been determined will be avoided or subjected to a formal determination of eligibility if the site is located in proposed treatment areas during implementation.

Prior to treatment implementation, an intensive cultural resource inventory will be conducted. Significant cultural resources that are identified will be avoided prior to project implementation. Adequate buffer zones will be determined by the field office or USFS archaeologist and the sites will be monitored during and after implementation of the treatments to ensure compliance. If avoidance is not possible, other site mitigation measures will be completed prior to any implementation of the project. Successful avoidance of cultural resources negates any direct and indirect effects in this alternative.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

All eligible or listed cultural resources will be avoided in the implementation of this alternative. In addition, any sites whose eligibility as not been determined will be avoided or subjected to a formal determination of eligibility if the site is located in proposed treatment areas.

Prior to treatment implementation, an intensive cultural resource inventory will be conducted. Significant cultural resources that are identified will be avoided prior to project implementation. Adequate buffer zones will be determined by the field office or USFS archaeologist and the sites will be monitored during and after implementation of the treatments to ensure compliance. If avoidance is not possible, other site mitigation measures will be completed prior to any implementation of the project. Successful avoidance of cultural resources negates any direct and indirect effects in this alternative.

Cumulative Effects Common to Both Action Alternatives

Past and future actions that include historic grazing regimes, off-road vehicle use and other recreational activities can result in substantial ground disturbance and cause cumulative, long-term, irreversible adverse effects to paleontological and cultural resources. Some of the project area has previously been subject to mechanized logging and some of it has been chained or re-planted with trees. Illegal off-road vehicle use, which is increasing throughout the state, is also accelerating erosion to surface archaeological sites. Over time, fewer archaeological resources will be available to learn about past human lifeways, to study changes in human behavior through time, and to interpret the past to the public.

While it is hard to determine cumulative effects on unidentified archaeological sites, the two action alternatives would not greatly increase cumulative impacts to known cultural resources because all identified sites in the project area will be protected and avoided. Some minor resources, such as historic artifact scatters, could become scarcer due to prescribed fires and mechanical treatments; these features are not generally significant. Implementation of the SBEADMR project will be conducted in accordance to Section 106 of the NHPA under the USFS Programmatic Agreement (2015 Programmatic Agreement for Bark Beetle, Hazardous Fuel and Tree Reduction Programs). Currently, there are no known traditional cultural properties within or adjacent to the project area. Tribal consultation was initiated in September of 2013 to determine any possible locales that have not been previously identified. To date the GMUG has not received any comments or concerns from the tribes.

Economics

Changes Between Draft and Final

The analysis has been revised to include:

- Inclusion of 10-county GMUG analysis area in economic impact analysis;
- Updated inputs on alternative activities (e.g. harvest volumes, acres of non-commercial activities);
- The list of activities included in the stumpage rate (and therefore excluded from the PNV calculations) were modified;
- Inclusion of additional discussion on timber market in GMUG counties regarding historic cut and sold production and values and the capacity of the region to process by-products for energy (additional references include Headwaters Economics 2015 and Colorado State Forest Service 2016).

Compliance with Regulatory Direction

Multiple statutes, regulations and executive orders identify the general requirement for the application of economic and social evaluation in support of Forest Service planning and decision

making. These include, but are not limited to, the Multiple-Use Sustained Yield Act of 1960 (74 Stat. 215: 16 USC 528-531), National Environmental Policy Act of 1969 (83 Stat. 852; 42 USC 4321, 4331-4335, 4341-4347), and the Planning Act of 1974. CEQ regulations for implementing NEPA [40 CFR 1500-1508] do not require a monetary benefit-cost analysis. However, if an agency prepares a financial efficiency analysis, then one must be prepared and displayed for all alternatives [40 CFR 1502.23].

Office of Management and Budget (OMB) Circular A-94 suggests agencies prepare an efficiency analysis as part of project decision-making, using present net value (PNV) as the criterion.

Timber sales are guided by agency direction found in Forest Service Manual (FSM) 2430. Economic efficiency analysis is guided by Forest Service Handbook (FSH) 2409.18. Forest Service Handbook (FSH) 2409.19, Chapter 60 – Stewardship Contracting, provides direction for applying revenues generated from timber sales to achieve restoration and land management activities.

Executive Order 12898 requires federal agencies to identify and address any adverse human health and environmental effects of agency programs that disproportionately impact minority and low-income populations. The Order also directs agencies to consider patterns of subsistence hunting and fishing when an agency action may affect fish or wildlife.

Analysis Methodology

Indicators used in the analysis of economic effects include Present Net Value (PNV) in the financial efficiency analysis and jobs and labor income in the economic impact analysis. Maximum values were used for the inputs for the analysis (such as acres burned and timber harvested, costs of treatment and revenue). Since the costs are likely more variable, the resultant PNV can be interpreted as potential upper bound values for monetized, or marketed, costs and benefits.

Non-market values, such as the value of recreation experiences and ecosystem services, are difficult to quantify. Direction provided in 40 CFR 1502.23 and Forest Service Handbook 1909.15 (7/6/04) and 22.35 (01/14/05) provides for the use of qualitative analysis to evaluate the effects of these non-market values. Since proposed activities are anticipated to improve current resource conditions, these activities are highly likely to increase non-market values (benefits) associated with the natural resources within the SBEADMR project area. Since these non-market benefits are not included in the PNV, it is important to recognize that this study presents an agency financial efficiency analysis, rather than a Benefit-Cost Analysis intended to capture the ‘total economic benefits’ of society.

Financial Efficiency (PNV)

Financial efficiency is a comparison of the costs and benefits that can be quantified in terms of actual dollars spent or received in the analysis area over the life of the project. As the Forest Service Handbook 2409.18 indicates, this analysis provides a comparison of anticipated costs and revenues that are part of Forest Service monetary transactions. Given the information provided, financial efficiency measures are calculated in this analysis to provide a means of comparing the financial efficiency of alternatives. This analysis offers a consistent measure for comparison of alternatives, however, it should not be viewed as a complete answer, but as only an examination of trade-offs between costs and benefits.

The alternatives are compared using a financial efficiency measure called Present Net Value (PNV). The foundation behind the PNV calculations is the "Time Value of Money Principle," which states that money received now is worth more than some amount received in the future. A 4-percent discount rate is commonly used for evaluations of long-term investments and operations in land and resource management by the Forest Service (FSM 1971.21). This discount rate is used in the calculation of PNV. A positive PNV suggests the discounted sum of benefits is greater than the discounted sum of costs, and a negative PNV suggests the opposite.

The financial efficiency analysis is specific to the timber harvest and ecosystem management associated with the project (as directed in Forest Service Manual 2400–Timber Management and guidance found in the Forest Service Handbook 2409.18).

Costs that were not included in the stumpage rate, such as broadcast and pile burning, mastication, and contract administration are included in the PNV calculations. The road costs and some of the commercial timber harvest costs are built into the stumpage rate so including them in the PNV analysis would be redundant. The average stumpage rate for the area ($20 per CCF) was used to calculate revenue from the timber harvest per alternative. This stumpage rate was estimated from average bids over the past few years and is based on spruce harvest. The expected revenue is the stumpage rate of $20 per CCF multiplied by the amount of timber harvested. The actual timber value will depend on the market when the timber is sold, and may be higher or lower than this stumpage rate.

This analysis is not intended to be a comprehensive benefit-cost or PNV analysis that incorporates a monetary expression of all known market and non-market benefits and costs that is generally used when financial efficiency is the sole or primary criterion upon which a decision is made. Forest management is expected to yield positive benefits, but not necessarily financial benefits.

Regional Economic Impact Analysis

The economic impacts to the local economy affected by the proposed treatments are measured by estimating the employment (full- and part-time jobs) and labor income generated by (1) the processing of the timber volume from the project, and (2) the dollars resulting from restoration

activities. The direct employment and labor income benefit employees and their families and, therefore, directly affect the local economy. Additional indirect and induced multiplier effects (ripple effects) are generated by the direct activities. The total economic impact of restoration activities includes the direct, indirect, and induced effects and is measured through response coefficients[20] unique to the SBEADMR project analysis area.

The impacts on the analysis area were calculated based on SBEADMR activities that are expected to be carried out by contractors. If the work is completed by Forest Service staff, then the impacts were assumed to already be considered in the Forest Plan. For example, mastication activities are expected to be carried out by contractors, therefore these actions would directly impact jobs and labor income in that sector and were not previously analyzed.

The economic impact analysis estimates impacts at the regional level because it is uncertain at the county level where the spending will occur. For example, it is uncertain where SBEADMR mastication contractors will come from (how many per county) and where they will spend their income. Therefore, the economic impacts are estimated for the 10- and 22-county analysis areas, which better captures direct spending by individual firms in multiple counties and spending between firms across county lines.

Demand for goods and services provided by the GMUG National Forests can contribute to employment and income in the analysis area. At the local level, these jobs and income can have greater impacts on the smaller communities than at the larger regional scale. However, if demand exists for the commercial products, employment and income would likely still exist even if these goods and services were not provided by the GMUG. For example, the demand for paper made from timber harvest would likely be met by other suppliers at a larger regional scale if the commercial products were not produced from the SBEADMR project. The discussion of potential jobs and income impacts should occur alongside consideration of non-market values and financial efficiency for a more complete understanding of the economic impacts.

Treatment Estimates

The annual estimates below are expected to be implemented over an approximately 8-12 year implementation timeframe. Cumulative totals are the maximum number of treatment acres and harvested volume, or CCF, analyzed in this FEIS. While the project is not constrained to a 10 year timeframe, this period is used for purposes of estimating costs and benefits over time.

[20] Response coefficients are rates of response of the local economy to each dollar spent by the Forest Service or by users of National Forest resources (i.e. recreation visitors) in private sector businesses. These are generated using IMPLAN software.

Not all of the costs are included in the economic impacts analysis because if the activities are expected to be carried out by Forest Service staff, these costs were already analyzed in the Forest Plan. *Contracted costs* are used to analyze economic impacts to employment and labor income.

However, all of the costs are used in the *financial efficiency analysis* to be able to compare costs to benefits of the proposed activities, with the exception of those costs already included in the stumpage rate. For example, road costs are already incorporated in the stumpage rate of $20/ccf, so it would be redundant to include them as additional line items in the financial efficiency/PNV analysis. However, because some of the road activities would be carried out by contractors, and these contractors would receive associated labor dollars, such road activities are included in the *economic impact analysis*.

This report assumes that the resiliency harvest volume is 10 ccf per acre (e.g. 3,600 acres * 10 ccf per acre to get total resiliency harvest volume of 36,000 ccf) and salvage harvest volume is 20 ccf per acre (2,400 acres * 20 ccf per acre to get total salvage harvest volume of 48,000 ccf).

Treatment costs within the Wildland Urban Interface (WUI) are expected to be greater than costs outside of the WUI. This is reflected in the sale preparation costs in Table 320 ($647 per acre for WUI sale preparation treatments and $347 per acre for non-WUI sale preparation treatments). This increased cost for WUI treatments is due to such activities as the temporary closure of roads and hazard tree removal. For the Proposed Action only, WUI treatments are assumed to be the salvage acres and non-WUI treatments are resiliency acres.

Table 320. Annual Treatment Estimates and Cost per Alternative.

COST CATEGORY	Alt. 2 units	Alt. 3 units	Price per unit	Unit
NON-COMMERCIAL ACTIVITIES				
PRESCRIBED FIRE				
Broadcast Burning Maximum (WUI)	0	2,000	$ 125	acre
Broadcast Burning Maximum (WUI & Non-WUI)	2,500	0	$110	acre
Pile Burning[21]	500	500	$30	acre
MECHANICAL				
Mastication (WUI)	1,000	2,000	$500	acre
Mastication (Non-WUI)	1,000	0	$400	acre

[21] Pile burns are applied to a subset of the noncommercial mechanical acres.

COST CATEGORY	Alt. 2 units	Alt. 3 units	Price per unit	Unit
Contract Administration[22]	750	1,500	$25	acre
Lop and Scatter (WUI & non-WUI)	500	500	$150	acre
Thin and Pile (WUI & non-WUI)	500	500	$150	acre
COMMERCIAL ACTIVITIES				
TIMBER HARVEST REVENUE				
Resiliency Timber Volume	36,000[23]	42,000	$20	ccf
Salvage Timber Volume	48,000[24]	39,000	$20	ccf
Weed Spraying*	180	180	$205	acre
Sale Preparation: WUI	2,400[25]	6,000	$647	acre
Sale Preparation: Non-WUI	3,600[26]	0	$347	acre
Sale Administration	4,500	4,500	$25	acre
Site Preparation*	1,500	500	$152	acre
Planting*	1,000	500	$400	acre
Regeneration Surveys*	3,000	2,500	$25	acre
Plantation Survival Exams*	1,000	500	$17	acre
Pile Burning*	4,620	5,500	$30	acre
ROADS				
Surface Replacement Collections*	420,000	420,000	$2	ccf-mile
Road Construction*	18	8	$9,700	mile
Road Reconstruction*	54	34	$20,900	mile
Road Decommissioning*	36	17	$3,000	mile
Road Maintenance*	71	50	$4,400	mile

[22] Only a subset of the noncommercial mechanical acres would be administered under contract.

[23] Volume generated via the following equation: 3,600 resiliency acres * 10 ccf/acre = 36,000 ccf.

[24] Volume generated via the following equation: 2,400 salvage acres * 20 ccf/acre = 48,000 ccf.

*These costs have already been included in the stumpage price and therefore are excluded from the PNV calculations.

Affected Environment

The GMUG lies within Delta, Garfield, Gunnison, Hinsdale, Mesa, Montrose, Ouray, Saguache, San Juan, and San Miguel counties. However, the SBEADMR project area is expected to impact a wider region based on the location of commercial harvesting and processing. The analysis area was chosen based on the location of contractors for processing forest products and materials from the GMUG forests. In addition to the GMUG counties listed above, the area with likely economic impacts from this project includes Archuleta, Chaffee, Dolores, Eagle, Fremont, La Plata, Lake, Mineral, Montezuma, Pitkin, Rio Grande, and Summit counties. The area's social and economic characteristics are dependent on the extent of the area examined, thus area information is presented for the potentially affected 22-county region.

The effects analysis presented below includes a discussion of the economic impacts in the GMUG 10-county area. Over the life of the SBEADMR project, timber processors and contractors could be located in the broader 22-county area, but it is also important to detail the effects of timber processing on the smaller GMUG area. However, while the timber originates from the counties containing GMUG land, the indirect and induced economic impacts are likely better captured in the broader analysis area.

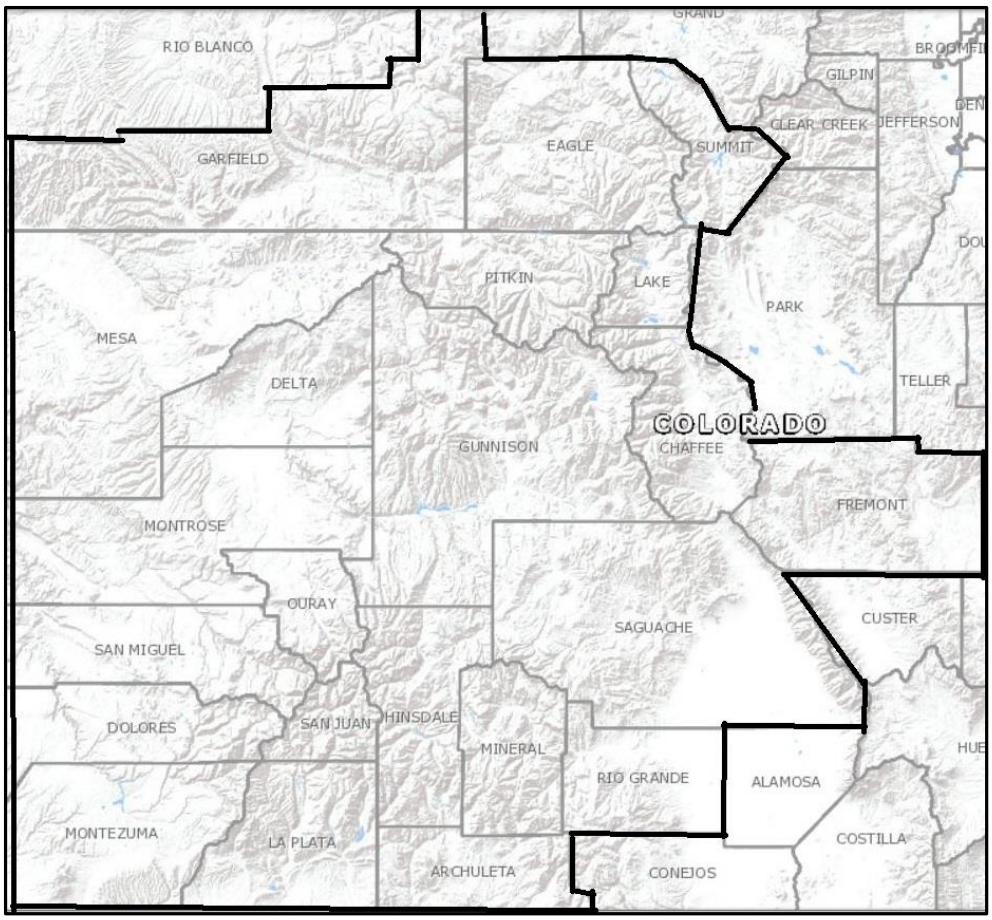

Figure 64. Map of SBEADMR economic analysis area.

Population and Demographic Change

From 2000 to 2012, the population of the 22-county analysis area grew from 495,904 to 581,853, a 17.3 percent increase. The growth seen in the analysis area exceeded the national growth rate and Colorado's (9.8 and 17.2 percent, respectively). San Juan County had the largest change in population, a 34 percent increase. Mineral County had the greatest decrease in population, a 16 percent change (U.S. Department of Commerce 2013).

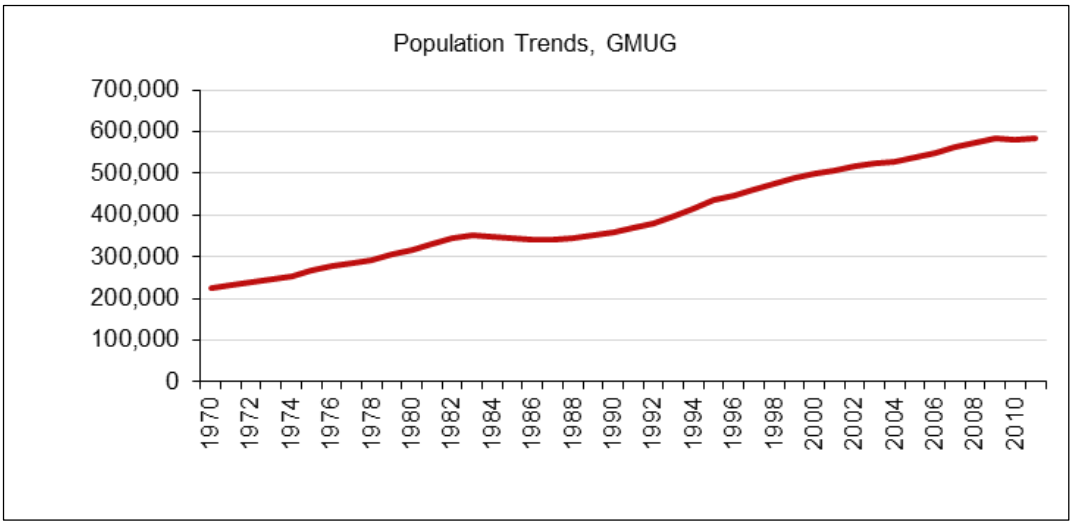

Figure 65. Population change in the 22-county analysis area between 1970 and 2010 (U.S. Department of Commerce 2013b).

Employment

From 2001 to 2013, total private employment in the 22-county analysis area increased from about 294,000 to 332,000 jobs, a 13 percent increase (U.S. Department of Commerce 2013b). Much of this growth is attributable to employment in services-related sectors shown in Figure 66, where total employment in the analysis area is disaggregated into three industry groupings: services-related sectors, non-services related sectors, and government. Services-related sectors consist of the following sectors: Utilities, Wholesale Trade, Retail Trade, Transportation and Warehousing Information, Finance and Insurance, Real Estate and Rental and Leasing, Professional, Scientific, and Tech., Mgmt. of Companies and Enterprises, Administrative and Support Services, Educational Services, Health Care and Social Assistance, Arts, Entertainment, and Recreation, Accommodation and Food Services, and Other Services. Non-services related sectors consist of the following sectors: Mining, Construction, Manufacturing, and Agriculture, Forestry, Fishing, and Hunting (EPS-HDT 2012).

For total private employment, from 2001 to 2011, employment in services-related sectors increased from 76 percent to 80 percent while employment in the non-services related sectors decreased from 24 percent to 20 percent (U.S. Department of Commerce 2013b). Thus the services-related sectors have historically been an important part of the area economy and have increased in importance.

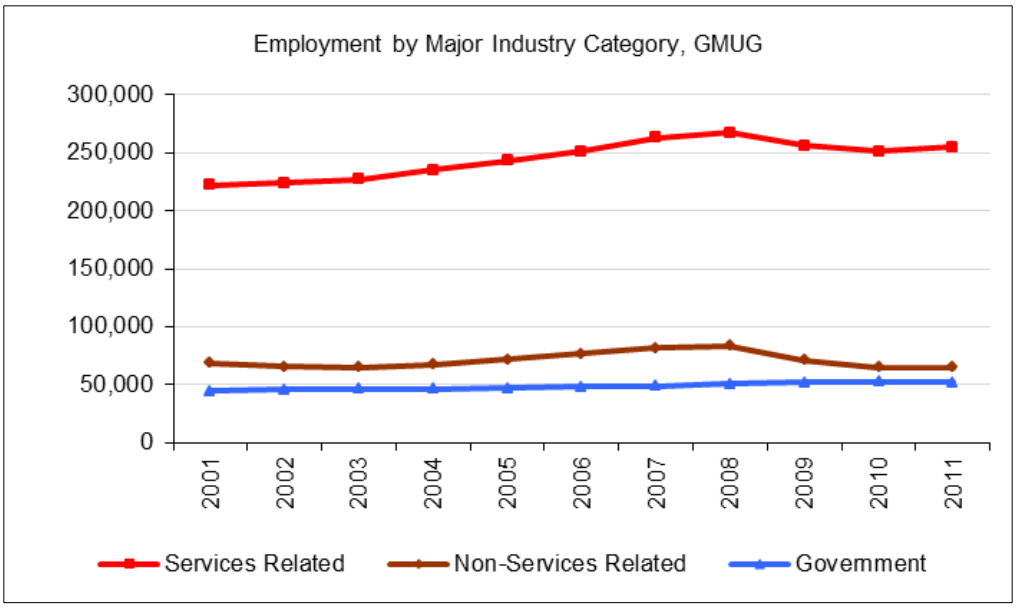

Figure 66. Services and Non-Services employment history (U.S. Department of Commerce 2013b).

Employment specialization within the 22-county analysis area is distributed amongst industry sectors and displayed below in Figure 67 (IMPLAN 2012).[27] Identification of employment specialization for the analysis area provides a frame of reference for effects from changes in management from the SBEADMR project. Specialization is examined using the ratio of the percent employment in each industry in the region of interest (22-county analysis area) to the percent of employment in that industry for a larger reference region (the state of Colorado). For a given industry, when the percent employment in the analysis region is greater than in the reference region, local employment specialization exists in that industry (USDA Forest Service 1998). Of particular interest is where specialization occurs within industries related to SBEADMR management, such as forest products. The potential impacts on the electric power generation, transmission, and distribution are also important to consider if the salvaged wood is used for energy production in the region. It should be noted that the contributions from the SBEADMR project represent only a portion of the economic activity reflected in industry sectors seen in Figure 68.

[27] The numbers in Figure 66 are not directly comparable to the IMPLAN numbers in Figure 67 since IMPLAN data include government, farm and proprietor employment in addition to wage and salary employment. The IMPLAN data also includes estimates for non-disclosures that similarly include farm and proprietor employment in addition to wage and salary employment.

Figure 67. Analysis area employment specialization (IMPLAN 2012).

Using this method to determine specialization applied with 2012 data, the analysis area can be characterized as most specialized in the Accommodation and Food Services, Construction, and Arts, Entertainment, and Recreation sectors, and slightly specialized in the Electric power generation and Logging sectors since the percent of total employment in the analysis area is 0.1 percent greater than in the state of Colorado (IMPLAN 2012). As Figure 69 illustrates, 46 percent of logging jobs in the state are in the 22-county analysis area, 17 percent of wood manufacturing jobs in the state are located in the analysis area and 16 percent of the electric power jobs in the state are in the analysis area.

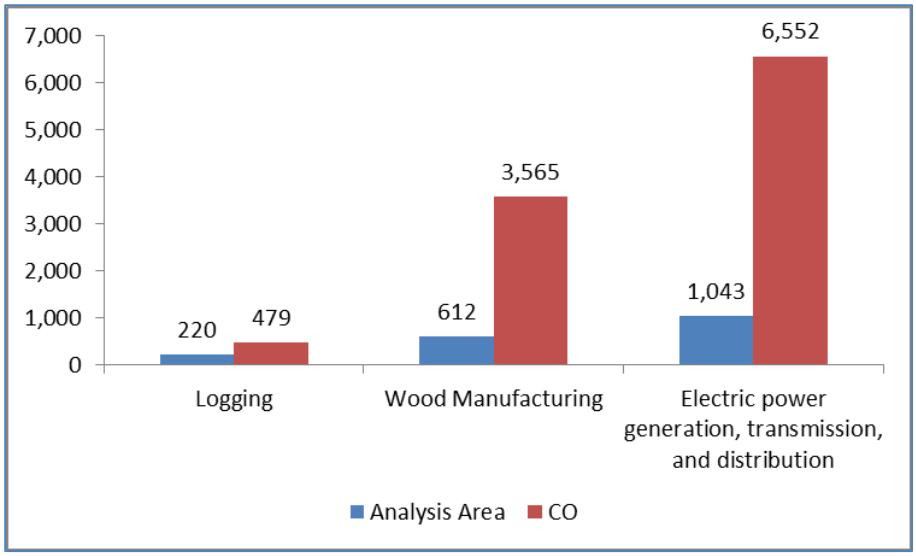

Figure 68. Employment in sectors related to SBEADMR management (IMPLAN 2012).

Economic Well-Being and Unemployment

While the services-related sectors have increased, in general, the service-related sectors do not pay as much as the non-services sectors, thus increases in the percent of total employment attributable to these sectors could decrease area economic well-being. Within the analysis area, the services and non-services related sectors paid average annual wages of $34,911 and $51,240, respectively, in 2012 inflated to 2013 dollars (U.S. Department of Labor 2013). Thus, increases in employment in sectors associated with lower wages alongside decreases in sectors associated with higher wages could indicate a decrease in area economic well-being. However, some people might move to the area and take a lower paying services-related sector job in exchange for the opportunity to experience unique natural and cultural amenities. Population and employment changes are related to natural amenities (Mueser 1995, Lewis 2002) often provided by public lands. The GMUG operates as a steward of many of these natural amenities and consequently supports a portion of area population and employment growth.

Total personal income (TPI) and per capita personal income (PCPI) are useful measures of economic well-being. From 2000 to 2013, annual TPI in the economic analysis area increased from $19 billion to $23.9 billion, and annual PCPI increased from $38,023 to $40,648 (all measures adjusted for inflation to 2013 dollars). This translates to a TPI increase of 26 percent and a PCPI increase of 6.9 percent over this time period (US Department of Commerce 2013b).

While PCPI is a useful measure of economic well-being, it should be examined alongside changes in real earnings per job. Since PCPI includes income from 401(k) plans as well as other non-labor income sources like transfer payments, dividends, and rent, it is possible for per capita income to rise, even if the average wage per job declines over time. Compared to the state of Colorado, the average earnings per job and PCPI in the analysis area ($39,824 average earnings per job and

$40,648 PCPI) were much lower in 2013 than for the state ($54,554 average earnings per job and $46,897 PCPI) (US Department of Commerce 2013b).

From 2000 to 2012, average annual unemployment rates in the analysis area increased alongside national and state rates from 3.2 to 8.5 percent. Starting in 2007, unemployment followed state and national trends and rose to 9.6 percent in 2010 and then began to decline (US Department of Labor 2013).

Components of Personal Income

Further examining trends within personal income provides insight to the area economy and its connection to the GMUG lands. There are three major sources of personal income: (1) labor earnings or income from the workplace, (2) investment income, or income received by individuals in the form of rent, dividends, or interest earnings, and (3) transfer payment income or income received as Social Security, retirement and disability income or Medicare and Medicaid payments.

Labor earnings were the largest source of income in the analysis area accounting for 58.9 percent of all income in 2012 (U.S. Department of Commerce 2013b). Labor earning's share of TPI has decreased from 1970 to 2012 (from 71.6 to 58.9 percent) while the share of non-labor income has risen (from 28.4 to 41.1 percent). As a share of TPI, investment income and transfer payments rose from 16.8 to 25.7 and 11.6 to 15.5 percent, respectively, over this 40-year time period (U.S. Department of Commerce 2013b).

These patterns reflect the importance of the aging population, who are more likely to have investment earnings than younger adults. As the population of the area continues to age, the share of income from these non-labor sources should continue to rise as long as residents continue to stay in the area after retirement or new retirees move in. As noted above, the development of rural recreation and retirement-destination areas are related to natural amenities (Mueser 1995, Lewis 2002) often provided by public lands. The GMUG operates as a steward of many of these natural amenities and consequently supports a portion of non-labor income.

Using the specialization criterion applied with 2012 data, the analysis area can be characterized as most specialized in the Accommodation and Food Services, Transportation and Warehousing, and Construction sectors (shares of total labor income in these sectors are, respectively, 3.7, 3.5 and 3 percent greater than shares in the state, as seen in Figure 70 below). The 22-county area can also be considered slightly specialized with respect to the Electric power generation sector since the percent of total labor income in the analysis area is 0.1 percent greater than in the state of Colorado (IMPLAN 2012).

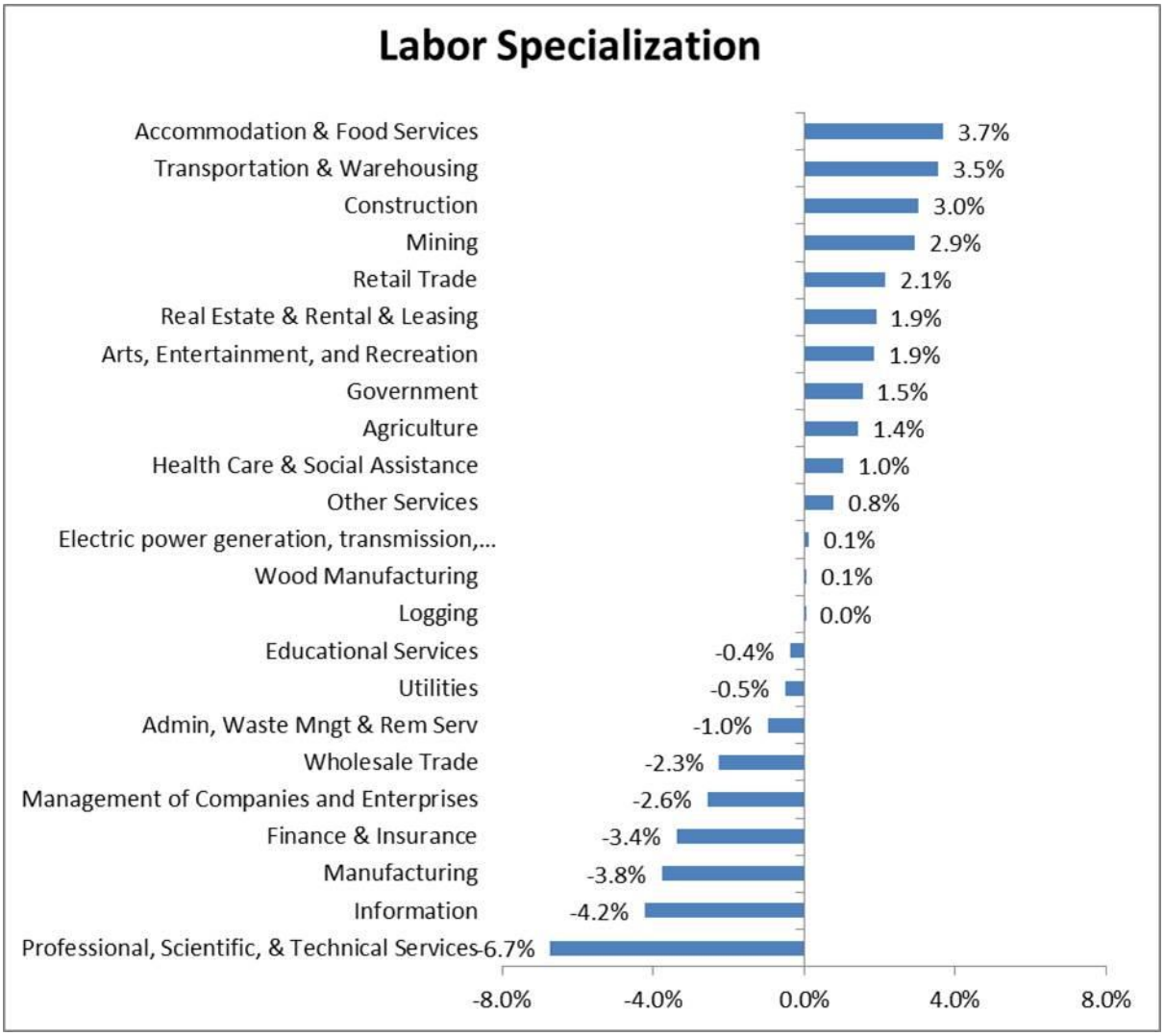

Figure 69. Analysis area labor income distribution and specialization (IMPLAN 2012).

Environmental Justice

Executive Order 12898 states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." In order to make this determination, "Agencies should consider the composition of the affected area, to determine whether minority populations, low-income populations, or Indian tribes are present in the area affected by the proposed action, and if so whether there may be disproportionately high and adverse human health or environmental effects on minority populations, low-income populations, or Indian tribes."

The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The CEQ has interpreted health effects with a broad definition: "Such effects may

include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities or Indian Tribes …when those impacts are interrelated to impacts on the natural or physical environment" (CEQ 1997).

Race and Ethnicity

According to CEQ (1997) guidance, "minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis."

Colorado's population is predominately white and significantly less diverse than the general U.S. populations. However, Table 321. Racial and Hispanic Composition of 2012 Population in the 22-County Analysis Area (U.S. Department of Commerce 2013). indicates that the 22-county region's share of those identifying themselves as American Indian and Alaska Native was higher than the Colorado and U.S. levels, but not by a meaningfully greater amount (U.S. Department of Commerce 2013). Montezuma County was estimated to have the highest percent of those identifying themselves as American Indian and Alaska Native, 11.2 percent (U.S. Department Of Commerce 2013). Rio Grande, Saguache and Lake counties reported the highest percent of individuals that identified themselves as Hispanic (42.8, 41.3, and 34.2 percent of total population, respectively). Therefore, minority populations appear to exist in Montezuma, Rio Grande, Saguache, and Lake counties and potential effects from the alternatives to these groups will be discussed below.

Table 321. Racial and Hispanic Composition of 2012 Population in the 22-County Analysis Area (U.S. Department of Commerce 2013).

Location	White Alone	Black or African American Alone	American Indian and Alaska Native Alone	Asian Alone	Native Hawaiian and Other Pacific Islander Alone	Some Other Race Alone	Two Or More Races	Hispanic or Latino Origin
United States	63.7%	12.2%	0.7%	4.8%	0.2%	0.2%	2.0%	16.4%
Colorado	70%	3.8%	0.6%	2.7%	0.1%	0.2%	2.1%	20.6%
County Region	78.2%	1.0%	1.4%	0.7%	0.1%	0.2%	1.4 %	17.1%

Poverty

Poverty is an important indicator of both economic and social well-being. Individuals with low incomes are more vulnerable to a number of hardships which may negatively affect their health, cognitive development, emotional well-being, school achievement and which may promote socially unacceptable behavior (Hopson 2011). In general, low-income individuals tend to rely more heavily on natural resources and depend more directly on NFS lands for sustenance and

home heating. Since these individuals will be more vulnerable to changes in the management of local resources, it is important for forest management to understand how these forest users may be affected by restricting forest uses. The Census Bureau uses a set of income thresholds to determine poverty levels.

According to the CEQ (1997) guidance, "low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports." As seen in Figure 70, the SBEADMR analysis area has the same poverty levels as Colorado and lower poverty rates than the U.S. However, Saguache County has far higher poverty levels than the state and country and likely meets the CEQ's Environmental Justice criterion for low-income populations.

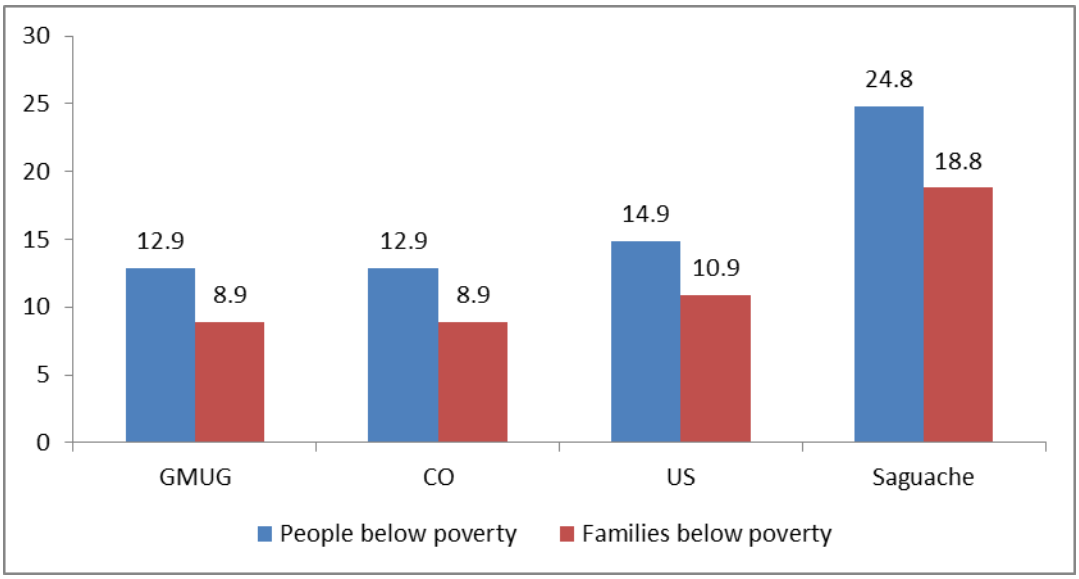

Figure 70. Individuals and families living below the poverty level, 2012 (U.S. Department of Commerce 2013).

Timber Market

In general, since the 2008 recession, the market for timber in the Western U.S. has experienced a prolonged decline which has caused wood product prices and production to drop. "Capacity utilization at sawmills and other timber-using facilities in the West fell from over 80 percent in 2005 to just over 50 percent in 2009 and 2010" (Keegan 2011). However, since 2010, timber production and value has slightly increased in the GMUG Forests, as seen in Figure 71 below (Headwaters Economics 2015).

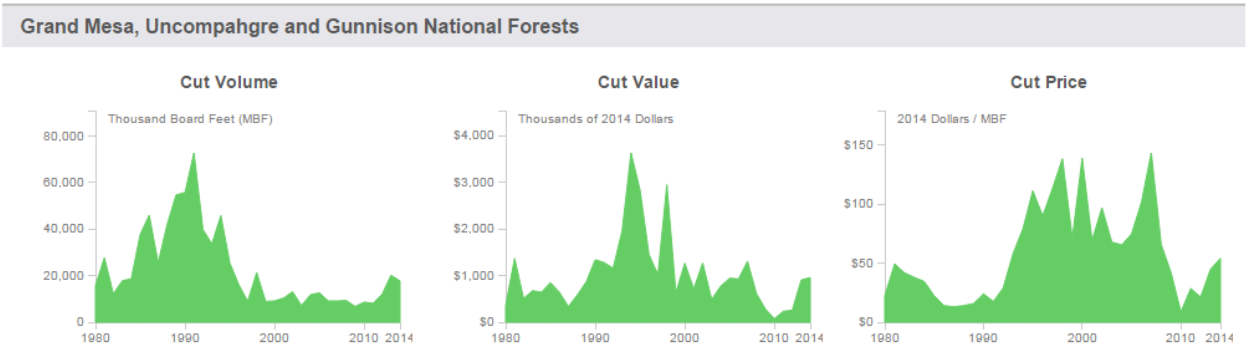

Figure 71. GMUG Cut and Sold Report 1980-2014 (Headwaters Economics 2015)

There is capacity for expanding markets, such as salvaged timber for use as biomass in the energy industry. For example, "Across Colorado, many communities, governmental and educational facilities are choosing woody biomass as an energy source as it becomes an increasingly attractive renewable and carbon neutral resource" (Colorado State Forest Service 2016). According to the Colorado State Forest Service, there are currently nine facilities in Colorado that are using biomass for energy, as seen in Figure 72 below (Colorado State Forest Service 2016). With an increase in supply of wood products, the capacity to produce energy from biomass could change.

Current Facilities in Colorado Using Biomass	
Location	**Facility Type**
Boulder County	3.3 MMBtu/hr wood chip boiler
South Routt School District	600,000 Btu/hr wood pellet boiler
National Renewable Energy Lab in Golden	9.9 MMBtu/hr wood chip boiler
Gilpin County	3.3 MMBtu/hr wood chip boiler
Mountain Park Environmental Center	Two manually fed 425,000 Btu/hr cordwood boilers
Colorado State University Foothills Campus	1.5 MMBtu/hr wood chip boiler
Mountain Parks Electric	1.1 MMBtu/hr wood pellet boiler
Jim Hubbard Fire Management Building	150,000 Btu/hr wood pellet boiler
Gypsum, CO	11.5 MW woody biomass Combined Heat & Power

Figure 72. Facilities in Colorado Using Biomass (Colorado State Forest Service 2016)

An analysis of the market for salvageable timber (Prestemon 2013) evaluated the feasibility of harvesting and increasing mill capacities in the Western states, including Colorado. The authors found that Colorado had one of the highest amounts of dead salvageable timber, with the largest volumes on National Forest land. The analysis revealed that the costs were greater than the revenue, most likely due to the high volume per acre removed, the resulting market saturation and lower market prices. In addition, Prestemon (2013) found that the effects of an expansion in processing capacities are smaller when only pulpwood mills are considered (not sawtimber mills) because pulpwood has lower value relative to costs. When considering the duration of expected salvage supply, when the supply is fixed due to a declining epidemic situation, the prices become

less depressed; whereas if the beetle epidemic continues and salvageable timber supply is more dynamic, the prices are more likely to decline (Prestemon, 2013).

Another source of salvaged timber is from wildfires, which can be a substantial shock to timber markets. Following a wildfire, some of the dead timber is salvaged and brought to market, similar to the effect of beetle epidemics. This can flood markets, temporarily decreasing the price of timber. While processing capacity is generally too low to lead to a substantial price shock, the price of timber may increase over the long-run due to the overall reduction in timber inventories (Mercer 2000).

Non-Market Values

Because some recreational and environmental values are not traded in markets, they can be characterized as non-market values. Non-market values can be broken down into two categories, use and non-use values. The use-value of a non-market value is the value to society from the direct use of the asset; within the GMUG this occurs through recreational activities such as hiking, bird watching and OHV use. Viewing aspen groves is another popular recreational activity. The use of non-market goods often requires consumption of associated market goods, such as lodging and gas.

Non-use, or passive use, values of a non-market value reflect the value of an asset beyond its current use. These can be described as existence, option and bequest values. For example, an existence value for the GMUG might be the value individuals place on the mere existence of undeveloped scenic landscapes in the GMUG. In addition to implicit existence values, society's willingness to pay to preserve resources for future use attaches additional passive use values. The potential benefits people would receive from future use are referred to as option values when future use is expected to occur within the same generation and bequest values when preservation allows future generations to benefit from resource use. Within the GMUG, bequest and option values might exist for numerous plant species, aspen ecosystems, undeveloped scenic landscapes, wild and scenic rivers, heritage sites, and recreational trails. Rosenberger (2012) found that "non-use benefits are more than three-and-a-half times greater than recreation-use benefits." While it is difficult to quantify the significance of the non-use benefits for the SBEADMR due to unavailable information, the Rosenberger finding demonstrates that these non-use values can hold significant value and should be considered alongside the quantitative analysis.

The current damage to the GMUG from the spruce beetle and Sudden Aspen Decline may have multiple effects on non-market values. For example, the visible damage to the trees may impact the aesthetic values people derive from visiting the forest. This is partially reflected in the property values in the local area. According to Rosenberger (2012), "healthy trees add positive value to a property through aesthetic value, ecosystem services, and increased owner satisfaction." There is also evidence that forest pests, such as the spruce beetle, can reduce the quality and visitation rate for recreation. When viewsheds are impaired and the dense forest

necessary for certain game species is not available, visits for wildlife viewing and hunting may decline (Rosenberger 2012).

While use and non-use values exist in the SBEADMR analysis area, valuation is not always feasible during the planning process; however, this does not preclude their consideration. Other public involvement efforts for projects in the area indicate that non-market values exist for recreation opportunities, land uses of traditional and cultural importance, and natural amenities managed by the GMUG. There is also value associated with restoration actions and a healthy Forest, such as long-term supply of ecosystem services (e.g. water quality, air quality, and biodiversity).

Alternative 1 (No Action) – Direct, Indirect and Cumulative Effects

No direct effects on the local economy would occur under the No Action Alternative. Within the 22-county analysis area, economic conditions and trends (employment, labor income, unemployment, TPI, PCPI, non-labor income, etc.) would not change relative to the SBEADMR project since no actions would be taken. In addition, any potential revenue from the sale of timber would not be realized under the No Action Alternative.

Indirect effects on local economic conditions could occur as a result of the No Action Alternative. Greater non-prescribed wildland fire-related costs could result if fuels are left untreated under the No Action Alternative. Potential threats and costs to human life, property and fire-fighter safety under the No Action Alternative would be greater than under the Proposed Action and Alternative 3. Where hazardous fuels have been treated, fire suppression costs near values at risk, and associated risk to life and property should be less when wildland fires occur compared to areas where fuels have not been treated. However, it is not possible to predict the level and costs of non-prescribed wildland fire under the No Action Alternative.

Additionally, it is likely that the GMUG would close more areas to recreation, absent the wide-ranging hazard tree treatments included in the action alternatives. Visitors would be displaced which could change the distribution of recreation-related revenue.

Under the No Action Alternative, the impacts to some ecosystem services may be more severe. For example, for some observers, there would be higher negative impact to viewsheds from the expanses of dead, dying, and fallen trees now and in the long-term compared to the other alternatives. Although these services are difficult to quantify, they should be considered. The lack of measurable direct and indirect effects translates to a lack of measurable cumulative effects to economic conditions under the No Action Alternative.

Environmental Justice

As indicated in the discussion above, minority and low-income populations exist in the area. While the No Action Alternative is not expected to have a disproportionately high and adverse

human health or environmental effect on these communities, increased susceptibility to wildfire could result. Consequently, additional unmeasurable indirect economic effects associated with increases in wildland fire-related costs are possible, which could result in impacts to local communities. However, there is no reason to suspect that any impacts will disproportionately affect minority and low income populations.

Direct and Indirect Effects Common to All Action Alternatives

Treatment Costs

Vegetation treatment is associated with a decrease in wildfire suppression costs and a decrease in net resource damage (Mercer 2000). Treatments conducted within the wildland urban interface (WUI) are likely more expensive than treating non-WUI lands. One study found that mechanical "treatments occurring within the WUI were on average 62 percent more expensive than treatments occurring outside the WUI" (Calkin and Gebert 2006). The costs of treatment could potentially be underestimated if treatments were implemented within the WUI. The cost of sale preparation for salvage treatments includes both roadside (WUI) and non-roadside costs.

Fuel reduction projects in and outside of the WUI can significantly reduce the risk of damage to values at risk from catastrophic wildfire (WFLC 2010). However, assessing the cost-benefit ratio of fuel reduction projects is questionable without information on the degree to which treatment reduces the risk of wildfire near values at risk. Furthermore, the scale and cost of prevented wildfire damage to values at risk is uncertain and widely variable. Anticipated reductions in the threat to human life and decreases in wildland fire-related costs such as property loss, lost revenues and suppression costs are not included in the analysis of PNV for the alternatives. While the PNV of treatments is negative under all alternatives, the prevention of damage to values at risk from one large fire could significantly increase the PNV of treatments.

As a result of the treatments proposed under all of the alternatives, the long-term provision of forest products will provide the opportunity for timber market stewardship contracting and improved utilization. Populations in the analysis area would be supported by both recovery and resiliency treatments. Furthermore, resiliency treatments provide ecosystem services. Table 323 shows the project area's potential for forest products in terms of maximum expected forest product volumes from treatments proposed under each alternative. These are the maximum annual volumes expected to occur for 10 years, or the timeframe used here for analysis purposes.

Timber Market

The economic effects of increased merchantable timber as a result of the SBEADMR project are important to consider. The SBEADMR project could increase the amount of timber on the market and also has the potential to affect the local energy industry. In addition, while the management alternatives assume full utilization by local processing, there is a chance that the local market may

not be capable of full utilization of the resulting timber. As a result, the employment and labor income effects may be a maximum potential contribution under the alternatives.

While the market for timber may be recovering, the prospective new and current uses in the GMUG region have the potential to fill the gap. Public Law 108-7 grants the Forest Service ten-year authority to enter into stewardship contracts or agreements to achieve agency land management objectives and meet community needs, which can encourage lumber companies to invest in new technologies to improve harvest techniques in the long-term.

The timber industry may benefit from a higher quality harvest of wood products, and local economies could experience such benefits as increased jobs and income, public safety, and local energy supply. The majority of timber processing is anticipated to be performed by Montrose Forest Products, located in Montrose County, therefore concentrating the economic impacts from the timber industry to a smaller geographic region (i.e. the 10-county GMUG economic analysis area). However, indirect and induced effects outside of the timber industry are better captured in the broader 22-county analysis area.

In addition to the economic impacts from the commercial harvest, additional economic impacts could accrue from non-commercial SBEADMR projects that are not accounted for in the quantitative analysis. For example, a 12.5 megawatt biomass processing facility in the Eagle Valley can use by-products from the non-merchantable non-commercial as well as the commercial projects to sustain jobs in the area.

Public Concern with Health and Human Safety

The effects to human health and safety from water and air quality, wildfire risk, and hazard trees are assessed in other sections of this EIS.

Non-Market Values

Resource-related impacts addressed in other sections of this document have the potential to negatively impact non-market values in the short-term. These include soil compaction, soil sterilization, spread of noxious weeds, impacts to water quality or quantity, modified recreation opportunities during project implementation, impacts on air quality during treatments, impacts on visual resources from smoke or mechanical treatments, increases in temporary road density, increases in activity, impacts to wildlife, etc. These particular impacts may reflect the personal sensitivities of individuals to a change in their environment, may impact ecosystems that relate to particular uses of an individual (for example, presence of game during a hunting season in a particular hunting unit may be disrupted during implementation), or other non-use values (for example, clean air or water). The potential for physical impacts as identified in other sections will be mitigated through the use of design features inherent to all action alternatives, and these should be relatively short-term in nature; however, individuals and populations may perceive effects related to their experiences or preferences that may last much longer, such as impacts on a

viewshed or scenic vista or, at a smaller scale, the presence of slash, stumps or burn scars in a particular treatment unit.

The action alternatives also have the potential to positively impact non-market values. Prescribed burning would be completed to spur regeneration of aspen and reduce the risk from wildfire that is driven by fuel accumulations. Reduced risk of wildfire has economic benefits, but also has non-market values such as the peace of mind that fire-safe land can provide community members. Additional non-market benefits from regenerated aspen stands may include enhanced recreation that is aesthetically pleasing, improved biodiversity of plant and animal communities, and the protection of watersheds.

Effects from fuels treatments will mostly be localized and benefit the areas in the WUI. Enhanced public safety due to a reduced threat of wildfire is a non-market value that would be realized, for the most part, by people living and working in the WUI, where treatments are concentrated near communities and public infrastructure. In addition, the spruce salvage and resiliency treatments are expected to reduce crown fire risk for red-stage stands. Additionally, an indirect effect of removing some tree material through salvage treatment is that future fires may impart lower severity, leading to less disruption of soil and watershed-related ecosystem functions. However, these effects will not likely change the overall fire behavior in the surrounding areas or the overall provision of ecosystem services. Benefits may accrue in the local areas where treatments occur and properties within the WUI from reduced wildfire risk.

The spruce-fir resiliency treatments are expected to improve stand conditions. The resiliency treatments are expected to reduce the impact of the spruce beetle and other stressors on the stand, which would as improve aesthetics of viewsheds and/or recreational experiences in the long-term.

Summary of Financial Efficiency

Economic efficiency analysis measures the ratio of economic benefits to economic costs resulting from activities under the SBEADMR project. Vegetation treatments in SBEADMR are proposed to meet both commodity and non-commodity objectives. Not all associated costs and benefits can be monetized due to data limitations and uncertainty. Therefore, the following discussion of financial efficiency is primarily descriptive in its analysis of tradeoffs.

Table 322 summarizes the Present Net Value (PNV) of the different alternatives from the Forest Service perspective and includes all available quantifiable costs and benefits (revenue) associated with these activities. A 4 percent discount rate was used over a period of 10 years (2016-2025). Over the 10-year treatment period, SBEADMR is expected to cost the Forest Service between $34.7 million and $44.2 million. This is the discounted cost of the project to the government. The anticipated revenue for the Forest Service from the timber harvest (benefits) is expected to range from $13.1 million to $13.6 million.

Table 322. Present Net Value of SBEADMR Treatments over 10-year Period, 4 Percent Discount Rate.

	No Action Alternative	**Alternative 2**	**Alternative 3**
PV Costs	$0	$34,659,885	$44,180,049
PV Revenue	$0	$13,626,305	$13,139,651
Present Net Value	$0	*-$21,033,580*	*-$31,040,398*

An important aspect of the financial efficiency analysis of forest treatment is the relationship between treatment (prescribed burning and mechanical thinning) and wildfire risk to values at risk in the WUI (incidence) and hazard (severity) reduction in the WUI. Mercer (2000) notes that treatment is associated with a decrease in wildfire suppression costs and a decrease in net resource damage; however, the precise relationship between treatment and wildfire cost reduction is not identified, and therefore neither quantified nor incorporated into the PNV analysis.

Summary of Regional Economic Impact Analysis

Employment and labor income supported by forest management actions under the action alternatives are displayed in Table 323 and Table 324. Results for Alternatives 2 and 3 reflect an increase in employment and income generated by proposed activities. These activities include harvesting and processing of commercial forest products, activities associated with resiliency treatments, and road work.

Table 323. Total (Direct, Indirect and Induced) Average Annual Employment and Labor Income for All Alternatives using 22-county analysis area.

Category	**No Action Alternative**	**Alternative 2**	**Alternative 3**
Timber Harvest-Resiliency	0	569	664
Timber Harvest-Salvage	0	758	616
Vegetation Management Activities*	0	43	33
Road Work*	0	4	3
TOTAL	0	1,374	1,315
Labor Income (thousands of 2012 dollars)			
Timber Harvest-Resiliency	$0	$21,756	$25,382
Timber Harvest-Salvage	$0	$29,008	$23,569
Vegetation Management Activities*	$0	$1,310	$1,054
Road Work*	$0	$186	$111
TOTAL	$0	$52,260	$50,116

*Only contracted costs were included in the economic impact analysis. Economic impacts of work performed by the Forest Service is captured in the Forest Plan. Contracted activities are mastication, lop and scatter (estimated 67

percent contracted), thin and pile (estimated 67 percent contracted), site preparation, planting, road construction, road reconstruction, and road decommissioning (estimated 70 percent contracted).

Table 324. Total (Direct, Indirect and Induced) Average Annual Employment and Labor Income for All Alternatives using 10-county analysis area.

Category	No Action Alternative	Alternative 2	Alternative 3
Timber Harvest-Resiliency	0	579	676
Timber Harvest-Salvage	0	772	627
Vegetation Management Activities*	0	44	33
Road Work*	0	4	2
TOTAL	0	1,398	1,339
Timber Harvest-Resiliency	$0	$21,467	$25,045
Timber Harvest-Salvage	$0	$28,623	$23,256
Vegetation Management Activities*	$0	$1,337	$1,068
Road Work*	$0	$146	$87
TOTAL	$0	$51,574	$49,457

*Only contracted costs were included in the economic impact analysis. Economic impacts of work performed by the Forest Service is captured in the Forest Plan. Contracted activities are mastication, lop and scatter (estimated 67 percent contracted), thin and pile (estimated 67 percent contracted), site preparation, planting, road construction, road reconstruction, and road decommissioning (estimated 70 percent contracted).

Economic impact analyses were performed using the broader 22-county analysis area, the targeted 10-county GMUG analysis area and a multi-regional approach. As seen by comparing Table 4 and Table 5, the estimated jobs impact to the 10-county area from the SBEADMR project is slightly greater than the jobs impact to the 22-county area; whereas the labor income impact to the 10-county area is slightly less than the labor income impact to the 22-county area. The results using the different analysis area were marginally different (less than 2 percent), likely due to variations in output per worker, industry presence, and relative size of impacts between the two analysis areas. Therefore, the majority of the economic impacts outlined for the broader analysis area will likely occur in the 10-county GMUG area. This is important to note since the jobs and income resulting from SBEADMR activities are expected to be concentrated in the smaller GMUG area.

Environmental Justice

In the 22-county analysis area, four counties, Montezuma, Rio Grande, Saguache, and Lake, have been identified as possible EJ populations, meeting minority and/or low-income criterion under EO 12898. Since vegetation treatments are not expected to occur in Montezuma, Rio Grande, or Lake Counties, no disproportionate high and adverse impacts to those EJ populations would be expected. They were included in the analysis area because they are considered part of the functional economy for the GMUG area, however, the social impacts will likely be minimal. Saguache County will likely receive vegetation treatments as a result of the SBEADMR project; however, the treatments would be spread out across the landscape and are not concentrated in

specific areas and are not expected to have a disproportionate high and adverse impact to any EJ populations.

There are social values for local access and recreation in the analysis area, as highlighted through scoping and public comments. These values can sometimes have greater impacts on EJ populations that rely on natural resources in the Forest for basic needs, such as fuelwood. EJ populations can also have limited access to green space, which is an environmental amenity that is often associated with higher income areas. However, impacts to access to NF land for subsistence uses and impacts to recreation will be minimized under SBEADMR, based on the application of design features to all action alternatives. One of the SBEADMR design features limits long term interruption to access with the use of flaggers and timing of road closures. While there may be a higher frequency of short-term access interruptions under Alternative 3 since it is focused on hazard tree removal near existing roads, the design features consistent across all alternatives ensure that road closures would not significantly limit access or use to the Forest for anyone.

Therefore, the Action Alternatives are not expected to have disproportionately high and adverse effects on the EJ populations in the analysis area. Furthermore, other resource impacts are not expected to be more concentrated in proximity to these populations, leading to no disproportionate human health or environmental effects on these populations.

Alternative 2 (Proposed Action) – Direct and Indirect Effects

Financial Efficiency

Table 322 summarizes the projected financial efficiency for Alternative 2. The PNV indicates the financial efficiency of the salvage and resiliency activities, including all costs and revenues associated with the activities and required design features. As noted in Table 320, restoration activities examined under this alternative include (among others) resiliency and salvage treatments, prescribed fire, mastication, weed spraying, and planting. A 4 percent discount rate was used over a period of 10 years (2016-2025).

Table 322 indicates that the proposed action alternative is not financially efficient for the timber harvest and required design features, as well as for all vegetation management activities noted above, as indicated by the negative PNV. The PNV for the proposed action is negative $21 million. However, since the PNV does not include non-market values such as ecosystem services, this is likely an underestimate of the value. The estimated revenue from treatments is the greatest under Alternative 2, and costs from Alternative 2 are lower than the costs from Alternative 3 since treatments in the WUI are more expensive and Alternative 3 has more treatments in the WUI. The expected non-market values derived outside of the WUI will likely be less under Alternative 2 than Alternative 3 because Alternative 2 has less volume of resiliency treatments than Alternative

3. However, the non-market values from resiliency treatments that will improve the overall health of the forest will be greater under Alternative 2 than the No Action alternative.

Indirect effects on financial efficiency could occur as a result of the proposed action alternative, however, estimates of these changes are not available. It is anticipated that fuels treatments under this alternative would contribute to fuels conditions that would have more resistance to wildland fire. This would likely reduce the threat to human life and decrease wildland fire- related costs such as property loss, lost revenues and suppression costs.

Regional Economic Impact Analysis

Timber production and vegetation management activities from this project would have direct and indirect effects on local jobs and labor income. Table 323 displays total estimates (direct, indirect and induced) for employment (full- and part-time) and labor income that may be attributed to the alternatives on an annual basis. Since the expenditures occur over a 10-year period, the estimated impacts of jobs and labor income would be spread out over the life of the project. These are not new jobs or income, but rather jobs and income that can be attributed to this project. Under the Proposed Action, it is estimated that 1,374 jobs and $52.3 million in labor income will be attributed to the SBEADMR project annually. Employment associated with all activities under this alternative would constitute 0.37 percent of total employment in the 22-county analysis area or 0.76 percent of total employment in the 10-county analysis area.

Salvaged timber harvest would be responsible for the majority of the total jobs and the total labor income associated with the project. The analysis assumes the timber volume processed would occur within the 22-county analysis area. However, if some of the timber were processed outside the region, then a portion of the anticipated jobs and income would not be realized in this regional economy.

Overall recreation visitation on the forest is not anticipated to change in the long-term, however short-term shifts in use on the forest could occur. Consequently, no change in recreation visitation and related economic impacts are anticipated, given the availability of substitute sites on the forest. As a result of short-term road closures due to maintenance and construction, there may be short-term impacts to recreation access in the local area. Since Alternative 2 includes the most miles of road work, there will likely be higher need for temporary road closures and therefore greater short-term impacts to access for recreation use.

Alternative 3 (WUI Alternative) – Direct and Indirect Effects

Financial Efficiency

Table 322 summarizes the projected financial efficiency for Alternative 3. The PNV indicates the financial efficiency of the timber sale and vegetation management activities, including all costs

and revenues associated with the activities and required design criteria. Vegetation management activities examined under this alternative include (among others) resiliency and salvage treatments, prescribed fire, mastication, weed spraying, and planting. A 4 percent discount rate was used over a period of 10 years (2016-2025).

Table 322 indicates that Alternative 3 is not financially efficient for commercial activities and required design features, as well as for all vegetation management activities noted above, as indicated by the negative PNV. The PNV for Alternative 3 is negative $31 million. However, note that financial efficiency analysis carried out from an agency accounting standpoint does not include non-market values such as ecosystem services and other societal benefits associated with reduced wildfire. If those non-market benefits are monetized and incorporated – as in a Benefit-Cost Analysis – PNV results have the potential to change significantly. While not always financially profitable, forest management activities such as restoration are expected to generate positive total economic benefits for the public. Some of these benefits are best described in a qualitatively manner below.

The estimated costs of treatments are the highest under Alternative 3 since it is focused on more expensive treatments in the WUI. For people living within the WUI, the expected non-market values derived from Alternative 3 will likely be greater than under the other action alternative, due to the shift in the geographic location of treatments and focus on public safety. Other non-market values derived from treatments within the WUI are from aesthetically pleasing landscapes and recreation opportunities; these may be greater within the WUI under Alternative 3 than under the Proposed Action Alternative.

Indirect effects on financial efficiency could occur as a result of Alternative 3, however, estimates of these changes are not available. It is anticipated that fuels treatments under this alternative would contribute to fuels conditions that would have more resistance to wildland fire. This would tend to reduce the threat to human life and decrease wildland fire-related costs such as property loss, lost revenues and suppression costs. Since Alternative 3 was developed with a focus to treat areas in and around the WUI, the expected costs from wildfire related to human safety and property damage would be lowest under this alternative.

Regional Economic Impact Analysis

Table 323 displays total estimates (direct, indirect and induced) for employment (full- and part-time) and labor income that may be attributed to the alternatives on an annual basis. Since the expenditures are estimated to occur over a 10-year period, the estimated impacts of jobs and labor income would be spread out over this period. These are not new jobs or income, but rather jobs and income that can be attributed to this project. Under Alternative 3, it is estimated that 1,315 jobs and $50.1 million in labor income will be attributed to the SBEADMR project annually. Employment associated with all activities under this alternative (Table 323) would constitute 0.35 percent of total employment in the 22-county analysis area or 0.72 percent of total employment in the 10-county analysis area.

Resiliency timber harvest would be responsible for the majority of the total jobs and the total labor income associated with the project (Table 323). The analysis assumes the timber volume processed would occur within the 22-county analysis area. However, if some of the timber were processed outside the region, then a portion of the jobs and income would be lost by this regional economy.

Overall recreation visitation on the forest is not anticipated to change in the long-term, however short-term shifts in use on the forest could occur similar to Alternative 2. As a result of short-term road closures due to maintenance and construction, there may be short-term impacts to recreation access in the local area. Alternative 3 includes less miles of roads proposed for maintenance, decommissioning and construction than Alternative 2 so effects to access would likely be smaller than Alternative 2 but greater than the No Action alternative.

Cumulative Effects Common to All Action Alternatives

Cumulative effects of management actions need to be considered in conjunction with the direct and indirect effects of other past, present and reasonably foreseeable activities being conducted in the 22-county analysis area. Past and present cumulative economic activity has already been absorbed by the local economy and is represented in the affected environment section presented above. For example, the employment distribution and specialization presented in Table 323 reflects past and present activities on all land ownerships and jurisdictions in the analysis area. Any change in the economic environment as a result of management actions would be in addition to other activities occurring simultaneously in the analysis area as well as those that could reasonably occur in the future. Each treatment may have a very small effect on the social and economic conditions of the analysis area individually; however, cumulatively they could change the distribution of jobs and income, as well as affect the social and economic variables discussed above. As noted in the analysis of employment and labor income impacts above, impacts associated with all activities under both action alternatives would constitute less than one percent of employment and labor income totals in the 22-county and 10-county analysis areas. In the 10-county analysis area, Alternative 2 impacts are 0.76 percent of total employment and 0.47 percent of total labor income; Alternative 3 impacts are 0.72 percent of total employment and 0.45 percent of total labor income. In the 22-county analysis area, Alternative 2 impacts are 0.37 percent of total employment and 0.23 percent of total labor income; Alternative 3 impacts are 0.35 percent of total employment and 0.22 percent of total labor income. The small cumulative economic impact from past and present activities indicates cumulative economic effects related to reasonably foreseeable activities are likely to be small.

Recreation Use

Changes between Draft & Final EIS

- Additional design features incorporated into the action alternatives to explicitly address

treatments within vicinity of Wilderness. No treatments are proposed in Wilderness, but the design feature ensures that boundaries are adequately and accurately identified as part of pre-treatment design.

  - REC-6: For treatments within ¼ mile of Wilderness boundaries, ensure that Wilderness boundaries are clearly marked by cadastral grade survey or set treatment boundaries at least 300 feet from boundaries located with resource grade GPS using standard parameters for assurance of accuracy.

- A section specifically addressing the Continental Divide National Scenic Trail has been added in response to public comments. The section takes a careful consideration of potential impacts to existing and proposed re-routes of the CDNST from SBEADMR action alternatives. Design feature SVR-6 has been expanded; see Scenic Resources section.

Affected Environment

Recreational use on the GMUG is approximately 2.5 million visits per year. Much of this use is driven by the scenery and recreational opportunities available on the forests. Use is focused at ski areas, developed recreation sites, on/along roads, trails and water-ways. Hunting is the primary use that extends further away from travel routes. Secondarily, personal use gathering of forest products extend some distance away from travel routes. During the snow season, multiple types of over-snow activities occur on travel routes and away from those routes.

Two goals of recreation management on GMUG are to provide for public safety and for enjoyable experiences. People engage in many different activities as they seek enjoyable experiences. Activities are frequency described as non-motorized or motorized. Some are considered high challenge, while others are more sedentary and lower challenge. The forest setting is sought to engage in these activities. That setting is valued for its topography, scenic views, water features, forests and openings. Within the forested landscape, people value healthy, natural appearing areas. The value of natural appearing areas tends to be lower in less dense areas of trees, value increases with increasing density, to a point where the forest appears crowded, thick and blocks views deeper into or through the forest. Variety of the forest appearance enhances peoples' perception of the forest condition and their appreciation of the scenery and the enjoyment of their experience.

This section will focus on public safety and recreational experiences that visitors are seeking. First, we will describe the types of experiences that people are seeking in general, then we will discuss the facilities and opportunities that are available on the Forests. Wilderness Areas, the Fossil Ridge Recreation Area, and Colorado Roadless Areas have been excluded from consideration for projects in this EIS. We will discuss the Continental Divide National Scenic Trail in this section.

Recreation Use

Recreational use on the GMUG is quantified by the National Visitor Use Monitoring Program (NVUM) (surveys of fiscal years 2009 and 2014). The reports estimate that the GMUG has 2.49 (90 percent confidence 2.11 – 2.86) million national forest visits annually. A national forest visit is defined as the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time. A national forest visit can be composed of multiple site visits. A site visit refers to the entry of one person onto a national forest site or area to participate in recreation activities for an unspecified period of time. Slightly more than half of the visits came from people traveling 50 miles or less to the forest. About 66 percent percent of visitors travelled 75 miles or less. This leads to the conclusion that most visitors to the GMUG are western slope residents. About 33 percent of GMUG visitors came to the forest between 30 and more than 300 times per year. Fifty percent came more than 10 times per year. More than half of GMUG recreation visitors visit multiple times each year.

The greatest primary recreation activity on the forest is downhill skiing and snowboarding (39 percent) followed by hiking/walking (9.9 percent) and cross-country skiing (9.3 percent). When we take out downhill winter sports from the primary activities, we see the following primary activity rates and average hours during each visit for that activity:

Hiking/walking (16%) – 4 hours
Cross-country skiing (15%) – 2.6 hours
Snowmobiling (14%) – 4.9 hours
Viewing natural features (11%) – 5 hours Fishing (11%) – 5.8 hours
Driving for pleasure (8%) – 3.9 hours
Motorized trail activity (5%) – 7.5 hours
Relaxing (4%) – 20.5 hour

For activities with less than 6 hours of that activity, it appears that those activities are mainly day- use. Where the activity lasts more than 6 hours, that activity appears to be supported by overnight camping on the Forests.

Camping is also a regular activity on the Forests with 5 percent participation at developed sites and 4 percent at dispersed sites. About 2 percent and 1 percent respectively consider these their main activities. These are longer duration activities with 37.5 hours and 61.4 hours, respectively, being the average duration for camping when it is their main activity. We conclude that while relatively smaller numbers of people consider camping their primary activity, for about half of the campers, camping supports other main activities.

Recreation Opportunities

Ski Areas

Skiing at developed ski areas is a high proportion of the recreation use on the GMUG. All of this use is day-use by definition in the NVUM surveys - all participants spend the night off of the Forests. In terms of how vegetation affects these activities, it is critical that trees do not fall in the skied portions of the area for safety reasons. Vegetation provides the wind-screening necessary for snow accumulation and provides the setting for enhanced visual appearance of the area. Treatment areas occur on all 3 ski areas. The potential treatments in these areas are salvage, resiliency, burning, mechanical treatment and hazard tree removal.

Developed Recreation

Developed recreation sites support recreational activities both on-site and off-site. Developed sites that support on-site recreational activities are typically campgrounds, rental cabins, picnic grounds, visitor centers, interpretive sites (natural and heritage) and scenic/wildlife viewing sites. Developed sites that support off-site activities are trailheads, fishing access sites, and boating access sites and sites identified as day-use sites which typically support multiple activities. These sites are easy to identify, as they usually have a substantial sign that identifies them and there is considerable investment in facilities such as roads/parking, toilets, tables and other infrastructure.

Treatments, primarily hazard tree removal or salvage (including pile and broadcast burning to clean up the site) will occur in developed sites. An objective of the program is to treat these areas for safety, as dead or dying trees are a hazard to people and property that use the area. The condition of the forest surrounding these areas is important to visitors as it serves as a gateway to other activities or people are residing at these sites for significant period of time. The entire suite of treatments may occur in the vicinity of developed recreation sites.

Dispersed Recreation

Most recreational activities that occur on the forests that do not involve constructed facilities are considered dispersed recreation. Many motorized activities occur on the roads within the forests, ranging from scenic drives in passenger vehicles, Off-Highway vehicle use and ATV/Motorcycle riding. Trails support some of these motorized activities along with mountain biking, horseback riding, hiking/walking. Other examples of dispersed recreation include camping (outside of developed campgrounds), photography, wildlife viewing and sightseeing as well as hunting and fishing, boating, snowmobiling and cross-county skiing/snowshoeing.

Dispersed Camping/Gathering Sites

Dispersed camping occurs along roads primarily and can occur along trails. Some of these areas are designated for camping and others are locations where people have established informal camping spots. The agency is concerned about safety at any locations that people gather or

gather and reside. The presence of dead or dying trees is a hazardous situation. Visitors must take personal responsibility for ensuring that their location is safe from hazardous trees.

A large number of these types of sites are likely to be within treatment areas. Treatments would focus on reducing hazard trees in the area around the site. Treatments affect the appearance of the forest which affects the visitors' satisfaction with the setting. Due to the longer term nature of use in these areas, the appearance has a larger impact on the visitor, than driving by a treatment areas.

Roads

The road system is discussed in other sections of this document. From the recreation perspective, the road system is very important to the recreating public. It provides for access and it provides the opportunity for some of the activities discussed previously.

Treatment areas are along a large number of roads. It is important that travel on and along the roads is safe, which is an objective of this program. The recreation visitor and the visitor driving through the forest will also be viewing or using the forest. It is important the appearance of the forest following treatment is maintained with a pleasing appearance. Road reconstruction is identified as an activity associated with some treatments. For recreation visitors, the condition of these roads is important. While access to the roads during treatment may impact visitors, it is most important that the condition of the roads following treatment is considered. Where we have objectives for passenger car travel, that user expects a reasonably smooth drive. Where we currently have roads that are more challenging, it is important to maintain that challenge level, unless we make explicit decisions to change the character of the road.

Trails

The trail system within the GMUG consists of 946 trails totaling 3,556 miles in length. About half of the trail mileage is not designated for motorized use and are used for hiking, backpacking, horseback riding and mountain biking. The other half of the mileage is designated for motorized recreation such as OHVs, ATVs, and motorcycles. On some motorized trails, non-motorized uses can also occur. There are a number of nationally designated Recreation Trails and the Continental Divide National Scenic Trail on the GMUG. See the CDNST discussion at the end of the Recreation section.

A number of the nationally designated trails and many of the remaining trails exist in the treatment areas. Treatments have not been specifically identified to improve safety on or along the trails. Treatments may occur along or adjacent to trails, thus improving the safety from hazard trees in the long run and changing the appearance of the forested environment along the trails, especially where resiliency treatments are implemented.

Winter Trails

The GMUG supports a wide range of winter recreation including snowmobiles, cross-country skiing, sledding, snowshoeing and dog-sledding. A number of these trails or areas are to be in treatment areas. The program being proposed in this document does not have an objective of treating these trails for safety. It will be important to consider public safety and the appearance of the forest during and after treatment operations in the vicinity of these facilities.

Also, winter activities can be affected by treatments and the management of the roads accessing those treatments during the winter will affect recreation opportunities and experiences. There are designated, managed snow trails for skiing and snowmobiling. These trails are managed in partnership with local clubs. Plowing a road can completely change the uses in those areas. Motorized and non-motorized winter users experiences will be adversely affected during treatments operations in winter-time.

Lakes and Streams

Fishing and use of water features for other recreation activities is very important on the GMUG. Treatment areas surround a number of lakes, streams and rivers. As with other sites where people remain for a period of time, public safety is very important. Dead and dying trees are a safety hazard which should be mitigated when treatments are considered in the vicinity of water features, especially those that are frequently used. The condition of the forest following treatment is very important for safety and appearance. Previous discussions about both aspects apply.

General Forest

The general Forest away from the facilities and features discussed previously in this section do not receive appreciable use. Previously we identified hunters and forest product gatherers as primary users away from developed facilities, roads and trails. Certainly there are other users such as photographers and nature study enthusiasts that enjoy the general forest. Treatments can have on impact on these areas. Due to the low amount of use in these areas and the inability to reasonably control the natural environment across vast acreages, the maintenance of public safety is lower priority here. Likewise, the importance of the appearance of the forest following treatment is less important, but should be considered. It is important that treatments that are adjacent to travel corridors, lakes and streams and the vicinity of dispersed sites are designed to not detract from the appearance of the condition of the environment from those sites. It is also important to design those treatments so that it is difficult for people to make new travel-ways from the existing travel-ways.

Recreation Special Uses

Recreation special uses include recreation residences, lodges, organization camps, outfitter-guides, recreation events, and other permitted recreation activities. The GMUG has issued special use permits for activities including outfitters and guides, and non-commercial groups

such as weddings, rallies or other events. Commercial permits are issued for such events as races, jeep rallies, wagon trains and concerts. Other permits are issued for activities that involve permanent and immobile structures such as recreation residences and ski areas and resorts. We discussed Ski Areas in a previous section, so they will not be discussed here.

Recreation Residences, Lodges/Resorts and Organization camps occur in treatment areas. These areas have significant infrastructure, and provide for recreational activities on-site and support recreational activities off-site. Working with these entities to provide for safety from dead or dying trees is important. Protecting their safety and their infrastructure during operations is important. The appearance and condition of the forest following treatment is important.

Recreation Events are permitted on the GMUG. Some are regularly occurring events and some are less frequent or one-time-only events. Events can be confined to a defined area or they may occur on roads and trails. Coordination of treatment activities with recreation events, especially for regularly occurring events, is very important. It is also important for permits that are granted sometimes 6-12 months in advance. Ensuring that we don't inadvertently modify areas where events have occurred for many years and where they are currently planned is important. Public safety and access is important when events are occurring. The condition of the forest following treatment is important for regularly occurring events.

Outfitter-guides provide a large number of different services to visitors. Their activities include: fishing, hunting, boating, hiking, ATVing, OHVing, snowmobiling, horseback riding, and others. The previous statements we have made about roads and trails apply here also. Activities along lakes and streams were also addressed previously as well as the general forest area. The Forest Service has made long term commitments to many of these providers. It is imperative that we consider the impact of these activities on the providers by insuring that we don't disrupt their operations and that we consider their activities during the design and implementation of treatments. Their safety and the appearance of the forest following treatment is important.

Management Areas that Emphasize Recreation Opportunities

On the GMUG, there are 3 Management Areas that emphasize recreation opportunities, not including Management Areas for Downhill Skiing (1B) and Developed Recreation Sites (1D). These areas are: Semi-Primitive Motorized Recreation Opportunities (2A), Roaded Natural and Rural Recreation Opportunities (2B), and Semi-Primitive Non-Motorized Recreation Opportunities (3A). Dispersed Recreation, Trails, and Recreation Special Uses occur in these 3 Management Areas, as well as the other Management Areas identified in this document. In these 3 Management Areas, Recreation Opportunities are emphasized over other resource values.

In 3A areas, the expectation is that the sights and sounds of human activity are fairly low. The evidence of human activity is subordinate in the environment, so natural appearance is expected. Sounds from communities and motorized vehicles are expected to be infrequent or very distant.

Treatments in these areas should harmonize with the environment and sounds from the treatments should avoid periods of higher use.

In 2A areas, the expectation is that the sights of human activity are fairly low, but the sounds of human activity, primarily from motorized vehicles are expected. The evidence of human activity is subordinate in the environment, so natural appearance is expected. Treatments in these areas should harmonize with the environment and sounds from the treatments would be consistent with these areas.

In 2B areas, which are typically along major road corridors, the expectation is that the sights of human activity is common, but the natural environment that isn't devoted to infrastructure will be pleasing and support the recreation activities sought in these areas. The sounds of human activity, primarily from motorized vehicles and other people are expected. There are generally much higher numbers of people recreating in these areas. There may be greater concern with treatment activities that are inconsistent with the desired recreational setting.

The other resource emphasis Management Areas also support recreation activities, however the other resource emphasis in those areas is more important than recreational pursuits. Key recreational areas outside of developed recreation sites in these areas should be considered during project implementation. Roads, trails, lakes, streams, and dispersed camping areas are features that attract visitors. Efforts to protect recreation opportunities in these areas should be considered where possible and where more frequent use is occurring and where consistent with the other resource emphasis.

Alternative 1 (No Action) – Direct and Indirect Effects

Through implementation of the No Action Alternative, typical management practices would continue, including hazard tree removal within developed recreation sites, in areas of concentrated use in the general forest, and along trails. However, such removal would not be made in a concerted effort or within the scope and timeframe of the Proposed Action Alternative.

Developed Recreation

Past and current management activities include an annual inspection and removal of hazard trees in campgrounds and other developed recreation areas, including rental cabins. Under the No Action Alternative, annual removal of all documented hazard trees or tree limbs would continue at its current limited scope, with assistance from timber management, forest health

management, and recreation specialists, or the sites would be closed. It is expected that the number of hazard trees would increase over time as the current bark beetle epidemic continues such that it would overwhelm our capacity for mitigation under the current methodology and budget. This would cause certain campgrounds, picnic areas and other recreation sites to delay opening, close access roads, or even close the entire facility for several months or up to multiple seasons. Hazard trees would continue to fall within sites closed for any length of time, potentially damaging the infrastructure such as picnic tables, restrooms, roads and administrative buildings, which would be additive to the length of time the site would be closed, as well as the costs associated with reopening the sites. Closures of recreational sites would be expected to last as long as the standing dead trees are present in the sites and may continue as long as necessary to clean-up or refurbish the sites for re-opening. Such conditions would be relative to concentrated fuel loads or damages to infrastructure within the boundaries of recreational areas.

The appearance of the residual stand in developed recreation sites is important. Due to the nature of this epidemic, the appearance of the area will be altered and evident for many years to come, as the stand regains a fuller forested character. Clean-up of the areas to a more natural appearance without a lot of slash or fallen trees would be extended over a long period of time.

Dispersed Recreation Sites, General Forest Area and Trails

Under the No Action Alternative, standing dead trees are likely to fall in dispersed recreation areas and across roads/trails, creating dangerous conditions for visitors, travelers and hikers. When people gather in areas of the forest, the presence of standing dead trees present a risk. Under the No Action Alternative, none of these sites are likely to be treated or cleaned up outside the current capability of the agency. That capability is very low and would only be able to be applied to a few, highly important locations. As trees fall across roads/trails, under the No Action Alternative, they would continue to be cut under the current capability of the agency. As with dispersed sites, the capability to respond to these situations is low.

It may become necessary to close sites, areas and trails to the public when the situation is deemed unsafe for human occupancy. Unauthorized routes around downed trees may be created, potentially causing soil compaction, erosion and damage to watersheds. For motorized uses, when trees fall across travel routes, they present a high hazard when they are not visible to travelers. Motorcycle, ATV and OHV users may encounter a fallen tree without any forewarning. There may also be other public safety impacts, such as visitors becoming trapped in remote regions due to trees falling, which may require personnel and other resources for rescue operations.

In summary, the lack of capability to respond to hazardous tree situations will result in loss of opportunity for recreation activities. The quality of the recreation experience would be diminished with difficult access and difficult sites conditions. Areas that aren’t cleaned up will

not have a pleasant appearing environment for recreation. Efforts to encourage re-growth won't be undertaken, so the duration of an impacted forest will be longer.

Recreation Special Uses

Under the No Action Alternative, effects would likely be realized at recreation residences, lodges, organization camps, and ski resorts. Owners of these facilities would need to address the safety aspects of hazard trees to their facilities, use and operations. There would not be larger scale treatment activities in the vicinity that could be coordinated with these owners occupying National Forest System lands.

Outfitter/Guides and Recreation Events would be affected by the factors discussed in Developed or Dispersed Recreation sections. Business opportunities would be adversely impacted.

In both of these types of use, facility based and guides/events, opportunities for the public would be diminished due to safety concerns. Additionally, the quality of the experience would be diminished as discussed in the previous discussions about Developed and Dispersed Recreation. Relocation of activities may be possible. Given the extent of the bark beetle epidemic, it is not likely that similar settings which do not have safety, setting, or experience impairments would be found on this Forest or adjacent affected Forests.

Management Areas that Emphasize Recreation Opportunities

Under the No Action Alternative, there are no effects to the settings in these management areas (2A, 2B and 3A). These areas will be affected by natural processes. The effects discussed in sections above can occur in these areas.

Alternative 1 – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no changes to recreation will result from the implementation No Action Alternative. However, the direct and indirect effects of natural processes in combination with past, on-going, and future activities could result in cumulative effects to recreation. With fewer treatments of hazard trees, more facility and area closures (affecting trails and roads in those areas) would occur to protect users until such time that the Forest Service can treat them. Closures of areas may be long-term, and would affect recreation opportunities.

Activities Common to Both Action Alternatives

The following design features are applicable to both action alternatives.

Table 325. Design Features for Recreation Resources.

Design Feature	Trigger for Use	Description	Effect
REC-1	In campgrounds	Avoid use of broadcast burning treatments in campgrounds (if piles are burned, ensure that impacts to residual trees are negligible).	Limit immediate and longer-term visual impact of treatments.
REC-2	In developed recreation sites	Developed recreation sites: Managed by concessionaire: plans need to consider impact to summer operating season and should minimize impacts to operations as much as possible. For Forest Service operated sites: coordinate with District to address any District concerns regarding impact to the operating season. For Forest Service operated sites: coordinate with District to address any District concerns.	Coordinate potential conflicts between timing of treatment implementation and recreation use.
REC-3	For dispersed recreation sites, and on trails and roads.	Coordinate with District recreation staff regarding any treatment-related closures for dispersed recreation sites, trails and roads.	Coordinate potential conflicts between timing of treatment implementation and recreation use.
REC-4	For all treatments near or on recreation residences, lodges or organization camps	Work with recreation residences, lodges and organization camps to design treatments adjacent to these tracts to also treat these tracts to the extent feasible.	Minimize conflict with special use permit holders; seek opportunities to design treatments to benefit recreation residences, lodges, and organization camps in the vicinity of planned treatments.
REC-5	For treatments in ski areas	Coordinate with the permit administer for these areas to define the vegetation management in the ski areas.	To maintain the appearance and function of the terrain and vegetation in ski areas.
REC-6	For all treatments	Coordinate with District recreation staff to address treatment-related impacts to special use permit holders in the treatment area.	Minimize conflict with special use permit holders; seek opportunities to design treatments to benefit recreation residences, lodges, and organization camps in the vicinity of planned treatments.
REC-7	For all treatments	For treatments within ¼ mile of Wilderness boundaries, ensure that Wilderness boundaries are clearly marked by cadastral grade survey or set treatment boundaries at least 300 feet from boundaries located with resource grade GPS using standard parameters for assurance of accuracy.	Meet the intent of the Wilderness Act.
REC-8	For treatments that occur in winter or impact winter recreation access or use routes	Coordinate with District recreation staff to address treatment-related impacts to winter uses, many of which are managed in partnership with clubs or other organizations.	Minimize conflict with partners and winter users.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

Developed Recreation Areas

Implementation of the Proposed Action would result in positive safety effects on treated recreational sites and facilities, including: campgrounds, picnic areas, trailheads. The effect on existing recreational activities may range from closure of a developed campground for a week to an entire season while hazard trees are cut and removed from the treatment area.

Treatments in developed recreation sites would accelerate removal of hazard trees over the typical rate without treatments. Site will be less likely to be closed for multiple years as they would be when numerous hazard trees exist and the capability of removing them is left to normal capacity. The experience after treatment compared to treatment under normal capacity, as described in the No Action Alternative, would be enhanced under this alternative. The areas will likely be cleaned up more thoroughly and resilience activities will enhance stand recovery. Also, the speed of these activities and effects will help the sites recover the forested environment sooner.

It may become necessary to close off part or the entire site during implementation. All closures would be coordinated with the Forest Concession Permit Administrator, for sites operated by the concessionaire to minimize effects to the public and the permit holder. Forest Service operated sites would be coordinated on the local district. The public would be informed of the purpose of the closure, the anticipated duration of the closure and directed to alternative recreation opportunities in the vicinity. The closure/partial closure of a site would affect users due to the additional personnel, machinery and noise on site and the loss of access to that particular developed recreational activity. As a result of past clearing projects in developed campgrounds, there may be an increase in travel trailers and motor homes; there also may be a decline in tent campers, most likely due to the reduced shade, increased wind and lack of privacy.

The removal of hazard trees and fuel loads would result in the mitigation of hazardous conditions and increased user safety within all treatment areas for the foreseeable future. Annual costs of assessing and treating hazard trees would be nearly eliminated, which would account for substantial savings for many years.

Another benefit that would be expected to result from a concerted effort to remove hazard trees would be that more roads, trails and developed recreation sites would consistently be open for public use following treatment.

Any implementation within developed recreation sites (trailheads, picnic areas, campgrounds) would follow the necessary parameters for felling and/or removing trees defined by the proposed Design Features. The Design Features aim to protect infrastructure and minimize potential

ground surface damage caused by project implementation and provide for removing the appearance of a disturbed environment in the immediate vicinity of the sites.

Dispersed Recreation Sites, General Forest Area and Trails

Dispersed recreational sites may be directly or indirectly affected by implementation of the Proposed Action Alternative, depending on their proximity to each treatment area. Many dispersed campsites are directly adjacent to NFS roads, and those that fall within the treatment areas would potentially be temporarily affected by activities such as the sights and sounds associated with the operation of heavy equipment, as well as increased traffic and personnel. After the hazard trees would be removed, however, these sites would more than likely see an increase in use since sites outside of the proposed treatment areas would potentially be blocked by falling trees or become high risk areas due to the public safety issues caused by the remaining hazard trees. The closure of existing sites could have the additional consequence of the public creating new dispersed locations, resulting in altered traffic patterns and campsites. Dispersed sites in Management Areas 2A, 2B and 3A would be treated when treatments occur in the vicinity. Sites in other Management Areas may be treated to provide for public safety.

Trails

Clearing of hazard trees in the project area would improve the safety of the public who use the trails for hunting, fishing, wildlife viewing and other activities. By felling and removing hazard trees adjacent to roads and trails, long-term closures would be minimized and visitors would continue to be able to access these activities. During project implementation these trails and roadways associated with dispersed sites could temporarily be closed and would see an increase in logging traffic and personnel activity. These activities may temporarily displace potential users of these sites and trails until the project is complete. Trails outside of treatment areas would continue to be treated on a case-by-case basis, which could lead to trail closures.

Snow trails for skiing and snowmobiling could be affected by winter operations. These activities are important to visitors, partner organizations and for local economies. Access roads will be affected by hauling activities. Ski trails may be affected by keeping roads open for timber activities. The skiing experience may also be affected by timber activities. It is important to address these impacts during treatment design. Effects to snow trails and access to them will be mitigated utilizing implementation criteria and through application of the design features.

Recreation Special Uses

Implementation of the Proposed Action Alternative could affect recreation residences, resorts, and organization camps and ski areas. This action would be expected to result in temporary negative effects at these facilities during project implementation since clearing would occur in

close proximity to these facilities. These effects would potentially include the sights and sounds of machinery and other activities required during project implementation. While these effects would be temporary, the visual impact would occur in a shorter time-frame as the clearing would be immediate as opposed to intermittent removal of dead trees under the No Action Alternative. The design features will help to give a cleaner appearance to the areas surrounding these facilities.

Implementation of the Proposed Action Alternative would have less of an effect on special use permitted activities that do not require immobile structures. Outfitting and guiding and recreation events may be temporarily displaced during project implementation; however, these events can often be relocated to prevent potential conflicts. There would likely be some permitted activities that would be reduced or eliminated during project implementation. The short-term effects of this would be expected to be less of an impact to these operations in the long term than the continual natural falling of trees in special use permit areas.

Management Areas that Emphasize Recreation Opportunities

Under the Alternative 2, there are no effects to the settings in these management areas (2A, 2B and 3A). These areas will be affected by natural processes. The effects discussed in sections above can occur in these areas.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

Developed Recreation Areas

Implementation of Alternative 3 would result in positive safety effects similar to the Proposed Action at treated recreational sites and facilities, including: campgrounds, picnic areas, trailheads. The effect on existing recreational activities may range from closure of a developed campground for a week to an entire season while hazard trees are cut and removed from the treatment area.

Treatments in developed recreation sites would accelerate removal of hazard trees over the typical rate without treatments. Site will be less likely to be closed for multiple years as they would be when numerous hazard trees exist and the capability of removing them is left to normal capacity. The experience after treatment compared to treatment under normal capacity, as described in the No Action Alternative, would be enhanced under this alternative. The areas will likely be cleaned up more thoroughly and resilience activities will enhance stand recovery. Also, the speed of these activities and effects will help the sites recover the forested environment sooner.

It may become necessary to close off part or the entire site during implementation. All closures would be coordinated with the Forest Concession Permit Administrator, for sites

operated by the concessionaire to minimize effects to the public and the permit holder. Forest Service operated sites would be coordinated on the local district. The public would be informed of the purpose of the closure, the anticipated duration of the closure and directed to alternative recreation opportunities in the vicinity. The closure/partial closure of a site would affect users due to the additional personnel, machinery and noise on site and the loss of access to that particular developed recreational activity. As a result of past clearing projects in developed campgrounds, there may be an increase in travel trailers and motor homes; there also may be a decline in tent campers, most likely due to the reduced shade, increased wind and lack of privacy.

The removal of hazard trees and fuel loads would result in the mitigation of hazardous conditions and increased user safety within all treatment areas for the foreseeable future. Annual costs of assessing and treating hazard trees would be nearly eliminated, which would account for substantial savings for many years.

Another benefit that would be expected to result from a concerted effort to remove hazard trees would be that more roads, trails and developed recreation sites would consistently be open for public use following treatment.

Any implementation within developed recreation sites (trailheads, picnic areas, campgrounds) would follow the necessary parameters for felling and/or removing trees defined by the proposed Design Features. The Design Features aim to protect infrastructure and minimize potential ground surface damage caused by project implementation and provide for removing the appearance of a disturbed environment in the immediate vicinity of the sites.

Dispersed Recreation Sites, General Forest Area and Trails

Dispersed recreational sites may be directly or indirectly affected by implementation of Alternative 3, depending on their proximity to the project area. Many dispersed campsites are directly adjacent to NFS roads, and those that fall within the treatment areas would potentially be temporarily affected by activities such as the sights and sounds associated with the operation of heavy equipment, as well as increased traffic and personnel. After the hazard trees would be removed, however, these sites would more than likely see an increase in use since sites outside of the proposed treatment areas would potentially be blocked by falling trees or become high risk areas due to the public safety issues caused by the remaining hazard trees. The closure of existing sites could have the additional consequence of the public creating new dispersed locations, resulting in altered traffic patterns and campsites. Dispersed sites in Management Areas 2A, 2B and 3A would be treated when treatments occur in the vicinity. Sites in other Management Areas may be treated to provide for public safety.

Trails

Under Alternative 3, it is less likely that there will be beneficial or negative effects to trails, due to the likelihood that fewer areas will be treated. The effects in treated areas will remain the same.

Clearing of hazard trees in the project area would improve the safety of the public who use the trails for hunting, fishing, wildlife viewing and other activities. By felling and removing hazard trees adjacent to roads and trails, long-term closures would be minimized and visitors would continue to be able to access these activities. During project implementation these trails and roadways associated with dispersed sites could temporarily be closed and would see an increase in logging traffic and personnel activity. These activities may temporarily displace potential users of these sites and trails until the project is complete. Trails outside of treatment areas would continue to be treated on a case by case basis, which could lead to trail closures.

Snow trails for skiing and snowmobiling could be affected by winter operations. These activities are important to visitors, partner organizations and for local economies. Access roads will be affected by hauling activities. Ski trails may be affected by keeping roads open for timber activities. The skiing experience may also be affected by timber activities. It is important to address these impacts during project design. Effects to snow trails and access to them will be mitigated utilizing implementation criteria and through the design features.

Recreation Special Uses

Implementation of the Alternative 3 would be similar to the Proposed Action for effects at recreation residences, resorts, and organization camps and ski areas. This action would be expected to result in temporary negative effects at these facilities during project implementation since clearing would occur in close proximity to these facilities. These effects would potentially include the sights and sounds of machinery and other activities required during project implementation. While these effects would be temporary, the visual impact would occur in a shorter time-frame as the clearing would be immediate as opposed to intermittent removal of dead trees under the No Action Alternative. The design features will help to give a cleaner appearance to the areas surrounding these facilities.

Implementation of the Alternative 3 would have less of an effect on special use permitted activities that do not require immobile structures than in the Proposed Action. Outfitting and guiding and recreation events may be temporarily displaced during project implementation; however, these events can often be relocated to prevent potential conflicts. There would likely be some permitted activities that would be reduced or eliminated during project implementation.

The short-term effects of this would be expected to be less of an impact to these operations in the long term than the continual natural falling of trees in special use permit areas.

Cumulative Effects Common to All Action Alternatives

Desirability of recreation opportunities may be reduced during active vegetation treatments where logging and logging traffic, visual impacts of recently treated areas and reduced trail opportunities impact the recreation experience. The action alternatives treatments of salvage and hazard trees, along with burning and mechanical treatments will reduce tree-related hazards to dispersed and developed recreation opportunities; however the combined treatments could impact visual landscapes at both the foreground and background that alter user experience either positively or negatively. These treatments may be visually evident for more than 10 years. Without treatments, a different viewscape will exist and may be visually evident for more than 10 years. Vegetation treatments could alter big game foraging and movement which may impact hunters. In the long-term vegetation treatments should result in more desirable forest conditions for motorized and non-motorized travel in the front-country, should improve conditions for hunting, site seeing (including vista points), and other developed and dispersed activities such as camping.

Continental Divide National Scenic Trail

The Continental Divide National Scenic Trail (CDNST) is a congressionally authorized trail. Treatment areas have been identified along the trail.

Compliance with Regulatory Direction

The revised 1991 Grand Mesa, Uncompahgre and Gunnison (GMUG) Forest Plan provides guidance for management of the CDNST trail and corridor on pages III-82 through III-83. These requirements are consistent with the 2009 Comprehensive Plan, which guides existing trail routes and potential locations of the trail.

Please see the Visual Quality and Scenery Management Section for terms used in this section and for descriptions of scenic impacts related to No Treatment and Treatments.

Analysis Methodology

See the Visual Quality and Scenic Resources Section for information about the Scenic Analysis process. See the Visual Quality and Scenic Resources Section and the Recreation Section for Design Features that will be applied to treatments in the vicinity of the CDNST. Those Design Features will not be repeated here.

Alternative 1 (No Action) – Direct and Indirect Effects

Under Alternative 1, the No Action Alternative, no treatments will affect the CDNST. Treatments for hazard trees could occur under other authorities. Natural events and human activities would continue to change the scenic landscapes. Most standing dead and dying trees

would remain standing up to approximately a decade and would therefore remain a hazard to forest users and travelers until removed or blown down. Strong winds could blow down dead and dying trees across the trail. In certain areas, visitors would notice high numbers of downed trees, which would negatively impact scenery.

Indirect effects to scenic quality include impacts from travelers avoiding downed trees and the continuing increase of dead and dying trees. Travelers could impact the immediate foreground of scenic resources by creating new paths around roads or trails blocked by naturally fallen trees that have not yet been removed by the Forest Service. Impacts could include eroded or bare soils; trampled or removed ground-level vegetation along created paths; and damage to young healthy trees.

In addition, the rate of spruce mortality from the spruce beetle epidemic continues to increase. Associated scenic impacts from spruce beetle will continue to increase, and there will be continued scenic impacts from sudden aspen decline (SAD), resulting in a long-term decline of the scenic resource.

Alternative 1 (No Action) – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no changes to scenic quality will result from the implementation No Action Alternative. The direct and indirect effects of natural processes in combination with past, on-going, and future activities could result in cumulative effects to scenic quality.

Effects Common to All Action Alternatives

See the Design Features in the Visual Quality and Scenic Resources Section and in the Recreation Section.

The direction for management of the trail, described previously, will protect the existing trail location and potential trail relocations.

Descriptions of the effects of no treatment and the proposed treatments are in the Visual Quality and Scenic Resources Section. Please refer to those sections. Additional discussion of those effects specific to certain sections of the trail is included below.

The current CDNST and potential re-location of the CDNST are in areas proposed for treatment in this document. The area under active consideration (a draft EIS was issued previously) is known as LuJan to LaGarita. The next area under discussion for future trail relocations is in the Spring Creek Pass area. Potential impacts from the activity to the existing and potential reroutes are considered below.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

Existing trail locations are generally not affected by treatments, however, approximately 15 miles of trail have treatments in the foreground. Most of the middle-ground along the trail is difficult to see from the trail, due to the dissected nature of the terrain and that the trail location is not at a great altitude above the existing terrain. For the most part the existing scenic integrity in this area is rated as moderate.

In the Spring Creek Pass Area (Map G-72, Appendix G), the existing scenic integrity is identified as moderate. Salvage treatments are proposed adjacent to the trail and in the foreground and middleground. A very small acreage of resiliency treatment is proposed along the trail. About 3 miles of trail have proposed treatments in the foreground. The middleground is mostly not visible due to the dissected nature of the terrain. This portion of the trail is fairly open or has been impacted and has numerous dead trees. Treatments here will improve the long-term appearance of the area. There will be short-term impacts as discussed in the other sections referenced in this section.

Relocation of the trail off of the road has not been analyzed in detail. Given the epidemic of dead trees in this area, visual impacts currently exist and should be improved with the treatments. There may be some impact from activities in the area along proposed re-routes. It is doubtful that those impacts would preclude relocation of the trail.

The Marshall Creek Subwatershed Area (Appendix G, Map G-76) is an area where no trail re-routes are currently contemplated near the trail. Proposed treatments are located in areas with moderate scenic integrity and some high scenic integrity. Approximately 7 miles of trail are located with ½ mile of treatments. About 4 miles of trail have a combination of treatments (salvage, resiliency and salvage/resiliency) on one side of the trail and about 3 miles on both sides of the trail. The design features described elsewhere will protect the foreground of the trail and impacts to the trail.

The Existing Trail and LuJan- LaGarita or Southern Re-route Area is shown on Maps G-73-75, Appendix G.

On Map G-73 (Appendix G), near the Eddiesville Trailhead, salvage and resiliency treatments are proposed. These treatments begin about ½ mile from the trail. They would be difficult to see from the trail, if they can be seen at all.

On Map G-74 (Appendix G), between the Monchego Park area and Luders Creek CG area which is about 1-2 miles north of Cochetopa Pass (NN14), salvage and resiliency treatments are planned along about 3 miles of trail within ½ mile of the trail, in the area of Cochetopa Pass. Some temporary roads will be created in that area. The impacts to the trail, which is an existing road, would be very minimal.

There are extensive proposed re-routes in this area. There are proposed treatments south of Monchego Park that cross over the Proposed Re-route and are mostly adjacent to the Salt House Re-route proposal. About 3.5 miles of the Proposed Re-route are affected by salvage or a combination of salvage/resiliency. Since this is mostly salvage, the re-route alignment will likely be enhanced by going through an area that will be more attractive after treatment. The Salt House Re-route will have about 3 miles of treatment on the downhill side of the trail. The effects are similar although only on one side of the trail.

There are treatments in the area even with Luders Creek CG southward about 4 miles. The Proposed Re-route is adjacent to treatments for about 3 miles and within ½ mile of treatment for nearly the entire length. The treatments here are mostly resiliency with some areas with a combination. With Retention VQO, the treatments should not be highly noticeable. Clean-up in the immediate foreground will provide cleaner looking setting in case the trail is built here.

The Los Creek Re-route proposal in this same general area would go through about 1 – 1.5 miles of the resiliency treatment area. The resulting stand after treatment is expected to have advance regeneration and young trees. Temporary roads would be created adjacent to and across the proposed re-route. These treatments and temporary roads would not preclude locating the CDNST here.

About 5 temporary roads are planned to cross the Proposed Re-route in this area. The Los Creek Proposed Re-route would have about 4 temporary road crossings. These temporary roads will be rehabilitated and blocked following treatment activity.

On Map G-75, Appendix G, the existing trail on NFSR 785 and NFST 486 is adjacent to about 1-2 miles of planned resiliency and salvage treatments. Impacts from these treatments should be fairly minimal. The Proposed Re-route would put the trail in the treatment area for about .5 miles. The affects would be fairly minimal, as discussed in the Visual Quality section.

In summary, the existing route will have some impacts in the foreground. The design features are intended to protect the scenic quality along the route. The proposed re-route will have very minimal effects from the treatments. The Los Creek re-route proposal will need location and careful planning of the treatment in that area.

Relationship of Proposed Activities to the Recreation Opportunity Settings (ROS)

As noted in the following Scenery section, there will be impacts to the setting in the short term from the proposed treatments. The same applies to the ROS. There will be short-term impacts during the management activity and for a period after treatment. Areas with dead trees that are salvaged will show evidence of logging for a period of time, the change to the setting was caused by natural factors followed by management activity. Priority Treatment Areas with treatment of the residual stand will be noticeable in the short-term also. An objective is to regain the current setting after treatment. The Design Criteria for the project are intended to keep the visual impacts to the setting from being dominant.

For the existing trail: Within the 0.5 mile foreground of the existing trail, two of the PTAs overlap areas identified as semi-primitive motorized (SPM). This overlap accounts for a total of approximately 3 acres. The area of overlap is not directly adjacent to the trail. The remainder of the PTAs overlap areas identified as roaded natural (RN).

Treatments in the three acres of semi-primitive motorized areas (SPM) along the CDNST that are implemented with the design criteria specified will not have an effect on the ROS classification. Page IV-10 of the 1986 ROS Book states in Table 5, Evidence of Humans Criteria for Semi-Primitive Motorized, "Natural setting may have moderately dominant alterations but would not draw attentions to motorized observers on trails and primitive roads in the area." Design criteria for VQO of Retention or Partial Retention will meet that standard, therefore the ROS classification will not be changed by the treatment activities proposed.

Treatments in the roaded natural (RN) areas will not alter the ROS setting to a different classification, which would be Rural. Page IV-10 of the 1986 ROS Book states in Table 5, Evidence of Humans Criteria for Roaded Natural ROS, "Natural setting may have modifications which range from easily noticed to strongly dominant to observers from within the area." However, from sensitive travel routes (such as the CDNST) and use areas these alterations would remain unnoticed or visually subordinate. Design criteria for VQO of Retention or Partial Retention will meet that standard, therefore the ROS classification will not be changed by the treatment activities proposed.

For the potential reroutes: The identified ROS within the foreground of the potential reroutes is roaded natural; treatments in such areas will not alter the ROS setting.

Regarding effects to the ROS from hazard tree removal: Areas identified for potential hazard tree removal within the foreground of the CDNST and identified potential reroutes overlap with areas identified as semi-primitive motorized and roaded natural. By the definition of the activity, hazard tree removal is within a maximum of 300 feet of an existing public road and would occur if and when hazard trees are identified. Therefore, there would be no impact to the existing ROS from potential roadside hazard tree removal.

Alternative 2 (Agency Preferred Action) – Cumulative Effects

The cumulative effects of Alternative 2, in combination with past, present, and reasonably foreseeable actions on the analyzed portions of the CDNST would be similar to those direct and indirect effects described here. No reasonably foreseeable actions are identified in this vicinity.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

The treatments along the CDNST under this alternative would be very minimal.

Existing trail locations are generally not affected by treatments; however, approximately 5 miles of trail have treatments in the foreground. Most of the middleground along the trail is difficult to see from the trail, due to the dissected nature of the terrain and that the trail location is not at a great altitude above the existing terrain. For the most part the existing scenic integrity in this area is rated as moderate.

In the Spring Creek Pass Area (Map G-68), the existing scenic integrity is identified as moderate. Hazard tree treatments are proposed on a road about ½ mile from the trail. The existing route will not be impacted by this activity. Given the epidemic of dead trees in the area, visual impacts currently exist. Relocation of the trail off of the road has not been analyzed in detail. Without treatment in this area, no impacts to potential relocation will occur.

The Marshall Creek Subwatershed Area (Map G-72) is an area where no trail re-routes are currently contemplated near the trail. Proposed treatments are located in areas with moderate scenic integrity and some high scenic integrity. Approximately 4 miles of trail are located with ½ mile of treatments comprised of a combination of treatments (salvage, resiliency and salvage/resiliency) on one side of the trail. Hazard Tree treatments are planned on 2 roads that intersect the trail. The design features described elsewhere will protect the foreground of the trail and impacts to the trail.

The LuJan- LaGarita or Southern Re-route Area is show on Maps G-69 through G-71. On Map G-69, near the Eddiesville Trailhead, no treatments are planned.

On Map G-70, between Monchego Park area and Luders Creek CG area, about 1-2 miles south of Cochetopa Pass, hazard tree treatments on roads near the trail are planned. The impacts to the trail, which is an existing road, would be very minimal.

There are extensive proposed re-routes in this area. The Salt House re-route proposal and the Proposed Southern re-route in this area are similar and neither is within 1 mile of proposed treatments, except for some Hazard Tree treatments on NFSR 864. These treatments would have minimal impact on the proposed routes. Hazard Tree treatments are planned on roads near the Proposed Re-Route and on a road that intersects the Proposed Re-Route. There would be minimal impact to the trail from these treatments. The Los Creek re-route proposal in this same general area would have Hazard Tree treatments on a road near the re-route and on a road that crosses the re-route. The potential routes should be protected during treatment in this area.

On Map G-71, the existing trail on NFSR 785 and NFST 486 is adjacent to very minor areas of planned resiliency and salvage treatments. Impacts from these treatments should be very minimal. The proposed re-route would not be impacted under this alternative.

In summary, the existing route will have very few impacts in the foreground. The design features are intended to protect the scenic quality along the route. The Los Creek re-route proposal will have some treatment nearby, but with very little effect.

Relationship of Proposed Activities to the Recreation Opportunity Settings (ROS)

For the existing trail: The extent and type of overlap of ROS and SBEADMR PTAs for Alternative 3 is the same as described for Alternative 2. The effects to the ROS are the same.

For the potential reroutes: As discussed above, there are no Alternative 3 PTAs that overlap within the foreground or middleground of identified potential CDNST reroutes.

Regarding effects to the ROS from hazard tree removal: Areas identified for potential hazard tree removal within the foreground of the CDNST and identified potential CDNST reroutes overlap with areas identified as semi-primitive, semi-primitive motorized, and roaded natural. By the definition of the activity, hazard tree removal is within a maximum of 300 feet of an existing public road and would occur if and when hazard trees are identified. Therefore, there would be no impact to the existing ROS from potential roadside hazard tree removal.

Alternative 3 (WUI Focus) – Cumulative Effects

The cumulative effects of Alternative 3, in combination with past, present, and reasonably foreseeable actions on the analyzed portions of the CDNST would be similar to those direct and indirect effects described here. No reasonably foreseeable actions are identified in this vicinity.

Forest Plan Compliance

The action alternatives would comply with the direction in the LRMP and the 2009 Continental Divide National Scenic Trail Comprehensive Plan.

There would be no irreversible or irretrievable negative effects on scenic resources due to either action alternative.

Scenic Quality and Visual Resources

Changes between Draft & Final EIS

- Design features have been clarified for more consistent implementation
- Design feature SVR-6 has expanded to explicitly cover proposed reroutes on the Continental Divide National Scenic Trail

Compliance with Regulatory Direction

The revised 1991 Grand Mesa, Uncompahgre and Gunnison (GMUG) Forest Plan provides guidance for all resource management activities on National Forest lands. The Forest Plan includes standards and guidelines for the management of scenic resources in the Forest-wide Direction and Management Area Prescriptions.

The work completed under the EIS will be implemented and documented via a Pre-Treatment Checklist (Appendix C). As each new treatment area is identified, the site would be surveyed and the specific visual quality objectives for each area, valued scenic resources and sensitivity level for scenery will be identified. Design features for scenic resources would be selected accordingly (See Appendix B and Table 326, below).

Analysis Methodology

Landscape viewing is subdivided into distance zones. For the visual analysis these distance zones and their related concern levels are defined as:

- Immediate Foreground: 0 feet to 300 feet (concern level 1) – This area receives the highest scrutiny.
- Foreground: 300 feet to one-half mile (concern level 1) – In this area, individual forms dominate (for example individual trees) and other sensory messages are received (for example birds singing).
- Middleground: one-half mile to four miles (concern level 2) – In this area, form, texture, and color remain dominant; human activities (such as timber harvest) may cause contrasting features if there are vantage points.

Past, current and reasonably foreseeable activities were reviewed to extrapolate reasonable cumulative effects. The cumulative effects of the activities can be grouped into four categories. First, a number of projects propose no immediate physical changes to scenic resources. Second, many projects proposing new or expanded work on trails or recreation sites are too small in scale to have a significant effect on scenic resources, and occur in areas where some modification of the scenic resource is expected. Third, many projects are being implemented with the express purpose of rehabilitating forest lands, which would improve scenic resources. Fourth, all projects proposed and underway require analysis and will take scenic impacts into account before implementation.

Affected Environment

The GMUG lies in the upper Colorado River Drainage and is located astride two distinct geographic areas; the Colorado Plateau and the Southern Rocky Mountains. The Colorado Plateau is characterized by high flat-top mountains and rolling plateaus, while the Southern

Rocky Mountain region has rugged mountains and valleys, steep slopes and dramatic changes in elevation. The vegetation types include many species of aspen, pine and fir, as well as grasslands and alpine meadows.

The characteristic landscapes of this forest are steep mountain lands and rolling plateau lands. The foreground and mid-ground are defined by the fine vegetative texture or stands of trees and meadows and color in the spring (wildflowers) and fall (fall color), with openings in forest

cover revealing dramatic landforms in the background. There are many areas with distinctive scenery, including waterfalls, narrow canyons and meadows full of wildflowers. Long views would tend to be finely textured views of common scenery. Scenery is framed by backgrounds featuring steep, often snow-capped mountains and unique geological formations.

There is significant evidence of beetle-killed and SAD-impacted stands throughout the forest. Because scenic views in the forest often encompass great distances over forested landscapes, beetle-killed and SAD-impacted stands can have a significant negative impact on scenic resources and landscape character.

Past, present and future management activities within the GMUG National Forests were reviewed for cumulative effects on scenic resources. The landscape characteristics remain in place with some changes resulting from natural events such as wildfires, winds, insects and disease; and human activities such as timber cutting, roads, trails, dispersed and developed recreation, mining, ranch/cabin developments, utilities, and livestock grazing and development.

Alternative 1 (No Action) – Direct and Indirect Effects

Under Alternative 1, the No Action Alternative, no acres would be treated under the SBEADMR project, although smaller recovery, resiliency, and hazard tree removal projects would continue to be implemented under existing authorizations. Natural events and human activities would continue to change the scenic landscapes. Developed campgrounds and picnic grounds would continue to have hazardous trees cut and removed to meet the public safety requirement (FSM 2332.11 Public Safety, Hazard Trees), but to a lesser extent and over a longer time period of implementation. Most standing dead and dying trees would remain standing up to approximately a decade and would therefore remain a hazard to forest users and travelers until removed or blown down. Strong winds could blow down dead and dying trees across trails and roads, campsites, trailhead parking areas and administrative sites. Trees falling naturally across Forest Service roads or forest trails would be cut to open access through travelways as required by the Highway Safety Act of 1966 and FSM 7733. Downed trees that were cut to open travelways would not be removed. The evidence of cut ends of logs, when viewed from the immediate foreground of travelways, would impact scenic quality. In certain areas, visitors would notice high numbers of downed trees in or near travel corridors and recreation areas, which would negatively impact scenery.

Indirect effects to scenic quality include impacts from travelers avoiding downed trees and the continuing increase of dead and dying trees. Travelers could impact the immediate foreground of scenic resources by creating new paths around roads or trails blocked by naturally fallen trees that have not yet been removed by the Forest Service. Impacts could include eroded or bare soils; trampled or removed ground-level vegetation along created paths; and damage to young healthy trees.

In addition, the rate of spruce mortality from the spruce beetle epidemic continues to increase. Associated scenic impacts from spruce beetle will continue to increase, and there will be continued scenic impacts from sudden aspen decline (SAD), resulting in a long-term decline of the scenic resource.

Alternative 1 (No Action) – Cumulative Effects

There are no proposed management activities under Alternative 1. Therefore, no changes to scenic quality will result from the implementation No Action Alternative. The direct and indirect effects of natural processes in combination with past, on-going, and future activities could result in cumulative effects to scenic quality. Given reasonable foreseeable vegetation management, fewer areas would be treated, leaving more visible dead and downed stands on the landscape for the long-term.

Activities Common to Both Action Alternatives

The following design features are applicable to both action alternatives.

Table 326. Design Features for Scenic Quality and Visual Resources.

Design Feature	Trigger for Use	Description	Effect
SVR-1	All Treatment Areas	If VQO maps are not locatable, the following VQO's will be used as interpreted from the 1991 LRMP. These will be applied to the Visual Management Guideline Classes identified in the Visual Resource Management Section discussed below. These requirements apply to vegetation treatments. 1A – Retention 1B - Modification, but Retain where possible 1D – Modification or Max. Modification 2A – Retention 2B – Partial Retention 3A - Retention 4B – Modification 4D – Modification 5A – Modification 5B – Modification 6A – Modification 6B – Modification 7A – Modification or Max. Modification 10E – Modification Other Management Areas are not planned for treatment. See other requirements for Sensitivity Level 1 Roads, Trails and View Points below. Those requirements are more restrictive than the general management area requirements shown here.	Limit immediate and longer-term visual impact of treatments
SVR - 2	In all treatment areas	Follow General Direction and associated standards and guidelines in the Visual Resource Management Section of the 1991 Land and Resource Management plan. This direction is found on pages III-12 through III-15. Consult with the forest visual resource specialist when implementing projects to ensure that these standards are being met. The visual resource specialist will adapt this direction to the situations where the forest has been heavily impacted with dead or dying trees. The visual system was not designed for these situations; however, the principles are to be applied.	Reduce visual evidence of management activities such that they repeat form, line, color and texture which are typically found in the characteristic landscape.

Design Feature	Trigger for Use	Description	Effect
SVR-3	In developed recreation sites, including trailheads and administrative sites (typically Visual Quality Objectives [VQOs] of Modification or Maximum Modification)	Cut stumps as low to the ground as feasible. Remove or chip slash at developed campgrounds or designated recreation areas, extending outwards 200 feet of any constructed feature; at designated dispersed sites; and other dispersed sites deemed important at the time of implementation. Alternatively, at designated dispersed sites or other dispersed sites deemed important and at developed recreation sites (except developed campgrounds or designated recreation areas) and at administrative sites, move heavy slash to designated slash piles and burn as soon as conditions allow. Note: designated recreation areas include but are not limited to: Taylor Canyon, Mesa Lakes, Island Lake, and Amphitheatre/Na-Gach.	Limit immediate and longer-term visual impact of treatments
SVR-4	In developed recreation and administrative sites (typically VQOs of Modification or Maximum Modification)	Minimize damage from mechanical treatments to young healthy trees and understory trees and shrubs.	Provide present and future shade and screening, and to maintain high quality recreational setting and desired scenic condition.
SVR-5	In areas with VQOs of Retention or Partial Retention	In areas of Retention or Partial Retention, minimize damage to natural features such as rock outcrops, young healthy trees and understory of trees and shrubs; cut stumps as low to the ground as feasible. Note: Retention and Partial Retention will be applied to National Recreation Trails, National Scenic Trails, National Historic Trails and State or Forest Service Scenic Byways/All-American Roads.	Reduce visual evidence of management activities, such that they repeat form, line, color and texture which are typically found in the characteristic landscape.
SVR-6	All designated trails (NRT, NST and NHT, and designated potential re-routes), scenic byways and sensitivity level 1 roads or trails.	The VQO is Retention for the foreground of these areas. The VQO is Partial Retention for the middleground of these areas. Design treatments based on the VQO. When cutting trees that fall across trails or within the trail corridor (generally 3 feet on either side of the trail), lop and scatter logs and limbs outside the corridor. Cut stumps flush with the ground in the immediate (to 300 feet) foreground of these travelways. Remove heavy slash (greater than 1 foot deep) within the immediate foreground (to 300 feet) to slash piles (which will be burned or are expected to be minimally apparent within 5 years) or chip. Slash may be scattered to depths of less than 1 foot.	Reduce visual evidence of management activities, such that they repeat form, line, color and texture which are typically found in the characteristic landscape.

Design Feature	Trigger for Use	Description	Effect
SVR-6 (continued)	All designated trails (NRT, NST and NHT, and designated potential re-routes), scenic byways and sensitivity level 1 roads or trails.	Do not use these routes for skidding. Minimize skid trails across these features. Rehabilitate any skid trails or temporary roads that intersect with these features or are present in the foreground (up to ½ mile). Do not locate landings along or within the foreground of these features. In the LuJan-LaGarita area of the proposed re-routes for the CDNST, the center-line of all of the proposed re-routes shown in this document will be marked prior to treatment and maintained during treatment – until a decision is made for a specific re-route, at which time only that re-route must be marked and maintained. The Design Features discussed above will be employed on the proposed re-routes. In the LuJan-LaGarita area of the proposed re-routes for the CDNST, the center-line of all of the proposed re-routes shown in this document will be marked prior to treatment and maintained during treatment – until a decision is made for a specific re-route, at which time only that re-route must be marked and maintained. The Design Features discussed above will be employed on the proposed re-routes.	Reduce visual evidence of management activities, such that they repeat form, line, color and texture which are typically found in the characteristic landscape.
SVR-7	All treatments	Revegetate and till disturbed and compacted soils on landings, burned slash pile sites, skid trails and temporary roads with native seed mixture after the completion of treatments. Block access to decommissioned or re-claimed temporary roads with naturalistic barriers.	Reduce soil contrast and encourage regrowth.

Alternative 2 (Agency Preferred Action) – Direct and Indirect Effects

The direct effect of the Proposed Action on scenic quality would be that, in treated areas, forest visitors would notice the removal of mature trees that once dominated the forest landscape. The immediate visual impact from resilience treatments may be negative, depending on the value of the observer for more or less dense stand settings. Openings resulting from removal of live and diseased trees of various sizes and shapes would be noticed by visitors traveling along road and trail corridors and in campsites. The immediate visual impact from recovery (salvage) treatments may be positive, as the removal of dead and dying trees may be considered an improvement upon the status quo. Fewer large stands of dead trees would be visible from travelways, potentially improving scenic quality.

Negative short-term impacts on scenic resources would occur from temporary roads and along existing corridors from mechanical management activities. In the short-term, mechanical treatments would be more apparent to visitors traveling through active work areas. Some felled

trees would remain on the ground to protect sensitive plants, hydric soils and wildlife habitat in identified sites. Some sections of trail corridors would have large amounts of felled trees visible on the ground by trail users, which could negatively impact scenery. Some trees would remain to provide present and future shade and screening. Some administrative sites may become more visible due to removal of screening trees.

Removing dead and diseased trees in affected spruce stands via recovery treatments would allow existing advanced regeneration to grow faster with less competition for light and moisture, which would improve scenic quality over the long-term.

Replanting in recovery-treated areas with no seed source or existing advanced regeneration would, in the long-term, recover a forested condition that would most closely approximate previous scenic qualities, in comparison to the likelihood that such areas would have otherwise converted to shrub and grasses.

Some larger treated sites may have adjacent green trees with shallow root systems. These trees may be naturally blown down by strong winds, causing downed trees with exposed roots to dominate the openings and lower the scenic integrity when viewed from recreation areas and scenic corridors. However, silvicultural prescriptions (Appendix A) are designed to limit the likelihood of blowdown post-treatment. Depending on the structural stand condition, prescriptions require maintenance of 60% of the original stocking in a treatment area or limit treatments to patch cuts of less than 3 tree lengths in size (.25 to 2 acre openings).

Resiliency treatments in spruce would, over the long-term, result in a more heterogeneous, multi-storied stand condition and maintenance of the spruce-fir vegetation type. Associated indirect impacts to scenic quality may include persistence of the vegetation type currently associated with the area, with a greater likelihood to persist throughout future stressors with less visible mortality.

Alternatives 2 (Agency Preferred Action) – Cumulative Effects

Alternative 2 would implement felling and/or removal of dead and dying trees. Some short-term negative scenic impacts would occur due to mechanical treatments and impacts along existing and temporary roads. The cumulative effects of these actions, combined with other related actions involving felling and/or removal of dead, dying and green trees, would be short-term negative impacts to the immediate foreground and foreground due to evidence of mechanical treatment. This is a temporary deviation from the prescribed VQO, but it is a practical necessity for treatments to occur. The design requirements are intended to minimize the impact of this temporary deviation. The salvage of dead trees from an epidemic over large areas is not a situation that is well handled with the visual management system, but we are applying the principles of that system to a large scale event that is not well addressed by existing direction. But for some observers, this would lead to a longer-term increase in scenic quality over existing conditions, promoting quicker regeneration of new trees within travelway

corridors and recreation areas. Across the landscape of the GMUG, however, about 4% of the area is proposed for actual treatment in the implementation timeframe, so the scale of such visual impacts would be limited. The action would not cause any long-term adverse cumulative effects to the scenic resource. Vegetation treatments on the forest will conform to the VQO's and proposed treatments must be reviewed in conjunction with surrounding treatments at the time of project design to minimize impacts on visual resources. In the long run, the character of the forest will be improved by these activities as a more diverse age class distribution is achieved than would otherwise exist. This will result in a better visual appearance of the forest compared to a forest dominated by older stands.

Alternative 3 (WUI Focus) – Direct and Indirect Effects

The direct effects of Alternative 3 on scenic quality in specific locations are similar to those from the Proposed Action, but are limited to areas within the WUI and road corridors. The effects that do occur will do so in an area that is inherently populated. The likelihood of the identified positive and negative impacts to scenic quality will continue to be more readily observed. However, the WUI is by nature a more developed environment with fewer continuous and dense expanses of vegetation, so the visual contrast of most treatments would not be as remarkable as in other alternatives.

Outside the WUI and road corridors, natural events and human activities would continue to change the scenic landscapes. There would be less removal or felling of standing dead and dying trees (except hazard trees), and such trees would remain standing for approximately a decade. These could be a hazard to forest users and travelers and block trails and roads, campsites, and trailhead parking areas. Downed trees blocking roads or trails would be cut by Forest Service workers or contractors to open access as required by the Highway Safety Act of 1966 and FSM 7733. These trees would not be removed and would impact scenic quality due to the evidence of cut ends of logs when viewed from the immediate foreground of travelways.

Indirect effects would be the same as described in the Proposed Action, but would concentrate the effects into a smaller geographic area, and one that is inherently populated. Both factors would continue the likelihood of the identified positive and negative impacts to scenic quality being more readily observed.

Alternative 3 (WUI Focus) – Cumulative Effects

The cumulative effects of Alternative 3 are the same kind as described in the Proposed Action, but would be limited geographically to the WUI and road corridors.

Forest Plan Compliance

The various action alternatives would comply with the adopted visual quality objectives when the design features for scenic resources are followed. Trail sections with a large amount of cut

trees left on the ground and visible when viewed from nearby trails would appear as Modification or Maximum Modification VQO instead of Retention or Partial Retention VQO. Sections of road corridors where heavy felling and removal of dead and dying trees would occur would appear as Modification VQO instead of Partial Retention VQO.

There would be no irreversible or irretrievable negative effects on scenic resources due to any action alternative.

Cumulative Effects – Actions Considered & Analysis Approach

Cumulative effects take into account past, present, and reasonably foreseeable activities from actions other than the SBEADMR Project, in addition to direct and indirect effects of the SBEADMR Project. The area analyzed for cumulative effects is the project area for all resources unless otherwise noted. Cumulative effects are disclosed under each resource topic. It is important to note that the amount (e.g. acres, miles, etc.) of a certain activity in any alternative is approximate (based on inventory and survey estimates).

In order to understand the contribution of past actions to the cumulative effects of the proposed action and alternatives, this analysis considers past and present activities in the affected environment to establish a baseline for analyzing direct, indirect and cumulative effects. Because two decision-making triggers for adaptive implementation rely on a quantitative consideration of past impacts in watersheds and in lynx habitat, these analyses do quantify past actions with respect to the decision-making triggers.

This cumulative effects analysis, *with the exception of the cumulative analysis for the identified decision-making triggers for watershed and lynx,* does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. The Council of Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions. The memorandum states, “agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions.”

The cumulative effects analysis in this EIS is also consistent with Forest Service National Environmental Policy Act (NEPA) Regulations (36 CFR 220.4 (f)) (July 24, 2008), which state, in part:

> CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions. Once the agency has identified those present effects of past actions that warrant consideration, the agency assesses the extent that the effects of the proposal for agency action or its alternatives would add to, modify, or mitigate those effects. The final analysis documents an agency assessment of the cumulative effects of the actions considered (including past, present, and reasonably foreseeable future actions) on

> the affected environment. With respect to past actions, during the scoping process and subsequent preparation of the analysis, the agency must determine what information regarding past actions is useful and relevant to the required analysis of cumulative effects. Cataloging past actions and specific information about the direct and indirect effects of their design and implementation could in some contexts be useful to predict the cumulative effects of the proposal. The CEQ regulations, however, do not require agencies to catalogue or exhaustively list and analyze all individual past actions. Simply because information about past actions may be available or obtained with reasonable effort does not mean that it is relevant and necessary to inform decision making (40 CFR 1508.7).

With respect to ongoing activities considered, the individual resource specialists identified those that were pertinent to their analysis in their respective sections.

With respect to future activities considered, the IDT conducted a thorough search of the GMUG's Service Statement of Proposed Activities (SOPA), BLM's public NEPA webpages for each of the 3 BLM Field Offices in the area, consulted program leads on the GMUG, and consulted BLM NEPA coordinators. The adjacent Rio Grande National Forest is continuing to implement and plan timber and fuels activities, but these do not fall within the Cumulative Impact Analysis Area of the HUC12 subwatersheds and/or LAUs or in which SBEADMR activities are proposed. Public comments on the Draft EIS also contributed to a thorough list of foreseeable activities on federally managed lands in the SBEADMR area. For all but air resources, the Cumulative Impacts Analysis Area was identified as the Hydrologic Unit Code 12 (HUC12) subwatershed and/or Lynx Analysis Unit scale. These activities are detailed in Table 327. Reasonably foreseeable future action scenarios are projections made to predict future impacts – they are not actual planning decisions or resource commitments, though some in the list have been approved in planning decisions. Projections, which have been developed for analytical purposes only, are based on current conditions and trends and represent a best professional estimate. Unforeseen changes in factors such as economics, demand, and federal, state, and local laws and policies could result in different outcomes than those projected in this analysis.

With respect to future vegetation management on state and private land within the Cumulative Impact Analysis Area – the HUC12 subwatersheds and/or Lynx Analysis Units in which SBEADMR activities are proposed – the GMUG consulted the Colorado State Forest Service. The total treatments planned encompass 240 acres throughout multiple HUC12 subwatersheds and/or Lynx Analysis Units in which SBEADMR activities are proposed. By Geographic Area in which they are planned, such state and private treatments total between <0.001-5% of the planned future activities on federal grounds. Therefore, the impacts of these future fuels and hazard tree treatments on state and private lands are commensurate with the level of impacts disclosed from activities on federally managed land. More detail regarding these state and private treatments is included in the Biological Assessment. Other future activities on private lands will include additional exurban residential development, associated road construction, oil and gas development, irrigation and other small-scale infrastructure projects, and continued livestock

grazing. Generally, the impacts of future activities on nearby private land is commensurate with the level of impacts disclosed from activities on federally managed land.

Table 327. Reasonably Foreseeable Future Activities.
Actions considered are those within a HUC12 subwatershed and/or Lynx Analysis Unit in which there are also proposed SBEADMR activities.

GA, Category of Activity & Project Name	Estimated Disturbance Acres
Grand Mesa	**2,090**
O&G	**60**
Axia Energy - Hightower 3 pad	12
Axia Energy Well Pad Expansion	3
Gunnison Energy - Spaulding 15-pad	8
Gunnison Energy - Spaulding 15-pad	37
Timber	**476**
Grand Mesa Resort CE	476
Reservoirs	**5**
Monument Reservoir - associated road construction	5
Fuels	**1,549**
Battlements	564
Grand Mesa Resort WUI	317
Mesa Point	50
Nick Mountain	619
Gunnison Basin North	**79,381**
Ski Areas	**102**
Crested Butte Mountain Resort Expansion	102
Fuels	**79,279**
Flat Top	4,715
Main Gulch	16,033
Quartz Creek	1,285
Soap Creek	12,577
Taylor Canyon	44,050
Tin Cup	20
West Elk	565
West Mountain	34
Gunnison Basin South	**25,945**
Timber	**7,351**
Archuleta project area	125
Corduroy project area	160
Deadman project area	470
Divide Salvage Project	247
Highway 149 South Salvage Project	242

GA, Category of Activity & Project Name	Estimated Disturbance Acres
Long Draw CE	300
Lujan project area	50
Millswitch project area	800
Monchego project area	160
Myers project area	490
Pine Creek project area	390
Salaya project area	700
Samora project area	150
(BLM) Southwest Gunnison Bark Beetle Salvage	3,067
Fuels	**18,594**
Barret	1,479
Los Pinos	4,231
Myers	3,547
Sawtooth	9,337
North Fork	**99**
Coal	**48**
North Fork Coal Mining Area Exception	3
Spruce Stomp Coal Lease by Application	45
O&G	**51**
Gunnison & SG Interests' 5-pad EA	21
Petrox 2-APDs at Pilot Knob	5
SG Deadman Gulch APD	3
SG Huntsman Unit Proposal	3
Spadafora Waste Disposal Pits	19
North Fork Valley	**4,245**
Fuels	**4,245**
McCluskey	492
Soap Creek	3,753
San Juans	**293**
Fuels	**293**
Ouray NEPA	293
Uncompahgre Plateau	**67,274**
Fuels	**67,274**
25 Mesa	2,398
25 Mesa Thinning	464
Brushy Ridge	4,604
Busted Arm	205
Calamity	4,223
Copper King	1,758
Corral Creek	6,781
Cottonwood	56

GA, Category of Activity & Project Name	Estimated Disturbance Acres
Coyote Basin	549
Dave Wood	2,032
Ed Joe	605
Glencoe	2,261
Hanks	838
Horsefly Stewardship	535
Lafair	5,625
Little Monitor	2,922
Lockhart	4,931
Love Mesa	2,499
Mesa Creek	1,872
Naturita (Thunder Road)	624
Pine Hill	685
Rocky Pitch	3,426
Sanborn	5,705
Sawmill Mesa	2,748
WIMP 1	320
WIMP 2	2,953
WIMP 3	2,697
WIMP 4	1,155
WIMP 5	1,802
Total	**179,326**

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

These relationships between short-term uses and long-term productivity are addressed in the effects sections for each resource. In this project, design features incorporated into all action alternatives, Decision-Making Triggers for Adaptive Implementation, the Pre-Treatment Checklist – including documentation of Forest Plan compliance, Annual Treatment Review, and the Adaptive Implementation framework for incorporating information from emerging science and monitoring – will ensure that the long-term productivity of the land is not impaired by short-term uses.

Unavoidable Adverse Effects

The following is a description of adverse effects that are unavoidable with implementation of action alternatives. For further discussion of the effects on the resources listed below, see Chapter 3 under the respective resource topics.

Silviculture resources would continue to be impacted by spruce beetle and SAD.

Wildlife habitat for certain species would be adversely affected to varying levels with implementation of the action alternatives. The Wildlife section of Chapter 3 discloses those effects.

Air quality would be adversely affected on a temporary/seasonal basis as a result of planned burning of hand/equipment piles and dust from roads and activities.

Scenic quality would be affected adversely for some observers by the treatments; scenic resources for some observers would continue to be impacted by visual evidence of spruce beetle and SAD on the landscape.

Surface fuel loadings could increase if a particular treatment prescription does not include treatment of those fuels. This would generally only occur outside the WUI where slash is desired to improve regeneration success (i.e., create microsites).

Soils can be eroded wherever vegetation and soils are disturbed. Compaction can occur where vehicles and equipment are used.

Heritage resources can be disturbed or destroyed where human or natural activities take place; however, all eligible or listed cultural resources will be avoided in the implementation of this project.

Botany resources can be adversely affected by treatments such as timber harvest, prescribed fire and road building which can ultimately affect the overall capacity of the species to persist as an individual plant, as a single population, or as a group of populations in a local area.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

There are not **irreversible** commitments of resources with any of the alternatives analyzed.

Irretrievable commitments of resources are discussed under the effects sections in Chapter 3. Key **irretrievable** commitments of resources include the following:

Soil productivity and timber productivity is lost in the near and medium-term where road construction is planned in all action alternatives.

Air quality would be temporarily impacted to varying degrees by smoke generated from burning hand/equipment piles and by dust from road use resulting from implementation of the action alternatives.

Wildlife habitat loss or modification for certain wildlife species is likely under all alternatives. As vegetation recovers, habitat would eventually return over various periods depending on treatment/disturbance amount. There will be some treatment in lynx habitat, which will result in some lynx habitat loss until vegetation regenerates, however, these losses will stay within allowable impacts in accordance with the Southern Rockies Lynx Amendment. The maximum number of acres of lynx habitat which may be lost or modified by treatment is discussed in further detail in the Wildlife section of Chapter 3.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with …other environmental review laws and executive orders." Other laws, policy and executive orders which are integrated into this project are outlined in Chapter 1, in the Management Direction and Strategy section. Specific laws pertaining to particular resource areas are outlined in Chapter 3 under the respective resource areas.

(This page intentionally blank)

CHAPTER 4. LIST OF PREPARERS, CONSULTATION AND COORDINATION

A. PREPARERS

The following people participated in initial internal scoping, were members of the Interdisciplinary Team, and/or provided direction and assistance during the preparation of this DEIS.

Scott Armentrout	Grand Mesa, Uncompahgre and Gunnison National Forests, Responsible Official

FEIS Project Leaders

Clay Speas	Wildlife, Fish and Rare Plants Program Manager
Samantha Staley	Forest Planner

DEIS Project Leaders

Clay Speas	Wildlife, Fish and Rare Plants Program Manager
Adam Shaw	Environmental Coordinator
Alicia Reiner	Fire Ecologist
Scott Williams	Fire Management Specialist

Interdisciplinary Team

Carmine Lockwood	Renewable Resources and Strategic Planning Staff Officer
Scott Williams	Fire Management Specialist – Air Quality, Project Record Management
Wendy Boes	Botanist – Botany, Noxious and Invasive Weeds
Barry Johnston	Botanist – Botany, Noxious and Invasive Weeds
Suzanne Parker	Wildlife Biologist - Botany
Paul Claeyssens	Archaeologist – Cultural Resources
Leigh-Ann Hunt	Archaeologist – Cultural Resources
Kristen Loughery	Economist – Economics
Adam Shaw	Environmental Coordinator
Alicia Reiner	Fire Ecologist – Fire and Fuels
Dan Huisjen	Fire Ecologist – Fire and Fuels
Chris Barrett	GIS Specialist
Kathy Abramson	GIS Specialist
Carol Howe	Resource Information Specialist – GIS Analysis
William (Tony) Smith	GIS Program Manager – GIS Analysis
Lucretia Smith	Range Management Specialist – Range
Clare Hydock	Range Management Specialist – Range, Noxious & Invasive Weeds

Jim Cuthbertson	Recreation Program Manager – Recreation, Visual Resources & Continental Divide National Scenic Trail
Tom Eager	Research Scientist
Jim Worrall	Research Scientist
Roy Mask	Research Scientist
Mike Hill	Architect – Scenic Quality and Visual Resources
Beth Stewart	Forester – Silviculture
Matthew Bienkowski	Forester – Silviculture
Chris Bielecki	Logging Engineer – Transportation
George Goehl	Civil Engineer – Transportation
Patrick (Doug) Marah	Transportation Engineer – Transportation
Gail Bakker	Hydrologist – Watershed and Soil
Beth Anderson	Soil Scientist – Watershed and Soil
Ben Stratton	Hydrologist – Watershed and Soil
Joan Carlson	Hydrologist – Watershed and Soil
Teresa Sue	Wildlife Biologist – Wildlife (Terrestrial)
Matt Vasquez	Wildlife Biologist – Wildlife (Terrestrial)
Clay Speas	Wildlife, Fish and Rare Plants Program Manager – Threatened & Endangered Species
Matt Dare	Biologist – Fisheries
Melvin Woody	Biologist – Aquatic Species
Shelby Reeder	Writer/Editor
Niccole Mortenson	Engineering and Minerals NEPA Project Specialist – DEIS & Draft ROD Reviewer
Mary Johnson	Administrative Assistant – Mailing List Manager
Lee-Ann Loupe	Public Affairs – Public Information

Additional Forest Service staff that assisted during various stages of the planning process include: Jamie Gamboa, Fire Management Officer; Craig Warren, Fire Management Specialist; Jim Ramirez, Fire Management Officer; Corey Robinson, Fire Management Officer; Erick Stahlin, Fire Management Officer; Warren Young, Soil Scientist; Gary Shellhorn, Hydrologist; Todd Gardiner, Forester; Drew Stroberg, Forester; Art Haines, Silviculture; Matt Etzenhouser, Forester; Trey Schillie, Policy Analyst.

B. GOVERNMENT AGENCIES AND TRIBAL GOVERNMENTS CONTACTED

FEDERAL GOVERNMENT

U.S. Environmental Protection Agency, Region 8
U.S. Fish and Wildlife Service
U.S. Department of Energy, Western Area Power Administration

Federal Aviation Administration, Northwestern and South Pacific Divisions
U.S. Army Corps of Engineers
U.S. Federal Highway Administration, Colorado Division
Department of Interior, Office of Environmental Policy and Compliance
Department of Agriculture, Natural Resources Conservation Service

TRIBAL GOVERNMENT

Southern Ute Indian Tribe
Ute Tribe of the Unitah and Ouray Reservation
The Hopi Tribe
Acoma Pueblo
Pueblo of Zia
Zuni Tribe of the Zuni Reservation

STATE GOVERNMENT

Colorado Department of Transportation
Colorado State Historic Preservation Office
Colorado Parks and Wildlife, Division of Wildlife
Colorado State Division of Water Resources, Water Division No. 5
Colorado Air Pollution Control Division
Colorado Water Conservation Board
Colorado Division of Water Resources
Colorado State Forest Service
Colorado Department of Public Health and Environment

LOCAL GOVERNMENT

Board of Commissioners:

- Montrose County
- San Miguel County
- Mesa County
- Hinsdale County
- Saguache County
- Gunnison County
- Ouray County
- Delta County

Town of:

- Orchard City
- Crawford
- Cedaredge
- Hotchkiss
- Grand Junction
- Fruita

- Paonia
- Palisade
- Collbran

C. INDIVIDUALS AND ORGANIZATIONS WHO COMMENTED DURING AND AFTER FORMAL SCOPING

The announcement regarding the availability of the FEIS will also be sent to all attendees of public meetings who provided contact information. Copies of public meeting sign-in sheets are available in the project file. See Appendix H1 for comments received on the Draft EIS and the associated responses. Appendix H2 includes copies of comment letters received from all government entities.

Scoping Commenters – Individuals (NOTE: Many people listed below were signatories to organization comment letters.)

Steve Acquafresca
C. Douglas Atchley
Norman Birtcher
Suzanne Bohan
Hilary Cooper
Bill Day
David Dearborn
Cindy Dozier
Gary Ellis
Art Etter
Nancy Fishering
Adam Gall
Craig Grother
Denis Hall
Ron Henderson
C. Bruce Hovde
Leigh Kuwanwisiwma
Terri Lamers
Roz McClelland
Allison Melton
Alden Naranjo
J. Mark Roeber
Larry Sanders
Sarah Sauter
David Schneck
Logan Scott
Barbara Sharrow

David Smith
Rocky Smith
Tom Sobal
Eric Sorenson
Carl Spaulding
James Stafford

Susan Thompson
Tom Troxel
Rein van West
Ron Velarde
Steven Webber
Stan Whinnery
David White

Scoping Commenters - Organizations

Mesa County Board of County Commissioners

Delta County Board of County Commissioners

Director, USEPA Region 8, NEPA Compliance and Review Program

Sheep Mountain Alliance
Hinsdale County Board of Commissioners
Montrose County Board of Commissioners
Colorado Timber Issue Coordinator
Uncompahgre Habitat Watchman
Backcountry Hunters and Anglers
Hopi Tribe
Rocky Mountain Recreation Initiative
Montrose Forest Products, LLC
High Country Citizens' Alliance
Southern Ute Indian Tribe
Western Slope Conservation Center
Intermountain Forest Association
Western Colorado Congress
Colorado Parks and Wildlife
U.S. Department of Energy, Western Area Power Administration

Commenters Outside of Formal Scoping, Comment Periods – Individuals

(NOTE: Many people listed below were signatories to organization comment letters.)

Ralph Files
Greg Warren
Wayne Quade
Rein van West
Sarah Sauter
Hilary Cooper
Sloan Shoemaker
Allison N. Melton
Luke Schafer
Tehri Parker
Delia Marlone
Roz McClelland
James Lockhart
Dan Olson
Christine Canaly
Tom Sobal
Nancy Fishering
Mary M. Chapman
Norman Birtcher
David White
Glen Davis
Ron Henderson
Jimbo Buickerwood
Rocky Smith
Kevin Mueller
Craig Grother
Norman Birtcher
Matt Sandler
Emily Hornback

Commenters Outside of Formal Scoping, Comment Periods - Organizations

Western Colorado Congress
Sheep Mountain Alliance
Colorado Timber Industry Association
Rural Resource Solutions
Montrose Forest Products
Montrose County Board of County Commissioners
Habitat Watchman
High Country Conservation Advocates
Wilderness Workshop
Conservation Colorado
Rocky Mountain Wild
Sierra Club, Rocky Mountain Chapter
Rocky Mountain Recreation Initiative
Wild Connections
San Juan Citizens Alliance
San Luis Valley Ecosystem Council
Quiet Use Coalition

(This page intentionally blank)

INDEX

1991 GMUG Amended Forest Plan, 21, 50

2012 Land Planning rule, 22

adaptive implementation approach, iii, 28

adaptive management, vi, 22

aerial forest health survey, 7

age class, v, 15, 281

Air Quality Related Values, 217

Allotment Management Plans, 397

AMPs, 397

Annual Operating Instructions, 397, 398

Annual Treatment Review, 42, 745

AOIs, 397

APE, 676, 677, 678, 679, 681, 682, 683, 759

AQRV, 217, 236, 759, 765, 769

Area of Potential Effects, 676, 759

aspen clones, 18

aspen regeneration, 20, 31, 63, 64, 289, 293, 295, 355

ATV, 294

Best Management Practices, i, 52, 66, 141, 197, 198, 205

BMPs, 198, 803

broadcast burning, vi, 50, 289, 295, 331, 346, 350, 389

Canada Lynx, 804

canopy fuels, 274, 282, 289, 295

carbon emissions, 15, 232, 233

carbon sequestration, 231

carbon sink, 229, 230, 231, 232

carbon storage, 232

CDPHE, 219, 220, 223, 228, 236, 238, 240, 242, 246, 249, 776, 777, 779

CEQ, i, 30, 218, 274, 686, 741, 777

Clean Air Act, 217, 219, 220, 221, 236, 761

climate change, 10, 11, 15, 18, 20, 22, 218, 228, 231, 232, 357, 364, 381, 394, 395, 773, 776, 777, 785, 786, 788, 794, 807

Climate projections, 18, 28

Colorado Department of Agriculture, 372, 776

Colorado Department of Public Health and Environment, Air Pollution Control Division, 220

Colorado Forest Restoration Institute, 30

Colorado Roadless Areas, 38

Colorado State University, 30, 778, 779, 780, 792, 796

Colorado Water Quality Control Commission, 779

coppice cutting, 48, 355

Council on Environmental Quality, i, 30, 777

CSTs, 678, 679, 681, 684, 761

Cultural Areas, 38

Culturally scarred trees, 678, 761

cutthroat trout, 767

Deciding Official, vii, 26

developed recreation, 199

dispersed recreation, 20, 62, 765

drought, v, 15, 16, 18, 20, 228, 231, 232, 343, 345, 762, 773, 776, 783, 785, 791, 793, 807

ecological restoration, 22, 790, 791

Ecological Restoration and Resilience Policy, v

economic well-being, 695

Emergent Habitat, 9, 16

Endangered Species Act, 369, 457

Environmental justice, 777

Environmental Protection Agency, i, 217, 227, 228, 237, 240, 241, 242, 781, 782

EPA, i, 217, 218, 219, 220, 226, 235, 239, 240, 243, 771, 781, 782

ESA, 369, 457

fire lines, 390

Forest Plan, iii, v, viii, 21, 23, 24, 25, 26, 30, 38, 42, 49, 50, 64, 198, 220, 221, 227, 273, 274, 277, 285, 343, 373, 374, 688, 745

Forest Plan standards and guidelines, 25

Forest Supervisor, iii, vii, 26, 27, 51, 198, 763, 787

fuel loading, 64, 259, 281, 282, 288, 293, 294, 296, 353, 389

GHG, i, 217, 218, 219, 222, 226, 227, 228, 246, 260, 261, 262, 263, 268, 269, 270, 271, 777

GMUG National Forest Land and Resource Management Plan, iii, v

greenhouse gases, 227

habitat structural stage, 9

hazard trees, v, 20, 51, 52, 69, 205, 349, 352, 680, 681, 704, 802

IDT, i, vi, 30

Interdisciplinary Team, i, vi

Intergovernmental Panel on Climate Change, 234

invasive species, 342, 343, 352, 353, 354, 355, 356, 357, 360, 362, 363, 372, 373, 374, 376, 377, 379, 380, 381, 382, 383, 385, 386, 387, 390, 392, 394, 395, 790, 800

IPCC, 234, 235

LAUs, 66

Lost Habitat, 9, 16

LRMP, 221, 398

Lynx Analysis Units, 66

Management Areas, 24, 293

Management Indicator Species, i, 457

MIS, i, 457

NAQQS, 217

National Ambient Air Quality Standards, 217, 225, 226, 237, 240, 263, 271

National Environmental Policy Act, i, iii, vi, 1, 37, 373, 686, 777

National Forest Management Act, i, 23, 25, 50, 220

National Historic Preservation Act, 675, 761

National Register, 675, 676, 677, 679, 681, 761

NEPA, i, iii, vi, 1, 27, 30, 33, 37, 43, 65, 207, 218, 397, 675, 680, 686, 741, 745, 747, 777, 801

NFS roads, 197, 201

NOI, vi, 26, 27

non-native plant species, 31, 376, 775

Northern goshawk, 42

Notice of Intent, vi, 26

OHV, i

Persistent Habitat, 9, 16

pile burning, vi, 50, 51, 293, 294, 295, 348, 349, 353, 370, 389, 390, 782

PNV, 5, 13, 686, 687, 689, 703, 705, 706, 708, 709, 710

prescribed burning, vi, vii, 220, 222, 223, 242, 245, 248, 249, 255, 259, 262, 263, 265, 270, 271, 273, 288, 301, 382, 681, 682, 683, 684, 706, 788

present net value, 686

Prevention of Significant Deterioration, 217, 221

PSD, 217, 219, 220, 221, 768

public involvement, vi, 26, 28, 30

Public Lands Partnership, 28, 29

public safety, vi, vii, 20, 33, 200, 221, 704, 705, 710

Recovery treatments, 69

Regional Haze Rule, 219

Research Natural Areas, 18, 38

resiliency treatments, v, vi, 31, 32, 289, 290, 705, 706

Rocky Mountain Research Station, 28, 30, 773, 775, 778, 780, 781, 785, 786, 790, 794, 795, 796, 797, 799, 808

SAD, i, v, 2, 3, 11, 13, 15, 16, 17, 18, 32, 33, 64, 68, 232, 289, 322, 331, 746

Schedule of Proposed Actions, 26

scoping, vi, vii, 26, 27, 28, 29, 30, 32, 33, 37, 742

seed banks, 353, 389

seral stages, 5, 13

Silvicultural Prescription Matrix, 42

smoke sensitive areas, 245, 249, 769

soil heating, 284, 285, 345, 353

SOPA, 26

Southern Rockies Lynx Amendment, 43, 48, 199, 747

Special Interest Areas, 38

species composition, 20, 386

spruce bark beetle, 31, 32

spruce mortality, 2

SRLA, 43

stand conditions, 4, 11, 23, 64, 277, 279, 285, 289, 352, 705

stand density, v, 233, 277, 769

successional pathways, 350, 353, 381, 386

suckering, 15

sudden aspen decline, iii, v, vi, 11, 16, 18, 28, 31, 344, 345, 391, 790, 796, 802, 808

surface fuels, 239, 245, 274, 277, 278, 281, 282, 283, 284, 288, 289, 290, 295, 296, 301

threatened and endangered species, 337

Threatened Habitat, 9, 16

timber market, 703

Treatment Design Checklist, 42, 398

vectors, 31, 354, 374, 375, 380, 382, 387, 389, 390, 395

water influence zones, 343, 347, 348

water yield, 11, 773, 775, 784, 786, 789, 794, 798

Western Bark Beetle Strategy, iii, v, 3, 23

Wilderness Areas, 18, 227, 236

wildland-urban interface, iii, 354, 396

windthrow, 6, 7, 32, 282, 284

WUI, 62

GLOSSARY

Abiotic. "The nonliving components of the environment, such as air, rocks, soil, water, coal, peat, plant litter, etc." (Thomas 1979).

Administrative NFS Road. Any NFS road that is not a public road.

Air Quality Related Value (AQRV). A scenic, cultural, physical, biological, ecological, or recreational resource on federal lands which may be affected by a change in air quality as defined by the Federal Land Manager (FLM).

Alkaline. "Material that is basic rather than acidic; having a pH greater than 7.0 (Harris and Harris 2001).

Allelopathy. A biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms (en.wikipedia.org).

Alluvial. "Pertaining to material or processes associated with transportation or…deposition by concentrated running water" (USDA National Resources Conservation Service 2014).

Alpine. "Those portions of mountains that rise above the cold limits of trees" (Daubenmire 1978).

Alpine Zone. "The treeless alpine tundra, sometimes divided into low alpine, alpine, and high alpine zones, of which the last may correspond to what is called the 'nival' zone which hardly supports any vegetation except lichens" (Löve 1970).

Annual. "Enduring for not more than a year. A plant which completes its entire life cycle from germinating seedling to seed production and death within a year" (Dayton 1950). Often difficult to distinguish in some cases from biennial or monocarpic.

Aquatic. "Of or pertaining to water; growing in water. A plant or animal inhabiting water" (Dayton 1950), often exclusively.

Aquatic Ecosystem. The distinctive ecosystem dominated by water, aquatic plants, or aquatic animals. Usually the substrate for plant and microorganism growth is water, not soil in the usual sense. Distinct from the riparian ecosystem, which is a terrestrial ecosystem, and water-dependent but where the substrate is soil. In the aquatic ecosystem, producers include phytoplanktonic algae, and autotrophic consumers include crustaceans, rotifers, and fish. Heterotrophic consumers include benthic insects, mollusks, and crustaceans (Odum 1971:19). See terrestrial ecosystem and riparian ecosystem.

Archaeological Sites. Archaeological sites are a type of cultural resource consisting of the surface and/or buried remains of past human activity, typically present are artifacts and/or features of that activity or the tools and mechanisms for such use.

Area of Potential Effects (APE). The Area of Potential Effects (APE) is defined in the regulations implementing the Section 106 review process as "The geographic area or areas within

which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking." [36 CFR Part 800.16(d)].

Argillaceous. "Clayey; of or pertaining to plants growing on clay soils" (Harris and Harris 2001).

Aspen clone. Analogous to aspen 'stand' and aspen 'community'. Unique habitat occupied by aspen (*Populous tremuloides)*.

Aspen mix. Areas where aspen is dominant, but species other than spruce and aspen may be present.

Aspen/Spruce mix. Areas where aspen and spruce are co-dominant.

Bankfull. Elevation of stream bank where flooding begins.

Basal Area (BA) – See Appendix B, this document for explanation; the cross-sectional area of all stems in a stand measured at breast height (4.5 feet) and expressed per unit of land area, generally square feet per acre.

Biennial. "A plant that completes its life cycle within two years, producing only vegetative growth in the first year, and flowering in the second" (Hickey and King 2000).

Biota. The combined plants and animals of a region.

Bog. "A wetland comprised of in-situ accumulations of poorly to moderately decomposed peats that are derived chiefly from sphagnum mosses. The water is acidic" (Helm and others 1985). "Sphagnum moss-dominated communities whose only water source is rainwater. They are extremely low in nutrients, form acidic peats, and are a northern phenomenon generally associated with low temperatures and short growing seasons;" hydrology is ombotrophic, trophic state is mostly oligotrophic (Mitsch and Gosselink 1986:24,261). Also see "fen."

Browse. "Twigs and shoots, with their leaves, cropped by livestock [or wildlife] from shrubs, trees, and woody vines" (Dayton 1950). "The parts of shrubs, woody vine, and trees available for animal consumption" (Artz and others 1983).

Caespitose. Sometimes spelled cespitose. "Tufted: having the stems in a tuft, as a bunch grass" (Dayton 1950).

Canopy Cover. "The area of ground surface included in a vertical projection of individual plant canopies" (coverage in Daubenmire 1978). The relative size of a polygon formed by the outer edges of the canopy of all plants of a given species (see Smith and others 1995). Canopy cover is usually expressed as a percentage, independently estimated for each plant species and for several non-species categories (bare soil, litter, rock, gravel, lichen, moss, etc.). The sum of canopy cover for all species in a plant community will be other than 100 percent in most, if not all, cases. See Daubenmire (1959) for a complete description of the concept. For mature trees, canopy cover is a synonym for crown cover; but canopy cover applies to all plant species, whether woody,

herbaceous, or cryptogamic, and also to non-species categories such as bare soil, litter, rock, and gravel.

Caudex. "The stem of a plant, usually a fern or a woody monocotyledon" (Hickey and King 2000)

Class I Area. Geographic area designated for the most stringent degree of protection from future degradation of air quality. The Clean Air Act designates as mandatory class I areas each national park over 6,000 acres and each national wilderness over 5,000 acres that existed as of the date of enactment (August 7, 1977).

Class II Area. These areas require somewhat less stringent protection from air pollution damage than Class I areas. All Forest Service managed lands that are not Class I areas are Class II areas.

Clearcut (clearcutting; clearfell) – removal of the entire stand in one cutting with reproduction obtained artificially or from seeds germinating after the clearing operation.

Clone. "An organism derived by sexual reproduction from a single parent; such organisms are therefore of the same genetic constitution" (Pritchard and others 1982). Examples in our include aspen, kinnikinnick, and Gambel oak.

Closure. Restriction of motor vehicle use on a travelway by means of elimination or prohibition. Closures may be permanent or temporary depending on management objectives.

Commercial Mechanical Treatment. Ground-based mechanized timber cutting on lands suitable for timber harvest as defined in the 1991 LRMP (Appendix F) and that produces a commercial product.

Common Stand Exams (CSE). Inventory plots installed to collect stand data and information.

Conifer. A tree that bears cones, in our area, the spruces (*Picea*), firs (*Abies*), Douglas-fir (*Pseudotsuga*), pines (*Pinus*), and juniper (*Juniperus*). Some botanists would not include juniper trees (for example, Dayton 1950).

Cultural Resources. Cultural Resources in this analysis consist of the significant archaeological and historical sites or structures left behind by Native American or Euro-American/other past occupation of an area. By law (National Historic Preservation Act-1966), such sites are at least 50 years old and have been determined to be significant and eligible for listing on the National Register (NR) of Historic Places as defined in 36 CFR 60. In general, these sites may be valued either for their association with history, Native American culture, or for their scientific research potential.

Culturally scarred trees (CSTs). CSTs are Ponderosa pines that have been determined to have been harvested (scarred) in prehistoric and proto-historic times to extract cambium for use as a food source by Native American populations.

Danger Tree. A standing tree that presents a hazard to people due to conditions such as deterioration of or damage to the root system, trunk, stem, or limbs or the direction or lean of the tree. *Synonymous with **hazard tree** for purposes of this Project.*

Deciduous. . "Falling away; not persistent or evergreen. Said of leaves that drop off in autumn," and also of plant species that have such leaves (Dayton 1950).

Decommissioning. Activities that result in the stabilization and restoration of unneeded roads or trails to a more natural state.

Decumbent. "Reclining on the ground but with the end ascending; bending horizontally at the base" (Dayton 1950).

Dendroglyphs. Any of various pictures, letters or symbols carved into tree boles and trunks by people in historic times. For the SBEADMR analysis, these typically refer to carved Aspen trees and associated often with sheepherding (Basque and other ethnic groups).

Designated road, trail, or area. A National Forest System road, a National Forest System trail, or an area on National Forest System lands that is designated for motor vehicle use pursuant to 36 CFR 212.51 on a motor vehicle use map.

Diameter @ Breast Height (DBH) – height at which tree diameter is normally measured specified as 4.5 feet above ground base of the tree.

Disturbance. "An event that causes a significant change from the normal pattern in an ecological system" (Forman and Godron 1986). Often subdivided into natural disturbances and man-caused disturbances. "Natural disturbances, such as drought, wild fires, grazing by native fauna, and insects are inherent in the development of any natural plant community," and in fact a natural plant community may be dependent on one or more of those disturbances.

Dominance. "The collective size or bulk of the individuals of a group of organisms [especially a species] as it determines their relative influence on other components of the ecosystem" (Daubenmire 1978). A plant species that is highly dominant on a site affects other components of the ecosystem to a greater extent than do other species, and the highly dominant species is a better expression of the local climate and site potential. Therefore, the relative dominance of plant species is of paramount importance for assessing the ecological potentials and management responses of a site. The best measure of dominance is canopy cover by species (Daubenmire 1968).

Ecosystem. A community of interacting organisms, considered together with the habitats and environments associated with the individuals and species of that community (after definitions of ecosystem and community in Daubenmire 1978).

Edaphic. "Due to, or pertaining to, the soil" (Harris and Harris 2001).

Ephemeral stream. A stream that flows only briefly and in response to a period of local rainfall.

Ethnographic Sites. A type of cultural resource: Locations where past use by Native American populations has been documented through the collection of oral histories, ethnographic interviews or broad culture area studies.

Evapotranspiration. Loss of water from the soil by evaporation and by transpiration from plants.

Evergreen. "Retaining most of its leaves throughout the year" (Hickey and King 2000).

Federal Land Manager (FLM). The Secretary of the Department with authority over such lands. (40 CFR 51.166(b)(24)). The FLM for the Forest Service has been delegated to the Regional Forester or individual Forest Supervisor.

Field Sampled Vegetation (FSVeg) stores data about trees, fuels, down woody material, surface cover, and understory vegetation. FSVeg supports the business of common stand exam, fuels data collection, permanent grid inventories, and other vegetation inventory collection processes. http://www.fs.fed.us/nrm/fsveg/

Fen. Low land that is covered wholly or partially with water, fed by groundwater, and has peaty alkaline soil.

Fern-Ally. "A member of the groups of fork ferns, club mosses, quillworts, or horsetails; classes of flowerless plants with usually small leaves" (Hickey and King 2000)

Flora. "The plant population of a particular region; a book listing and describing the plants found in a given area" (Hickey and King 2000).

Forb. "Forb is a term that has been coined by Dr. F. E. Clements to designate [herbaceous] flowering plants other than grasses and grasslike plants…" (Hanson 1929). Usually includes ferns and fern-allies, technically not flowering plants.

Forblands. "A community dominated by forbs" (Penfound 1967).

Forest road or trail. A road or trail wholly or partly within or adjacent to and serving the National Forest System that the Forest Service determines is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources.

Forest transportation atlas. A display of the system of roads, trails, and airfields of an administrative unit.

Forest transportation system. The system of National Forest System roads, National Forest System trails, and airfields on National Forest System lands.

Fuelwood – material collected that is utilized for burning.

Functional class (roads). The grouping of roads by the character of service they provide.

> **Arterial road**. An NFS road that provides service to large land areas and usually connects with other arterial roads or public highways.
>
> **Collector road**. An NFS road that serves smaller areas than an arterial road and that usually connects arterial roads to local roads or terminal facilities. Provides service to smaller land areas than an arterial road. It usually connects forest arterial roads to local forest roads or terminal facilities.

Local road. An NFS road that connects a terminal facility with collector roads, arterial roads, or public highways and that usually serves a single purpose involving intermittent use.

Gametophyte. "The sexual stage in the life cycle of a plant when the chromosomes in each cell are reduced to half the number, typically diploid reduced to haploid" (Hickey and King 2000).

Geophyte. "An herbaceous plant that perenniates by means of underground buds, e. g., bulbs, corms, rhizomes, etc." (Hickey and King 2000).

Graminoid. An herbaceous plant of one of three families: Grass (Poaceae), Sedge (Cyperaceae) or Rush (Juncaceae). Grasses and grasslike plants.

Grass. Plants and species belonging to the grass family (Poaceae, also called Gramineae).

Grassland. Land on which the dominant vegetation is comprised of grasses or grasslike plants (after Penfound 1967).

Habitat. The place where a plant or animal (individual, population, or species) lives. The biotic or abiotic environment of a plant, animal, or community. The study of habitat largely comprises the field of synecology, along with the relationship of habitat to community and ecosystem. Some ecologists would use the term habitat as a synonym for what we call site; such use is discouraged as confusing a species' (or population's) habitat with the area that it occupies. Habitat includes the concept of area covered by the species or population, but includes also much more, for example, structure and features contained within that area.

Hazard Tree. See **Danger tree** definition above.

Haze. An atmospheric aerosol of sufficient concentration to be visible. The particles are so small that they cannot be seen individually, but are still effective attenuating light and reducing visual range.

Herbaceous Plant (Herb). A non-woody flowering plant, with no persistent woody stem above ground. Sometimes taken to include ferns and fern-allies as well (see Penfound 1967).

Herbarium. "A collection of dried plants or parts of plants, usually mounted on sheets of thick paper, kept for the purposes of reference or research" (Hickey and King 2000).

Herbivore. "A plant-eating animal" (Pritchard and others 1982).

Historic Sites. A type of cultural resource: Locations, sites and structures dating from the historic period of an area, in the SBEADMR analysis this would be defined as 1801 to 1964 C.E. (common era, also formerly denoted as A.D.)

Individual tree selection (free thinning) – removal of individual trees based on project objectives.

Intermittent stream. A stream that flows seasonally.

Invertebrate. An animal without a backbone.

Limit of Acceptable Change (LAC). The amount of change that could occur without significantly altering an AQRV or sensitive receptor.

Lithic Scatters. A type of archaeological site; they are concentrations of stone tool manufacturing debris, utilized, broken and fully formed stone tools representing short and long term camps and limited activity sites.

Loam. Soil composed of a mixture of sand, clay, silt, and organic matter.

Macrobotanical Remains. Plant remains recovered from archaeological contexts that can be seen with the naked eye. These tend to be seeds and wood fragments, but nuts and other fruits may also be represented.

Macroinvertebrates. An invertebrate that is large enough to be seen without the use of a microscope.

Maintenance. The upkeep of the entire forest transportation facility including surface and shoulders, parking and side areas, structures, and such traffic-control devices as are necessary for its safe and efficient utilization.

Maintenance Levels (roads). Defines the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria.

> **LEVEL 1.** These are roads that have been placed in storage between intermittent uses. The period of storage must exceed 1 year. Basic custodial maintenance is performed to prevent damage to adjacent resources and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are "prohibit" and "eliminate" all traffic. These roads are not shown on motor vehicle use maps.
>
> Roads receiving level 1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic but may be available and suitable for nonmotorized uses.
>
> **LEVEL 2.** Assigned to roads open for use by high clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations. Warning signs and traffic control devices are not provided with the exception that some signing, such as W-18-1 “No Traffic Signs,” may be posted at intersections. Motorists should have no expectations of being alerted to potential hazards while driving these roads. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level. Appropriate traffic management strategies are either to:
>
> a. Discourage or prohibit passenger cars, or
>
> b. Accept or discourage high clearance vehicles.

LEVEL 3. Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. The Manual on Uniform Traffic Control Devices (MUTCD) is applicable. Warning signs and traffic control devices are provided to alert motorists of situations that may violate expectations.

Roads in this maintenance level are typically low speed with single lanes and turnouts. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users.

LEVEL 4. Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. Manual on Uniform Traffic Control Devices is applicable. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times.

LEVEL 5. Assigned to roads that provide a high degree of user comfort and convenience. These roads are normally double lane, paved facilities. Some may be aggregate surfaced and dust abated. Manual on Uniform Traffic Control Devices is applicable. The appropriate traffic management strategy is "encourage."

Mass Wasting. Dislodging and downslope transport of earth and rock as a relatively large (larger than soil particles) unit under direct gravitational stress. Includes slow displacements such as creep, rock glaciers, and solifluction, and also rapid movements such as landslides, rock slides, rock falls, earthflows, debris flows, and avalanches. Usually fluid agents (water, ice, air) play a subordinate role. See erosion.

Mastication. The use of mechanized equipment to reduce surface, ladder and small tree fuels into smaller particles in order to reduce some aspects of fire behavior such as rate of spread. Mastication is a broad category and can be accomplished through methods otherwise known as chipping.

Microclimate. “The climate of small areas,” generally areas smaller than a site or comprising the patches within a site (Ford-Robertson 1971). The climate of a microsite. In this Region, the influence of dominant plant species is often observable and active at the microclimate level.

Microsite. A subdivision of a site, a patch or subsite, that nonetheless has distinctive vegetation, land, or soils. In this Region, very few sites have no noticeable microsites.

Montane Zone. The lower forest zone, associated with forests of Douglas-fir (Pseudotsuga menziesii) and ponderosa pine (Pinus ponderosa), sometimes also including forests of blue spruce (Picea pungens). To the south and west of the UGB, the Montane Zone can also include white fir (Abies concolor). Usually forms a belt between the Colline Zone and the Subalpine Zone (Löve 1970, also see Rydberg 1915ab-1916). Not every site within the Montane Zone is potentially a

forest (some are grasslands, rocklands, shrublands, riparian areas, etc.); neither will every forest be dominated by the trees named above.

Morphology. A description of form and structure.

Motor vehicle. Any vehicle which is self-propelled, other than: (1) A vehicle operated on rails; and (2) Any wheelchair or mobility device, including one that is battery-powered, that is designed solely for use by a mobility-impaired person for locomotion, and that is suitable for use in an indoor pedestrian area.

Motor vehicle use map. A map reflecting designated roads, trails, and areas on an administrative unit or a Ranger District of the National Forest System.

Mychorrhizae. A fungus that colonizes plant roots and assists with nutrient exchange.

Mycorrhiza. "The association of fungi and the roots of plants to their mutual advantage" (Hickey and King 2000).

NAIP Imagery – digital ortho photography created by the National Agriculture Imagery Program (NAIP).

National Forest System road. A forest road other than a road which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority.

National Forest System trail. A forest trail other than a trail which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority.

Native Species. "A species that was part of an area's original fauna or flora" (Pritchard and others 1982). The area in question must usually be specified, by country, state, physiographic division, ecoregion, county, or other area. A native species cannot be a weed (in the recommended sense), but may nonetheless be an invader in some places and under some management regimes. Examples of native species in UGB include fringed brome, greenback cutthroat trout, silky lupine, Tracy bluegrass, and elk.

Natural Conditions. Conditions substantially unaltered by humans or human activities. As applied in the context of visibility, natural conditions include naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration.

Naturalized Species. A species that is not native, but has become part of the natural flora or fauna of an area, and is now capable of survival in the area without cultivation or other management. Many weeds have become naturalized species, but a naturalized species is not always an invader or a weed. The area in question must usually be specified (see native species above). Examples in UGB include cheatgrass, rainbow trout, smooth brome, poison-hemlock, Kentucky bluegrass, crested wheatgrass and mountain goat.

Objective Maintenance Level. The maintenance level to be assigned at a future date considering future road management objectives, traffic needs, budget constraints, and environmental concerns. The objective maintenance level may be the same as, or higher or lower than, the operational

maintenance level. The transition from operational maintenance level to objective maintenance level may depend on reconstruction or disinvestment.

Operational Maintenance Level. The maintenance level currently assigned to a road considering today's needs, road condition, budget constraints, and environmental concerns. It defines the level to which the road is currently being maintained.

Perennial. "Living for a number of years" (Hickey and King 2000).

Perennial stream. A stream that flows continuously.

Phylogeny. "The relationships between plants as determined by their evolutionary history" (Hickey and King 2000).

Pounds per Square Inch (PSI): The number of pounds of ground pressure exerted over one square inch of soil; a metric to assess soil compaction and to define equipment limits.

Propagule. "Any structure capable of giving rise to a new plant by sexual or asexual means" (Hickey and King 2000).

PSD Increments. The maximum increases in ambient pollution concentrations allowed over baseline concentrations. See 40 CFR 51.166 (c) for increments for specific pollutants.

Quadratic Mean Diameter (QMD): The square root of the arithmetic average of the squared values across a particular inventory (Avery and Burkhart 2002).

Realignment. Activity that results in a new location of an existing road or portions of an existing road and treatment of the old roadway.

Reconstruction (road or trail). Improvement and/or realignment of a travelway.

Regional Haze Visibility Impairment. Any humanly perceptible change in visibility (light extinction, visual range, contrast, coloration) from that which would have existed under natural conditions, caused predominantly by a combination of many sources from, and occurring over, a wide geographic area.

Relict. "A plant that has survived from a previous age or, because of changed circumstances, is growing in a place geographically remote from its most closely related species" (Hickey and King 2000).

Rhizome. A horizontal, "creeping, usually thickened, stem or branch growing partly or entirely under the surface of the ground" (Dayton 1950), by which the plant vegetatively reproduces.

Riparian Complex. A kind of mapped ecological unit which supports or may potentially support a specified pattern of community types, soils, landforms, and hydrological characteristics. It is identified on the basis of its potential vegetation (the highest seral stage attained in any of its regularly-appearing patches), overall geomorphology, geological substrate, and the repeated patterns of patches within the map unit. Boundaries and definition of patches within the riparian complex are determined by plant communities and community types, stream channel types and aquatic habitat types, and fluvial landforms. The pattern of patches is relatively constant among

sites in the same riparian ecological unit that are relatively unaffected by management, but the pattern often changes as management intensifies (after Padgett and others 1987).

Riparian Ecosystem. A distinct, terrestrial ecosystem, often located spatially between an aquatic ecosystem and a drier ecosystem, characterized by distinctive riparian vegetation and soils requiring high water tables at some time in the growing season, and often occupying distinctive landforms (floodplains, alluvial benches) as well. A riparian ecosystem can be distinguished from an aquatic ecosystem that sometimes might be adjacent to it, because the substrate for the riparian ecosystem is true soil.

Riparian Vegetation. "Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season" (Helm and others 1985). It is generally not possible to distinguish riparian plant communities from non-riparian ones on the basis of present vegetation. But it is possible to distinguish riparian plant associations (potential plant communities) from non-riparian ones. Distinguishing and delineating riparian plant communities is much more successful than delineating riparian areas on the basis of individual plant species (see hydrophyte). "The [climax plant] community is a more reliable indicator than any single species of it" (Clements 1920:30).

Road. A motor vehicle route over 50 inches wide, unless identified and managed as a trail.

Road improvement. Activity that results in an increase of an existing road's traffic service level, expands its capacity, or changes its original design function.

Sensitive Receptor. The AQRV, or part thereof, that is the most responsive to, or the most easily affected by the type of air pollution in question.

Sensitive Receptor Indicator. A measureable physical, chemical, biological, or social (e.g. odor) characteristic of a sensitive receptor.

Shade-tolerance – Species that have a tolerance to shading by other species. Shade tolerant species will grow and regenerate under a stand's over-story.

Shrub. "A perennial, woody plant that differs from a tree by its low growth [generally < 6 m] and the possession of several stems arising from the base" (Penfound 1967).

Shrubland. "Any land on which shrubs dominate the vegetation" (Penfound 1967).

Silviculture. The practice of controlling the planting, growth, composition, health, and quality of forests to meet diverse needs and values.

Smoke Sensitive Area. Any occupied areas where smoke fumigation occurs or may occur. Young children, the elderly and individuals with decreased lung function are most sensitive to smoke in smoke sensitive areas.

Spruce mix. Areas where spruce is dominant, but species other than spruce and aspen may be present.

Stand density index (SDI): See Appendix B, this document for explanation; a metric for measuring forested stand density. For this document, averages are reported within the treatment

units, where stand examination inventories have been conducted. This is an FVS modeled average for this document.

Stationary Source. A source of pollution that is well defined, such as the smokestack of a coal-fired power plant or smelter.

Stocking – an indication of growing space occupancy relative to a pre-established standard, such as basal area or trees per acre.

Storage. Used to describe an intermittent use road during the time it is closed to vehicular use. When referring to a National Forest System road, storage is synonymous with a Maintenance Level 1.

Subalpine Zone. A forest zone, associated with closed forests, closely associated with forests of subalpine fir (Abies bifolia and its close relative A. Arizonica) and Engelmann spruce (Picea engelmannii). Not every site within the Subalpine Zone is potentially a forest (some are grasslands, rocklands, shrublands, riparian areas, etc.); neither will every forest be dominated by the trees named above (see Rydberg 1915ab).

Succession. "The progressive development of vegetation towards its highest ecological expression, the climax; replacement of one plant community by another" (Pritchard and others 1982). The whole sequence of plant communities is called a sere. Secondary succession is usually more important to management than primary succession (see definitions of those terms).

Symbiosis. "The arrangement whereby two different organisms (symbionts) co-exist, not necessarily to their mutual advantage" (Hickey and King 2000).

Taxonomy. "The science of classification. In botany,…The classification or arrangement of plants according to their natural relationships and the principles underlying such classification" (Dayton 1950).

Temporary road. A road necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road or a forest trail and that is not included in a forest transportation atlas.

Trail. A route 50 inches or less in width or a route over 50 inches wide that is identified and managed as a trail.

Transpiration. The passage of water vapor from a plant through a membrane or pores.

Trees per acre (TPA): The number of trees, on average, on an acre of land where stand examination inventories have been conducted; this is a modeled average for this document.

Trophic. "Relating to the processes of energy and nutrient transfer from one or more organisms to others in an ecosystem" (Pritchard and others 1982).

Unauthorized Road or Trail. A road or trail that is not a forest road or trail or a temporary road or trail and that is not included in a forest transportation atlas.

Uneven-aged: Forest stand composed of intermingling of trees that differ markedly in age (Avery and Burkhart 2002)

Upper Diameter Limit (UDL) – the diameter at which removal of trees is restricted or meets the objectives of the silvicultural prescription. This may be a hard value or a flexible estimate depending on the type of thinning and the objectives of the silvicultural prescription.

Utes. A collection of Native North American tribes and bands speaking mutually intelligible languages in the Uto-Aztecan family, who mainly live in Colorado, Utah, and New Mexico.

Visibility Impairment. Any humanly perceptible change in visibility (visual range, contrast, coloration) from that which would have existed under natural conditions. (40 CFR 51.301(x)).

Visual Range. The distance at which a large black object would just disappear from view.

Volatile Organic Compound (VOC). Any compound of carbon, except those excluded by EPA that participates in atmospheric photochemical reactions (See 40 CFR 51.100(s)).

Volatilization. Evaporation of a substance.

Weighted average: for this document, the forest metric of interest (QMD, TPA, SDI, etc.) multiplied by the sum FVS output times the number of acres divided by the total acres affected.

Wetland. Land area that is saturated with water, either permanently or seasonally.

Wickiups. Wickiups are temporary brush structures of Ute Indian manufacture and use while preforming hunting and gathering tasks as part of their seasonal rounds.

Wildland Urban Interface (WUI). The area generally within one mile of any communities, administrative sites, utility corridors, developed sites, and ski areas.

(This page intentionally blank)

BIBLIOGRAPHY / REFERENCES

Agee, J. K. (2007). The severe weather wildfire – Too hot to handle? *Northwest Science* 71(1).

Air Now 2003. http://www.airnow.gov/index.cfm?action=pubs.index

Air Resource Specialists, Inc. (ARS). (1993). Deciview, a standard visibility index. *IMPROVE Newsletter* 2, No. 1. http://vista.cira.colostate.edu/improve/publications/NewsLetters/apr_93.pdf

Alexander, S.M., Waters, N.M. & Paquet, P.C. (2005). Traffic volume and highway permeability for a mammalian community in the Canadian Rocky Mountains. *Canadian Geographer 49*: 321-331.

Allen, C.D., Macalady, A. K., & Chenchouni, H. et al. (2010). A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management* 259(4): 660-684. http://dx.doi.org/10.1016/j.foreco.2009.09.001. (Site now discontinued.)

Altman, Bob, & Sellabanks, R. (2000). Olive-sided flycatcher(Contopus cooperi). *The birds of North America*(502), 28.

Anderson, H. E. (1982). *Aids to determining fuel models.* (General Technical Report INT-122). USDA Forest Service, Intermountain Forest and Range Experiment Station.

Andrews, P. L. (2014). Current status and future needs of the BehavePlus Fire Modeling System. *International Journal of Wildland Fire* 23:21-33.

Baker, M. B., Jr. (1986). Effects of Ponderosa pine treatments on water yield in Arizona. *Water Resources Research*. Vol. 22, No.1: 67-73.

Bartos, D. L. (2001). Landscape dynamics of aspen and conifer forests. In: Shepperd, W. D, D. Binkley, D., D.L. Bartos, D.L., T. J. Stohlgren, T. J., & L. G. Eskew, (Eds.). *Sustaining Aspen in Western Landscapes : Symposium Proceedings : June 13-15, 2000,* Grand Junction, Colorado. (Proceedings RMRS-P-18). Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Research Station: 5-14.

Bartos, D.L, and R. B. Campbell, Jr. (1998). Decline of quaking aspen in the Interior West: Examples from Utah. *Rangelands* 20(1): 17-24. Retieved from http://www.jstor.org/stable/4001217

Bartos, D. L., & Shepperd, W. D. (2010). The Aspen Mortality Summit, December 18 and 19, 2006. Salt Lake City, UT. USDA Forest Service. Proc.RMRS-P-60WWW. Retrieved from http://www.fs.fed.us/rm/pubs/rmrs_p060.pdf. Accessed June 24, 2013.

Beatty, B. L., Jennings, W. F. & Rawlinson R. C. (2003). *Botrychium ascendens* (trianglelobe *moonwort), Botrychium crenulatum (scalloped moonwort), Botrychium lineare* (narrowleaf grapefern): *A technical conservation assessment.* Lakewood, CO: USDA Forest Service, Rocky Mountain Region. Retrieved from http://www.fs.fed.us/r2/projects/scp/assessments/botrychiums.pdf.

Beatty, B. L., Jennings, W. F &. Rawlinson, R. C. (2004). *Machaeranthera coloradoensis (Colorado tansy aster): A technical conservation assessment*. Lakewood, CO: USDA Forest Service, Rocky Mountain Region. Retrieved from http://www.fs.fed.us/r2/projects/scp/assessments/machaerantheracoloradoensis.pdf.

Bebi, Peter, Kulakowski, D., & Veblen, TT. (2003). Interactions between fire and spruce beetles in a subalpine Rocky Mountain forest landscape. *Ecology 84*(2):362-371.

Bêche, L. A., et al. (2005). Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone. *Forest Ecology and Management*, 218 (2005): 37-59.

Bedford, B. L. & Godwin, K. S. (2003). Fens of the United States: Distribution, characteristics, and scientific connection versus legal isolation. *Wetlands* 23, no. 3: 608-629.

Bentz, B. J., Regniere, J., Fettig, C. J., Hansen, E. M., Hayes, J. L, Hicke, J. A., R. G. Kelsey, J. F. Negron, and S. J. Seybold. (2010). Climate change and bark beetles of the western United States and Canada: Direct and indirect effects. *BioScience* 60:602-613.

Berg, E. E., & Anderson, S. R. (2006). Fire history of white and Lutz spruce forest on the Kenai Peninsula, Alaska, over the last two millennia as determined from soil charcoal. *Forest Ecology and Management* 227:275-283.

Berg, N.D. 2010. Snowshoe Hare and Forest Structure Relationships in Western Wyoming. Master's Thesis – Utah State University.

Berg, N.D, E. Gese, J.R. Squires, and L.M Aubry. 2012. Influence of forest structure on the abundance of snowshoe hares in Western Wyoming. *The Journal of Wildlife Management* 76(7):1480-1488.

Bethlahmy, N. (1974). More streamflow after a bark beetle epidemic. *Journal of Hydrology* 23: 185-189.

Biederman, J.A., Harpold, A.A., Gochis, D.J., Ewers, B.E, Reed, D.E., Papuga, S.A and Brooks, P.D. (2014). Increased evaporation following widespread tree mortality limits streamflow response. *Water Resources Research* 50: 5395-5409.

Biederman, J.A., Somor, A.J., Harpold, A.A, Gutmann, E.D., Breshears, D.D. Troch, P.A. and Gochis, D.J. et al (2015). Recent tree die-off has little effect on streamflow in contrast to expected increases from historical studies. *Water Resources Research* Accepted Article doi: 10.1002/2015WR017401.

Beidleman, Carol A. (2000). Partners in Flight land bird conservation plan: Colorado. *Partner's in Flight, Estes Park, Colorado, USA.*

Birdsall, J. L., McCaughey, W. & Runyon, J. B. (2012). Roads impact the distribution of noxious weeds more than restoration treatments in a lodgepole pine forest in Montana, U.S.A. *Restoration Ecology* 20(4): 517-523.

Bisson, P. A., et al. (2003). Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. *Forest Ecology and Management*, 178 (2003), 213-229.

Boes, W. Johnston, B.C., & Parker, S. (2016). Biological assessment and biological evaluation of plants. Report for: Spruce Beetle Epidemic and Aspen Decline Management Response, EIS.

Bosch, J. M. & Hewlett, J. D. (1982). A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. *Journal of Hydrology.* 55: 3-23.

Bossard, C. C., Randal, J. M., & Hoshovsky, M. C., (Eds.). (2000). *Invasive plants of California's wildlands*. Berkeley, California: University of California Press.

Boyle, James R., Warila, James E., Beschta, Robert L., Reiter, Maryanne, Chambers, Carol C., Gibson, Wayne P., . . . Taylor, George. (1997). Cumulative effects of forestry practices: An example framework for evaluation from Oregon, U.S.A. *Biomass and Bioenergy, 13*(4–5), 223-245. doi: http://dx.doi.org/10.1016/S0961-9534(97)10011-3

Bradley, T, Gibson J., & Bunn (2006). *Fuels management and non-native plant species: and evaluation of fire and fire surrogate treatments in a chaparral plant community* (Final Report to the Joint Fire Science Program, Project number: JFSP 01B-3-3-27). Wiskeytown, CA: National Park Service.

Brandy, Paul M. (2001). *A hierarchical analysis of Olive-sided Flycatcher habitat use in a managed landscape*.

Cahill, D. B. (1951). *Net impact of spruce beetle outbreak on White River National Forest, 1939-1951* (Rocky Mountain Regional Report). Fort Collins, CO: USDA Forest Service.

Calkin, D. & Gebert, K. (2006). Modeling fuel treatment costs on Forest Service lands in the western United States. USDA Forest Service, Rocky Mountain Research Station, Missoula, MT. *Western Journal of Applied Forestry* 21(4): 217-221.

CAQDR 2013. Colorado Air Quality Data Report. 2013. Colorado Department of Public Health and Environment, Air Pollution Control Division. APCD-TS-B1.4300 Cherry Creek Drive South Denver, Colorado 80246-1530, (303) 692-3100. November 2014. http://www.colorado.gov/airquality/tech_doc_repository.aspx

Carnicera, J., Coll, M., Ninyerola, M., Pons, X., Sánchez, G. & Josep Peñuelas, J. (2011). Widespread crown condition decline, food web disruption, and amplified tree mortality with

increased climate change-type drought. Proceedings from the National Academy of Sciences 108(4): 1474-1478. Retrieved from http://dx.doi.org/10.1073/pnas.1010070108.

Carpenter, A. T., Murray, T. A., Decker, K., Berberian, R., Billerbeck, R., Carsey, K. & Coles, J. (2000). Creating an integrated weed management plan: A handbook for owners and managers of lands with natural values. In *Caring for the land*, 94 pp. Volume IV. Denver, CO: Colorado Departments of Natural Resources and Agriculture.

Castelle, A. J., Conolly, C., Emers, M., Metz, E. D., Meyer, S.Witter, M., …Cooke, S. (1992). *Wetland buffers: Use and effectiveness.* Report to Washington State Department of Ecology, Olympia, Washington. Edmonds, Washington: Adolfson Associates.

Catford, J. A., Jansson, R.; & Nilsson, C. (2009). Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. *Diversity and Distributions* 15(1): 22-40.

Cayan, D. R. Kammerdiener, S.; Dettinger, M. D., Caprio, J. M., & Peterson, D. H. (2001). Changes in the onset of spring in the Western United States. *Bulletin of the American Meteorological Society* 82 (3): 399-415.

CDA. (Colorado Department of Agriculture). (2013). The Official State Web Portal. Retrieved from http://www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618874438>

CDOT. (Colorado Department of Transportation). 2012. Annual roadkill reports. Accessed online 7/30/2013 at: http://www.coloradodot.info/programs/environmental/wildlife/data/annual-roadkill-reports.

CDOT (Colorado Department of Transportation). 2014. Traffic volume maps. Accessed online 7/30/2013 at: http://dtdapps.coloradodot.info/Otis/TrafficData.

CDPHE (2007). (Colorado Department of Public Health and Environment). *Colorado state implementation plan for regional haze*, Technical Support Document, Mandatory Class I Federal Area: Maroon Bells-Snowmass Wilderness Area. Denver, CO: Air Pollution Control Division, Retrieved from http://www.cdphe.state.co.us/ap/RegionalHaze/TSDMaroonBellsOct.pdf

CDPHE (2010a). *Prescribed fire in Colorado annual summary report for calendar year 2010*. Air Pollution Control Division Technical Services Program. Updated August 2011.

CDPHE (2010b). Memorandum: Prescribed fire smoke permits, use of ozone alert information. Prepared by Coleen Campbell and Sarah Gallup, August 5, 2010.

CDPHE. (2011). *Colorado visibility and regional haze state implementation plan for the twelve mandatory class I Federal areas in Colorado*. Colorado Air Pollution Control Division Revised Regional Haze Plan. Air Quality Control Commission, approved 01/07/2011.

CDPHE(2012a). *Colorado Air Quality Control Commission: Report to the public 2012 – 2013*. Denver, CO: Air Pollution Control Division, Colorado Department of Public Health and Environment. Retrieved from http://www.colorado.gov/cs/Satellite?c=Page&childpagename=CDPHE-AQCC%2FCBONLayout&cid=1251592949477&pagename=CBONWrapper

CDPHE. (2012b). Colorado Water Quality Control Commission *Regulation 93 (5 CCR 1002-93) Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List (amended 02/13/12, effective 03/30/12)*. Retrieved from https://www.colorado.gov/pacific/cdphe/water-quality-control-commission-regulations

CDPHE. (2015a). Colorado Water Quality Control Commission *Regulation 35 (5 CCR 1002-35) Classifications and Numeric Standards for Gunnison and Lower Delores River Basins 9amended 1/12/15, effective 6/30/15).* Retrieved from https://www.colorado.gov/pacific/cdphe/water-quality-control-commission-regulations

CDPHE. (2015b). Colorado Water Quality Control Commission *Numeric Standards Table: Regulation 35*. Retrieved from https://www.colorado.gov/pacific/cdphe/water-quality-control-commission-regulations

CDPHE (2015c). Colorado Air Quality Control Commission, Regulation Number 9, Open burning, prescribed fire, and permitting, 5 CCR 1001-11

Center for Climate Strategies (CCS). (2007). *Final Colorado greenhouse gas inventory and reference case projections 1990-2020.* Denver, CO: Colorado GHG Inventory and Reference Case Projection, CCS. Retrieved from http://www.coloradoclimate.org/ewebeditpro/items/O14F13894.pdf

CEQ (1997). (Council on Environmental Quality). *Considering cumulative effects under the National Environmental Policy Act*. [Place of publication not stated]: Council on Environmental Quality. Retrieved from : http://energy.gov/nepa/downloads/considering-cumulative-effects-under-national-environmental-policy-act

CEQ (1997b). *Environmental justice: Guidance under the National Environmental Policy Act*. Washington, DC: Executive Office of the President.

CEQ (2005). (Council on Environmental Quality). *Considering cumulative effects under the National Environmental Policy Act*. [Place of publication not stated]: Council on Environmental Quality. Retrieved from http://clinton4.nara.gov/CEQ/reports/effects/ccenepa.html

CEQ (2010). *Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions.* Memorandum, February 18, 2010. Retrieved from http://energy.gov/sites/prod/files/CEQ_Draft_Guidance-ClimateChangeandGHGemissions-2.18.10.pdf

Chadde, S. W., Shelly, J. S., Bursik, R. J., Moseley, R. K., Evenden, A. G, Mantas, M., … Heidel. B. (1998). *Peatlands on national forests of the northern rocky mountains: Ecology and conservation.* RMRS-GTR-11, 75 pp. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Clevenger, A.P., Chruszcz, B., Gunson,K. & Wierzchowski, J. (2002). *Roads and wildlife in the Canadian Rocky Mountain Parks – movements, mortality, and mitigation.* Final Report to Parks Canada. Banff, Alberta.

Collins, B.J., Rhodes, C.C.. Battaglia, M.A., & Hubbard, R. M.. (2012). The effects of bark beetle outbreaks on forest development, fuel loads and potential fire behavior in salvage logged and untreated lodgepole pine forests. *Forest Ecology and Management*, 284:260-268.

Collins, B. M., Moghaddas, J. J., & Stephens, S. L. Initial changes in forest structure and understory plant communities following fuel reduction activities in a Sierra Nevada mixed conifer forest. *Forest Ecology and Management*. 239: 102-111.

Colorado Geological Survey (N.D.) Ouray/Silverton, Retrieved from http://geosurvey.state.co.us/minerals/HistoricMiningDistricts/OurayHMD/Pages/OuraySilverton.aspx

Colorado Natural Heritage Program. (2013a). Data on file. Colorado Natural Heritage Program. Fort Collins, CO: Provided to the Forest Service under contract, January 2013.

Colorado Natural Heritage Program. (2013b). *Colorado rare plant guide*. February 22, 2013. Fort Collins, Colorado: Colorado State University. Retrieved from http://www.cnhp.colostate.edu/download/projects/rareplants/index.asp

Colorado Parks and Wildlife, 2006. Candidate Conservation Agreement with Assurances for Gunnison sage-grouse (*Centrocerus mimimus*).

Colorado Parks and Wildlife. 2013. Wildlife Profiles and Information. Accessed at: http://wildlife.state.co.us/WildlifeSpecies/Profiles/Pages/WildlifeProfiles.aspx.

Colorado Parks and Wildlife et al. 2013. Candidate Conservation Agreement for the Gunnison sage grouse, Gunnison Basin Population.

Colorado State Forest Service. (2016). Wood to Energy Program. Accessed January 4, 2016. http://csfs.colostate.edu/cowood/wood-to-energy/.

Colorado State Forest Service. (2008). *2008 Report: The health of Colorado's forests, special issue: High elevation forests.* Colorado State University. Retrieved from http://csfs.colostate.edu/pages/forest-types-spruce-fir.html.

Colorado State Forest Service. (2010). *Forestry best management practices to protect water quality in Colorado.* Fort Collins, CO: Colorado State Forest Service & Colorado State University.

Colorado Water Quality Control Commission. (2012). *Colorado's Section 303(D) list of impaired waters and monitoring and evaluation list.* Colorado Department of Public Health and Environment, 5 CCR 1002-93, Regulation #93. Retrieved from http://www.colorado.gov/cs/Satellite/CDPHE-Main/CBON/1251595703337.

Combrink, T., Fox, W., & J. Peterson, J. (2012). *Workforce needs of the four forest restoration initiative project: An analysis.* Ecological Restoration Institute, Northern Arizona University.

Cornwell, W. K., Bedford, B. L., & Chapin, C. T. (2001). Population of arbuscular mycorrhizal fungi in a phosphorus-poor wetland and mycorrhizal response to phosphorus fertilization. *American Journal of Botany* 88 (10): 1824-1829.

Coulter, C. T., Southworth, D., & Hosten, P. E. (2010). Prescribed fire and post-fire seeding in brush masticated oak-chaparral: Consequences for native and non-native plants. *Fire Ecology* 6 (2): 60-75.

Crimmins, S. M., Dobrowski, S. Z, Greenberg, J. A., Abatzoglou, J. T., &. Mynsberge, A. R. (2011). Changes in climatic water balance drive downhill shifts in plant species' optimum elevations. *Science* 331(6015): 324-327.

Crum, S. & Keene, S. (2009). *The Uncompahgre Mesas forest restoration and demonstration project cultural resource assessment* (Report R2000-02-04-06-065), Delta, Colorado: USDA Forest Service.

D'Antonio, C., Levine, J., & Thomsen, M. (2001). Ecosystem resistance to invasion and the role of propagule supply: A California perspective. *Journal of Mediterranean Ecology* 2: 233-245.

Dare, M., & Woody M. (2016). *Biological evaluation and assessment, management indicator species assessment, fisheries and aquatics.* Delta, CO: Grand Mesa-Uncompahgre-Gunnison National Forest.

Davis, M.B., Shaw, R.G., & Etterson, J.R. (2005). Evolutionary responses to changing climate. *Ecology* 86, 1704-1714.

Day, C. A.. (2013, February). Statistically downscaled climate change projections for the Animas River Basin, Colorado, USA. *Mountain Research and Development*, 33(1):75-84. International Mountain Society.

DeBano, L. F. (1991). The effect of fire on soil properties. *Proceedings Management and Productivity of Western-Montane Forest Soils.* Retrieved from http://forest.moscowfsl.wsu.edu/smp/solo/documents/GTRs/INT_280/DeBano_INT-280.php

DeByle, N., & Winokur, R, (Eds.) (1996*). Aspen: Ecology and management in the Western United States* (General Technical Report 119). USDA Forest Service. Rocky Mountain Research Station.

Dees, L. (2004). Ute ethnohistoric research. In *The Utes of west central Colorado: the Uncompahgre and White River bands, an ethnographic overview.* Office of Community Services, Fort Lewis College, Durango, Colorado. Report on file at the USFS Supervisor's Office, Delta, Colorado.

Denver Convention and Visitor Bureau. (2012). Tourism pays for Colorado. Retrieved from: http://www.denver.org/tourismpays/tourism-in-colorado

DeRose, J.R. & Long, J.N. (2007). Disturbance, structure, and composition: Spruce beetle and Engelmann spruce forests on the Markagunk Plateau, Utah. *Forest Ecology and Management* 244: 16-23.

DeRose, J. R.& Long, J.N. (2009). Wildfire and spruce beetle outbreak: simulation of interacting disturbances in the central Rocky Mountains. *Ecoscience* 16(1):28-38.

Douglas-fir (Pseudotsuga menziesii var. glauca). Retrieved 12/2015 from Fire Effects Information System: http://www.fs.fed.us/database/feis/plants/tree/psemeng/all.html

Driscoll, D. G., et al. (2002). *Hydrology of the Black Hills area, South Dakota*. (Water-Resources Investigations Report 02-4094). Rapid City, SD: U.S. Department of the Interior, U.S. Geological Survey.

Driver, K. M. (2010). *Distinguishing the hydrologic regimes and vegetation of fens and wet meadows in the Rocky Mountains.* (Master's thesis). Colorado State University, Fort Collins, CO.

Dudley M. (2011). *Aspen mortality in the Colorado and Southern Wyoming Rocky Mountains: Extent, severity, and causal factors* (Master's thesis). Fort Collins, Colorado: Colorado State University.

Dukes, J. S., & Mooney, H. A. (1999). Does global change increase the success of biological invaders? *Tree* 14(4): 135-139.

Dwire, K. A. & Kauffman, J. B. (2003). Fire and riparian ecosystems in landscapes of the Western USA. *Forest Ecology and Management*, 178(2003) 61-74.

Eager, Tom. Personal communication 2013-2014. Entomologist, USDA Forest Service Gunnison Service Center, Gunnison, Colorado.

Eager, Tom. Personnel Communication. 2015. Entomologist, USDA Forest Service Gunnison Service Center, Gunnison Colorado.

Eaglin, G. S., & Hubert, W.A. (1993). Management briefs: Effects of logging and roads on substrate and trout in streams of the Medicine Bow National Forest, Wyoming. *North American Journal of Fisheries Management,13* (4), 844-846.

Elder, K., Dwire, K. Hubbard, R., Rhoades, C., Ryan, S., Young, M., Goodbody, A. (2006). *Second Interagency Conference on Research in the Watersheds*, May 16-19, 2006, Coweeta Hydrologic Laboratory, Otto, NC.

Elliot, W.J. (2000). Roads and other corridors [Chapter 9]. In: *Drinking water from forests and grasslands*. (General Technical Report, SRS-GTR-39). Asheville, NC. U.S. Department of Agriculture, Forest Service, Southern Research Station. P. 85-100.

Elliot, W. J., Miller, I. S., & Audin, L. (Eds.) (2010). *Cumulative watershed effects of fuel management in the western United States.* (General Technical Report RMRS-STR-231). Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Environmental Protection Agency. (2005). *National management measures to control nonpoint source pollution from forestry*. (EPA Office of Water Report EPA-841-B-05-001). Washington, D.C. Retrieved from http://water.epa.gov/polwaste/nps/forestry/forestrymgmt_index.cfm

Environmental Protection Agency. (2010). Air trends – sulfur dioxide. Retrieved from http://www.epa.gov/airtrends/sulfur.html

Environmental Protection Agency. (2011). National ambient air quality standards (NAAQS). Retrieved from http://www.EPA.gov/air/criteria.html.

Environmental Protection Agency. (2012a). Laws and Regulations. Clean Water Act. Retrieved from http://www.epa.gov/lawsregs/laws/cwa.html.

Environmental Protection Agency. (2012b). Floodplain Management. Executive Order No. 11988. Retrieved from http://water.epa.gov/lawsregs/guidance/wetlands/eo11988.cfm.

Environmental Protection Agency. (2012c). Wetlands. Protection of Wetlands. Executive Order No. 11990. Retrieved from http://water.epa.gov/lawsregs/guidance/wetlands/eo11990.cfm.

Environmental Protection Agency (2012d). *Stratospheric ozone levels. Report on the Environment*. Retrieved from http://www.epa.gov/roe/

Environmental Protection Agency. (2013). Treatment of data influenced by exceptional events. Retrieved from http://www.epa.gov/ttn/analysis/exevents.htm

Environmental Protection Agency (2014a). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2012. Published April 15, 2014, EPA 430-R-14-003. Washington, DC.

Environmental Protection Agency. (2014b). Motor Vehicle Emissions Simulator (MOVES). Washington, D.C.: Author. Retrieved from http://www.epa.gov/otaq/models/moves/index.htm

Environmental Protection Agency 2015a. Overview of Greenhouse Gases. Retrieved from: http://www3.epa.gov/climatechange/ghgemissions/gases.html

Environmental Protection Agency 2015b. April 15, 2015. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2013. U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., N.W., Washington, DC 20460. U.S.A. EPA 430-R-15-004

Environmental Protection Agency 2015c. Air Quality Statistics Report. Retrieved from: http://www.epa.gov/airdata/ad_rep_con.html

EPS-HDT. (2012). *Economic profile system human dimensions toolkit.* Headwaters Economics, USDA Forest Service and Bureau of Land Management. Retrieved from http://www.headwaterseconomics.org

Erickson, H. & White, R. (2007). *Invasive plant species and the Joint Fire Science Program.* (General Technical Report PNW-GTR-707). Portland, Oregon: USDA Forest Service, Pacific Northwest Research Station.

Erickson, H. E. & White, R. (2008). *Soils under fire: Soils research and the Joint Fire Science Program.* (General Technical Report, PNW-GTR-759). Portland, Oregon: USDA Forest Service, Pacific Northwest Research Station.

Esquilín, J., Aida E., Stromberger, M.E. et al. (2007). Microbial community structure and activity in a Colorado Rocky Mountain forest soil scarred by slash pile burning. *Soil Biology & Chemistry* 39(2007), 1111-1120.

Farmer, A. M. 1993. The effects of dust on vegetation – a review. *Environmental Pollution 79*:63-75.

Farrar, D. R. 2011. *Botrychium paradoxum* species account. Web. 12 Sept. 2013. <http://www.public.iastate.edu/~herbarium/botrychium/B-paradoxum.pdf>

Farrar, D. R. & Popovich, S. J. (2012). Ophioglossaceae C. Agardh 1822: Moonwort family (OPH). In Weber, W. A. & Wittmann, R. C., (Eds.) *Colorado flora: Western slope*. (pp. 23-34) Fourth Edition. Boulder, CO: University Press of Colorado.

Ferguson, L., Duncan, C. L.n& Snodgrass, K. (2003). *Backcountry road maintenance and weed management* (Publication No. 0371–2811–MTDC), Missoula, MT: USDA Forest Service, Technology and Development Program.

Fites, Jo Ann, M. Campbell, A. Reiner, T. Decker. 2007. Fire Behavior and Effects Relating to Suppression, Fuel Treatments, and protected Areas on the Antelope complex Wheeler Fire. Report. 41 pp. last accessed 4/16/2015: http://www.fs.fed.us/adaptivemanagement/projects/FBAT/docs/Antelope_FINAL3_12_04_07.pdf

Fitzgerald, J.P., Meaney, C.A. & Armstrong, D.M.. (1994). *Mammals of Colorado*. Denver Museum of Natural History Univ. Press of Col. Niwot, CO. 467 pp.

Flack, J. A. D. (1976). *Bird populations of aspen forests in western North America.* Ornithological Monographs 19: iii-viii, 1-97. Retrieved from http://www.jstor.org/stable/40166754.

Fornwalt, P. J. & Rhoades, C. C. (2011). Rehabilitating slash pile burn scars in upper montane forests of the Colorado Front Range. *Natural Areas Journal* 31(2), 177-182.

FR (Federal Register), 78 FR 7864. U.S. Fish and Wildlife Service Proposed Rule to list the distinct population segment of the North American wolverine in the contiguous United States, as a threatened species under the Endangered Species Act. Available online: http://www.gpo.gov/fdsys/pkg/FR-2013-02-04/pdf/2013-01478.pdf.

FR (Federal Register), 78 FR 7890. U.S. Fish and Wildlife Service Proposed Rule to establish a nonessential experimental population (NEP) area for the North American wolverine (*Gulo gulo luscus*) in the Southern Rocky Mountains of Colorado, northern New Mexico, and southern Wyoming. Available online: http://www.gpo.gov/fdsys/pkg/FR-2013-02-04/pdf/2013-01479.pdf.

FR (Federal Register), 79 FR No. 224. Endangered and Threatened Wildlife and Plants; Designated Critical Habitat for Gunnison Sage-Grouse; Final Rule. http://www.fws.gov/mountain-prairie/species/birds/gunnisonsagegrouse/GuSGCriticalHabitat_11202014.pdf

FR (Federal Register), 79 FR 69312. Endangered and Threatened Wildlife and Plants; Threatened status of Gunnison sage-grouse; Final Rule. http://www.fws.gov/mountain-prairie/species/birds/gunnisonsagegrouse/GUSGFinalListingRule_11202014.pdf

Funk, J., Saunders, S., Sanford, T., Easley, T., & Markham, A. (2014). Rocky Mountain forests at risk: *Confronting climate-driven impacts from insects, wildfires, heat, and drought* (Report from the Union of Concerned Scientists and the Rocky Mountain Climate Organization). Cambridge, MA: Union of Concerned Scientists.

Gambel oak (Quercus gambelli). Retrieved 12/2015 from Fire Effects Information System: http://www.fs.fed.us/database/feis/plants/tree/quegam/all.html

Gergel, S.E. and M.G. Turner, Editors. (2002). Learning landscape ecology: A practical guide to concepts and techniques. New York, NY: Springer-Verilog New York, Inc.,. 316 p

Gibson, J. (2002). *An evaluation of Whiskeytown's shaded fuel breaks, 2001-2002 summary report.* Whiskeytown, CA: DOI National Park Service, Whiskeytown National Recreation Area.

Gifford G. F., Humphries, W., Jaynes, R. A. (1984). A preliminary quantification of the impacts of aspen to conifer succession on water yield. II. Modeling results. *Journal of the American Water Resources Association* 20(2): 181-186. Retrieved from http://dx.doi.org/10.1111/j.1752-1688.1984.tb04669.x.

Gilbertson, R. L. (1980). Wood-rotting fungi of North America. *Mycologia* 72(1): 1–49.

Gregg, R. E. (1963). *The ants of Colorado, with reference to their ecology, taxonomy, and geographic distribution*. Boulder, Colorado: University of Colorado Press.

Griffin, J., Simard, J. M., & Turner, M.G. (2013). Salvage harvest effects on advanced tree regeneration, soil nitrogen and fuels following mountain pine beetle outbreak in lodgepole pine. *Forest Ecology and Management 291* 228-239.

Griffis, K. L., Crawford, J. A., Wagner, M. R., & Moir, W. H.. (2001). Understory response of management treatments in northern Arizona ponderosa pine forests. *Forest Ecology and Management* 146: 239–245.

Grode, J. (2008). Southern Rockies lynx amendment biological assessment. Rocky Mountain Region: USDA Forest Service. Retrieved from: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5357386.pdf

Gucinski, H., et.al. (2001). *Forest roads: A synthesis of scientific information* (General Technical Report PNW-GTR-509). Portland, Oregon: USDA Forest Service, Pacific Northwest Research Station.

Gunnison Sage-grouse Rangewide Steering Committee. (2005). *Gunnison sage-grouse rangewide conservation plan.* Colorado Division of Wildlife, Denver, Colorado, USA.

Hapner v. Tidwell, US District Court for the District of Montana, October 30, 2008.

Hardy, C. C. (1996). *Guidelines for estimating volume, biomass and smoke production for piled slash* (General Technical Report PNW-GTR-364). Portland, OR: USDA Forest Service, Pacific Northwest Research Station. Retrieved from http://www.treesearch.fs.fed.us/pubs/26244

Hart, Sarah J., T. Schoennagel, T.T. Veblen, T.B. Chapman. (2015). Area burned in the Western United States is unaffected by recent mountain pine beetle outbreaks. PNAS 112(14) 4375-4380.

Harvey, B. J., Donato, D.C. & Turner, M.G.. (2014). Recent mountain pine beetle outbreaks, wildfire severity, and postfire tree regeneration in the US Northern Rockies.

Hatchett, B., M.P. Hogan, and M.E. Grismer. (2006). Mechanical mastication thins Lake Tahoe forest with few adverse impacts. *California Agriculture* 60(2): 77-82.

Hauser, R., Archer, S., Backlund, P., Hatfield, J., Janetos, A., Lettenmaier, D., Ryan, M.G., Schimel, D., & Walsh, M., (2009, November). The effects of climate change on U.S. Ecosystems. USDA. Retrieved from http://www.usda.gov/img/content/EffectsofClimateChangeonUSEcosystem.pdf

Headwaters Economics. 2015. "National Forest Timber Sales and Timber Cuts, FY 1980-2014." Accessed January 4, 2016. http://headwaterseconomics.org/dataviz/national-forests-timber-cut-sold.

Hebertson, E.G.,& Jenkins, M.J., (2008). Climate factors associated with historic spruce beetle (Coleoptera: Curculionidae) outbreaks in Utah and Colorado. *Environmental Entomology 37* (2): 281-292.

Hicke, J. A., Johnson, M.C., Hayes, J.L., & Preisler, H.K. (2012). Effects of bark beetle-caused tree mortality on wildfire. *The bark beetles, fuels and fire bibliography.* Paper 223. Retrieved from http://digitalcommons.usu.edu/barkbeetles/223.

Hopson, L. M., & Lee, E. (2011). Mitigating the effect of poverty on academic and behavioral outcomes: The role of school climate in middle and high school. *Children and Youth Services Review*. 33, 2221-2229.

Howard, J. L. (1996). Populus tremuloides. In: *Fire effects information system*, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Retrieved from http://www.fs.fed.us/database/feis/ .

Huang C., Anderegg W. R. L. (2012). Large drought-induced aboveground live biomass losses in southern Rocky Mountain aspen forests. *Global Change Biology* 18: 1016-1027. Retrieved from http://dx.doi.org/10.1111/j.1365-2486.2011.02592.x.

Hubbard, R., Elder, K, Rhoades, C., Hays, P., & Sins, B. (2014). Small bugs with big impacts: Ecosystem and watershed-level responses to the MPB epidemic [Chapter 7]. In: Matonis, M., Hubbard, R., Gebert, K., Hahn, B., Miller, S. & Regan, C. *Future Forests Webinar Series, Webinar Proceedings and Summary: Ongoing Research and Management Responses*

to the Mountain Pine Beetle Outbreak (Proceedings RMRS-P-70). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. P. 61 – 72.

Huggard, David, Klenner, Walt, Vyse, Alan. (1999). Windthrow following four harvest treatments in an Engelmann spruce - subalpine fir forest in southern interior British Columbia, Canada. *Canadian Journal of Forest Research* 29(10): 1547-1556.

Humphries, W., Gifford, G. F. & Jaynes, R. A. (1984). A preliminary quantification of the impacts of aspen to conifer succession on water yield – I. Heat pulse methodology for model calibration. *Water Resources Bulletin* 20(2): 173-179.

Hutto, R. L., & Young, J. S. (1999). Habitat relationships of landbirds in the Northern Region, USDA Forest Service. Gen. Tech. Rep. RMRS-GTR-32, U.S. Forest Service Rocky Mtn. Research Station, Ogden, UT.

IMPLAN. (2012). IMpacts for PLANning (IMPLAN). Minnesota IMPLAN Group, Inc. Version 3.1.1001.2. Copyright 2014. Additional information available at www.implan.com.

Ingersol, G.P., Mast, M.A., Campbell, D.H.,. Clow, D.W., Nanus, L. and Turk, J. T. (2007). Trends in snowpack chemistry and comparison to National Atmospheric Deposition Program results for the Rocky Mountains, USA, 1993-2004. *Atmospheric Environment 42* (2008) 6098–6113.

Interagency Lynx Biology Team. (2013). *Canada lynx conservation assessment and strategy. 3rd edition*. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and UDSI National Park Service. Forest Service Publication R1-13-19, Missoula, MT. 128 pp.

Ivan, J. (2011). *Putative Canada lynx (Lynx canadensis) movements across Hwy 114 near North Pass, Colorado.* Colorado Parks and Wildlife, Fort Collins, CO, 6 pgs. Available online: http://wildlife.state.co.us/Research/Mammal/Lynx/Pages/Lynx.aspx.

Ivan, J. (2015). Personal Communication. Colorado Parks and Wildlife Research Biologist. Fort Collins, Colorado.

Janetos, A., Hansen, D., Inouye, D., Kelly B. P. & Meyerson, B. (2008). Biodiversity. In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States. (*A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research). Washington, DC.

Jenkins, M.J., Dicus, C.A., & Hebertson, E.G. (1998). Postfire succession and disturbance interactions on an intermountain subalpine spruce-fir forest. PP219-229 In: Pruden, T. L. & Brennan, L. A. (Eds.) *Fire in ecosystem management: Shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology* conference proceedings, No. 20, Tallahassee, FL: Tall Timbers Research Station.

Jenkins, M. J., Hebertson, E., Page, W., & Jorgenson, A. (2008). Bark beetles, fuels, fires and implications for forest management in the Intermountain West. *Forest Ecology and Management* 254:16-34.

Jenkins, M .J., Hebertson, E. G. & Munson, A. S. (2014). Spruce beetle biology, ecology and management in the Rocky Mountains: An addendum to spruce beetle in the Rockies. *Forests* 5:21-71.

Johnson, M. C., Halofsky, J.E., & Peterson, D.L. (2013). Effects of salvage logging and pile and burn on fuel loading, potential fire behavior, fuel consumption and emissions. *International Journal of Wildland Fire 22*, 757-769.

Johnson-Groh, C., C. Riedel, L. Schoessler and K. Skogen. 2002. Belowground distribution and Abundance of Botrychium gametophytes and juvenile sporophytes. American Fern Journal, 92(2):80-92.

Johnston, B. C. (1994). *Key to plant subformations of the Rocky Mountain Region*. Gunnison, CO: USDA Forest Service.

Johnston, B.C. (2001). Field guide to ecological types of the Upper Gunnison Basin: An abridged version of *Ecological Types of the Upper Gunnison Basin* for field use. Technical Report R2-RR-2001-02, 295 pp. Lakewood, CO: USDA Forest Service. May, 2001.

Johnston, B.C. (2001). Multiple factors affect aspen regeneration on the Uncompahgre Plateau, West-Central Colorado. USDA Forest Service Preceedings RMRS-P-18.2001. USDA Forest Service. Retrieved from http://www.fs.fed.us/rm/pubs/rmrs_p018/rmrs_p018_395_414.pdf

Johnston, B. C. (2012). *Supplemental report on conditions of selected wildfires in the western Uncompahgre Plateau and surrounding areas: 47, Beaver, Bucktail, Burn Canyon, Campbell Creek, Dominguez, Maverick, and Tabeguache Fires, Mesa, Montrose, and San Miguel Counties, Colorado* (Report to Forest Supervisor, Grand Mesa-Uncompahgre-Gunnison National Forest), Delta, CO: Grand Mesa-Uncompahgre-Gunnison National Forest.

Johnston, B. C.; Huckaby, L., Hughes, T. J. & Pecor, J. (2001). *Ecological types of the Upper Gunnison Basin: Vegetation-soil-landform-geology-climate-water land classes for natural resource management* (Technical Report R2-RR-2001-01), 858 pp. Lakewood, CO: USDA Forest Service, Rocky Mountain Region.

Johnston, B. C., Stratton, B. T., Young, W. R., et al. (April 6, 2012). *Inventory of fens in a large landscape of West-Central Colorado.* (Report to Forest Supervisor, Grand Mesa-Uncompahgre-Gunnison National Forest). Delta, CO: USDA Forest Service. Available online: http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5363685

Jones, J., et al. (2000). Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. *Conservation Biology, 14*(1), 76-85.

Kane, J. M., Varner, M., Knapp, E. E., & Powers, R. F. (2010). Understory vegetation response to mechanical mastication and other fuels treatments in a ponderosa pine forest. *Applied Vegetation Science* 13:207-220.

Karl, T.R., Melillo, J.M., & Peterson, T.C. (Eds.). (2009). *Global climate change impacts in the United States: A state of knowledge report from the U.S. Global Climate Change Research Program.* New York, NY: Cambridge University Press.

Keegan, C.E., Sorenson, C.B., Morgan, T.A., Hayes, S.W., & Daniels, J.M. (2011). Impact of the Great Recession and housing collapse on the forest products industry in the Western United States. *Forest Products Journal,* 61.8.

Keeley, J. E. (2006). Fire management impacts on invasive plants in the western United States. *Conservation Biology* 20(2): 375-384. Retrieved from http://dx.doi.org/10.1111/j.1523-1739.2006.00339.x.

Keeley, J. E., & McGinnis, T. W. (2007). Impact of prescribed fire and other factors on cheatgrass persistence in a Sierra Nevada ponderosa pine forest. *International Journal of Wildland Fire,* 16: 96-106.

Kennedy, T. A., Naeem, S., Howe, K.M.,. Knops, J.M., Tilman, D. & Reich, P. (2002). Biodiversity as a barrier to ecological invasion. *Nature, 417*: 636-8.

Kingery, H.E. ed. 1998. *Colorado breeding bird atlas.* Denver, Co: Colorado Bird Atlas Partnership and Colorado Division of Wildlife, 636 p.

Kolbe, J.A., Squires, J.R., Pletscher, D.H, & Ruggiero, L.F.. (2007). The effect of snowmobile trails on coyote movements within lynx home ranges. *Journal of Wildlife Management. 71*(5): 1409-1418.

Kotliar, N.B. (2007). Olive-sided flycatcher (Contopus cooperi): a technical conservation assessment. U.S.D.A. Forest Service, Rocky Mountain Region. 38 p.

Kotliar, N.B. & Melcher, C.P. (1998). Habitat selection and behavior of Olive-sided Flycatchers under natural and managed disturbance regimes. Unpublished annual report prepared for U.S. Fish and Wildlife Service, USGS, Fort Collins, CO

Knapp, E.E., Schwilk, D.W., Kane, J.M. & Keeley, J.E. (2007). Role of burning season on initial understory vegetation response to prescribed burning in a mixed conifer forest. *Canadian Journal of Forest Research*, *37*: 11-22.

Knopf, F. L. &. Olson, T. E. (1984). Naturalization of Russian-olive: Implications to Rocky Mountain wildlife. *Wildlife Society Bulletin, 12*(3): 289-298.

Knowles, N., Dettinger, M. D., & Cayan, D. R. (2006). Trends in snowfall versus rainfall in the western United States. *Journal of Climate 19* (18): 4545-4559. http://dx.doi.org/10.1175/JCLI3850.1.

Kobziar, L. N. & McBride, J. R. (2006). Wildfire burn patterns and riparian vegetation response along two northern Sierra Nevada streams. *Forest Ecology and Management, 222*(2006) 254-265.

Kochi, I., Donovan, G.H., Champ, P.A., &. Loomis, J.B. (2010a). The economic cost of adverse health effects from wildfire-smoke exposure: A review. *International Journal of Wildland Fire, 19*: 803-817.

Kochi, I., Loomis, J., Champ, P., & Donovan, G. (2010b). Health and economic impact of wildfires: Literature review. USDA Forest Service.

Korb, J.E., N.C. Johnson, and W.W. Covington. (2004). Slash pile burning effects on soils biotic and chemical properties and plant establishment: Recommendations for amelioration. *Restoration Ecology* 12(1): 52-62.

Kuhn, T. J., Safford, H. D., Jones, B. E., & Tate K. W. (2011). Aspen (*Populus tremuloides*) stands and their contribution to plant diversity in a semiarid coniferous landscape. *Plant Ecology 212*(9): 1451-1463. Retrieved from http://dx.doi.org/10.1007/s11258-011-9920-4.

Kulakowski, D. & Veblen, T.T. (2007). Effect of prior disturbances on the extent and severity of wilfire in Colorado subalpine forests. *Ecology 88*(3): 759-769.

Lacey, J. R.; Marlow, C. B., & Lane, J. R. (1989). Influence of spotted knapweed *Centaurea maculosa* on surface runoff and sediment yield. *Weed Technology* 3(4): 627-631.

LaMalfa, E. & Ryel, R. (2008). Differential snowpack accumulation and water dynamics in aspen and conifer communities: Implications for water yield and ecosystem function. *Ecosystems 11*(4): 569-581. Retrieved from http://dx.doi.org/10.1007/s10021-008-9143-2.

Lewis, D., Hunt, G.L. & Plantinga, A. J. (2002). Public conservation land and employment growth in the Northern Forest Region. *Land Economics*, 78(2): 245-259.

Levine, J. M., Vilá, M., D'Antonio, C. M., Dukes, J. S., Grigulis, K. & Lavorel, S. (2003). Mechanisms underlying the impacts of exotic plant invasions. *Proceedings of the Royal Society of London, Series B 270*(1517): 775-781. Retrieved from http://dx.doi.org/10.1098/rspb.2003.2327.

Lichvar, R. W. (2012). *The national wetland plant list* (Publication No. ERDC/CRREL TR-12-11), Washington, DC: U. S. Army Corps of Engineers. October 2012. Retrieved from http://rsgisias.crrel.usace.army.mil/NWPL/.

Lisle, T. E., Adams, M. B., Reid, L. M., & Elder, K. (2010). Hydrologic influences of forest vegetation in a changing world: Learning from Forest Service experimental forests, ranges, and watersheds. In: Adams, M. B., NcNeel, J. & Rodriguez-Franco, C. (Eds.) *Meeting current and future conservation challenges through the synthesis of long-term silviculture and range management research* (General Technical Report WO-84). Washington, DC: USDA, Forest Service: 37-49.

Lodgepole pine (Pinus contorta var. latifolia). Retrieved 12/2015 from: Fire Effects Information System: http://www.fs.fed.us/database/feis/plants/tree/pinconl/all.html

Lukas, J. & Gordon, E. (2010). Impacts of the mountain pine beetle infestation on the hydrologic cycle and water quality: A symposium report and summary of the latest science. *Intermountain West Climate Summary* Vol. 6, Issue 4. 6 pp.

Mackes, K. H. & Lynch, D. L. (2001). The effect of aspen wood characteristics and properties on utilization. (RMRS-P-18 429-440). *USDA Forest Service Proceedings.*

Manier, D.J., N.T. Hobbs, D.M. Theobald, R.M. Reich, M.A. Kalkhan, M,R. Campbell. 2003. (Draft) Canopy dynamics and human caused disturbance on a semi-arid landscape in the Rocky Mountains, USA. Natural Resource Ecology Laboratory. Colorado State University. Fort Collins, CO. 56 pp.

Marchetti, S. B., Worrall, J. J. & Eager, T. (2011). Secondary insects and diseases contribute to sudden aspen decline in southwestern Colorado, USA. *Canadian Journal of Forest Research 41*: 2315-2325. Retrieved from http://dx.doi.org/10.1139/X11-106.

Mask, Roy. Personal communication 2013-2014. Entomologist, USDA Forest Service, Gunnison Service Center, Gunnison, Colorado 81230.

Massman, W. J., Frank, J. M., Shepperd, W. D., & Platten, M. J. (2003). In situ soil temperature and heat flux measurements during controlled surface burns at a southern Colorado forest site. In: Omi, P. N. & Joyce, L. A. (Technical Eds.) *Fire, fuel treatments, and ecological restoration.* (pp. 69-87) Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Research Station. Retrieved from http://www.fs.fed.us/rm/pubs/rmrs_p029.html.

MacDonald, L.H. &. Stednick, J.D. (2003). *Forests and Water: A State-of-the-Art Review for Colorado*. CWRRI Completion Report No. 1996. Colorado State University, Fort Collins, CO. 65 pp.

MacDougall, A. S. & Turkington, R. (2005). Are invasive species the drivers or passengers of change in degraded ecosystems? *Ecology 86*(1): 42-55.

McGlone, C.M., Springer, J.D. & Covington, W.W. (2009). Cheatgrass encroachment on a ponderosa pine forest ecological restoration project in northern Arizona. *Ecological restoration 27*(1): 37- 46.

McHugh, C. (May, 2014). Personal Communication with Ali Reiner

McIver, J. D., et al. (2013). Ecological effects of alternative fuel-reduction treatments: Highlights of the National Fire and Fire Surrogate study (FFS). *International Journal of Wildland Fire,* (22), 63-82.

Mearns, L.O. & Barsugli, J. (2009). Scenarios for Climate Change Adaptation Workshop for Natural Resource Managers in the Gunnison Basin. *Gunnison basin climate adaptation workshop: Participant notebook.* The Nature Conservancy. Retrieved from http://nmconservation.org/dl/Gunn_scenarios.pdf

Megahan, W. F. & Hornbeck, J. (2000). *Lessons learned in watershed management: A retrospective view* (pp. 177-188, RMRS-P-13).USDA Forest Service Proceedings

Meiners, S. J., Cadenasso, M. L. & Pickett, S. T. A. (2004) Beyond biodiversity: individualistic controls of invasion in a self-assembled community. *Ecology Letters 7*: 121-126.

Meehan, Timothy D., & George, T. Luke. (2003). Short-term effects of moderate- to high-severity wildfire on a disturbance-dependent flycatcher in Northwest California. *The Auk, 120*(4), 1102-1113.

Mercer, D. E., Pye, J. M., Prestemon, J. P., Butry, D. T., & T. P. Holmes, T. P. (2000). *Economic effects of catastrophic wildfires: Assessing effectiveness of fuel reduction programs for reducing the economic impacts of catastrophic forest fire events.* Final Report for the Joint Fire Science Program.

Merriam, K. E., Keeley, J. E. & Beyers, J. L. (2006). Fuel breaks affect nonnative species abundance in Californian plant communities. *Ecological Applications 16*(2): 515-527.

Michaelian, M., Hogg, E. H., Hall, R. J., & Arsenault, E. (2011). Massive mortality of aspen following severe drought along the southern edge of the Canadian boreal forest. *Global Change Biology 17*(6): 2084-2094. Retrieved from http://dx.doi.org/10.1111/j.1365-2486.2010.02357.x.

Mikkelson, K.M., Bearup, L.A., Maxwell, R.M. Stednick, J.D, McCray, J.E. & Sharp, J.O. (2013). Bark beetle infestation impacts on nutrient cycling, water quality and interdependent hydrological effects. *Biogeochemistry* 115: 1-21.

Moench, R. & Fusaro, J. (2002). Soil erosion control after wildfire. Colorado State University Cooperative Extension.

Morton, D.C., Roessing, M.E., Camp, A.E., & Tyrrell, M. L. (2003). *Assessing the environmental, social, and economic impacts of wildfire.* (GISF Research Paper 001). New Haven, CT: Yale School of Forestry and Environmental Studies.

Mote, P. W., Hamlet, A. F, Clark, M. P. & Lettenmaier, D. P. (2005). Declining mountain snowpack in western North America. *Bulletin of the American Meteorological Society* 86(1): 39-49.

Mountain Big Sagebrush (Artemesia tridentate subsp. vaseyana). Retrieved 12/2015 from Fire Effects Information System: http://www.fs.fed.us/database/feis/plants/shrub/arttriv/all.html

Mueggler, W. F. (1985). Vegetation associations. In: DeByle N.V. & Winokur, R.P,(Eds.) *Aspen: ecology and management in the western United States* (General Technical Report RM-119). Fort Collins, Colorado: Rocky Mountain Forest and Range Experiment Station, USDA Forest Service. p 45-55. Retrieved from http://www.treesearch.fs.fed.us/pubs/contents/24942.

Mueser, P.R., & Graves, P.E. (1995). Examining the role of economic opportunity and amenities in explaining population redistribution. *Journal of Urban Economics* 37(2): 176-200.

Neary, D. G., Klopatek, C. C., DeBano, L.F. & Folliott, P.F. (1999). Fire effects on belowground sustainability: a review and synthesis. *Forest Ecology and Management 122*: 51-71.

Oaten, D. K,& Larsen, K. W. (2008). Aspen stands as small mammal "hotspots" within dry forest ecosystems of British Columbia. *Northwest Science 82*(4): 276-285.

Ohms, S. R. (2003). Restoration of aspen in different stages of mortality in southern Utah. (Master's thesis). Logan, Utah: Utah State University.

O'Rourke, P. M. (1980). *Frontier in transition; A history of Southwestern Colorado*. Colorado BLM Cultural Resource Series, No. 10.

Page, W. & Jenkins, M. (2007). Mountain pine beetle-induced changes to selected lodgepole pine fuel complexes within the intermountain region. *Forest Science 53*(4):507-518.

Page, W.G., M.J. Jenkins and M.E. Alexander. 2013. Foliar moisture content variations in lodgepole pine over the diurnal cycle during the red stage of mountain pine beetle attack. *Environ. Model. Software 49*: 98–102.

Page, W. G., Jenkins, M.J. & Runyan, J.B. (2014). Spruce beetle-induced changes to Engelmann spruce foliage flammability. *Forest Science 60*(4): 691-702.

Parker T. J., Clancy, K. M., & Mathiasen, R. L. (2006). Interactions among fire, insects and pathogens in coniferous forests of the interior western United States and Canada. *Agricultural and Forest Entomology*. 8, 167–189.

Peppin, D., Fulé, P. Z., Hull Sieg, C., Beyers, J. L., & Hunter, M. E. (2010). Post-wildfire seeding in forests of the western United States: An evidence-based review. *Forest Ecology and Management* 260: 573-586.

Perrakis, D.B., Lanoville, R.A., Taylor, S.W., & Hicks, D. (2014). Modeling wildfire spread in Mountain pine beetle-affected forest stands, British Columbia, Canada. *Fire Ecology 10*(2): 10-35.

Pielke R. A., Doesken, N., Bliss, O., Green, T., Chaffin, C. *et al.* 2005. Drought 2002 in Colorado: An unprecedented drought or a routine drought? *Pure and Applied Geophysics* 162(8): 1455-1479. Retrieved from http://dx.doi.org/10.1007/s00024-005-2679-6

Poff, R.J. (1996). Effects of silvicultural practices and wildfire on productivity of forest soils. In *Sierra Nevada ecosystem project: Final report to Congress*. Vol. II: Assessments and Scientific Basis for Management Options. *Wildland Resources Center Report 37*(16), 477 – 493.

Pollet, J. & Omi, P. N. (2002). Effect of thinning and prescribed furning on crown fire severity in ponderosa pine forests. *International Journal of Wildland Fire 11*:1-10.

Ponderosa pine (Pinus ponderosa). Retrieved 12/2015 from Fire Effects Information System: http://www.fs.fed.us/database/feis/plants/tree/pinpons/all.html

Potts, D.F. (1984). Hydrologic impacts of a large-scale mountain pine beetle (*Dendroctonus ponderosae*) Epidemic. *Water Resources Bulletin* 20(3): 373-377.

Potts, J., & Stephens, S. (2009) Invasive and native plant responses to shrubland fuel reduction: comparing prescribed fire, mastication, and treatment season. *Biological Conservation* 142:1657-1664

Powers, R.F., et al. (1998). Assessing soil quality: Practicable standards for sustainable forest productivity in the United States. In: Davidson, E.A.; Adams, M.B.; Ramadrishna, K. (eds). *Criteria and indicators of soil quality for sustainable forest productivity* (pp 53 – 80). Spec. Publ. 53, Madison, WI: *Soil Sci. Soc. Am*.

Powers, R.F., et al. (2000). Long term soil productivity. *Canadian Journal of Forest Research,36:* 31 – 50.

Prestemon, J. P., Abt, K. L., Potter, K. M., & Koch, F. H. (2013). An economic assessment of mountain pine beetle timber salvage in the West. USDA Forest Service. *Western Journal of Applied Forestry*. 28(4): 143-153.

Pugh, E. & Gordon, E. (2012). A conceptual model of water yield effects from beetle-induced tree death in snow-dominated lodgepole pile forests. *Hydrological Processes*. Wiley Online Library.

Raffa, K. F., Aukema, B.H., Bentz, B.J., Carroll, A.L., Hicke, J.A., Turner, M.G., & Romme, W.H. (2008). Cross-scale drivers of natural disturbances prone to anthropogenic amplification: The dynamics of bark beetle eruptions. *BioScience* 58:6 501-517.

Rangwala, Imtiaz (Western Water Assessment & NOAA ESRL, Boulder) and Renee Rondeau (Colorado Natural Heritage Program) for the *Southwest Colorado Social-Ecological Climate Resilience (SECR) Project* funded by USGS's North Central Climate Science Center. Climate scenarios from Global Climate Models hadgem2-es.1.rcp85; cnrm-cm5.1rcp45; and cesm1-bgc.1.rcp85

Reed, A. & Metcalf, M. D. (1999). Colorado prehistory: *A context for the Northern Colorado River Basin.* Denver, CO: Colorado Council of Professional Archaeologists, Colorado Historical Society.

Rehfeldt, G.E. (2006). *A spline climate model for western United States* (General Technical Report RMRS-134) Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Rehfeldt, G.E., Crookston, N. L., Warwell, M.V., & Evans, J. S. (2006). Empirical analyses of plant-climate relationships for the Western United States. *International Journal of Plant Science 167*, 1123-1150.

Rehfeldt, G.E. & Worall, J. (2013). Sudden aspen decline. (Report for spruce beetle epidemic and aspen decline management response EIS). USDA Forest Service, GMUG National Forest.

Rehfeldt, G. E., Worall, J. W., Marchetti, S. B., & Crookston, N.L. (2015). *Adapting forest management to climate change: High resolution maps from bioclimate models with topographic predictors.* Moscow, ID: USDA Forest Service Rocky Mountain Research Station.

Reid, L.M. (1993). *Research and cumulative watershed effects*. (General Technical Report, PSW-GTR-141). Albany, CA: USDA Forest Service, Pacific Southwest Research Station.

Resilience Alliance., Walker, B. H., S. R. Carpenter, J. Rockstrom, A.-S. Crépin, and G. D. Peterson. 2012. Drivers, "slow" variables, "fast" variables, shocks, and resilience. *Ecology and Society 17*(3): 30.

Rhoades, C.C., Battaglia, M.A., Rocca, M.E. & Ryan, M.G. (2012). Short- and medium-term effects of fuel reduction mulch treatments on soil nitrogen availability in Colorado conifer forests. *Forest Ecology and Management* 276: 231-238.

Robichaud, P. R.; MacDonald, L. H. & Foltz, R. B. (2010). Fuel management and erosion. (pp. 79-100) In: Elliot, W. J., Miller, I.S., & Audin, L., (Eds.). *Cumulative watershed effects of fuel management in the western United States* (General Technical Report RMRS-GTR-231). Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Robichaud, P. R., Beyers, J. L. & Neary, D. G. (2000). *Evaluating the effectiveness of postfire rehabilitation treatments* (General Technical Report RMRS-GTR-63), Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. Retrieved from: http://www.fs.fed.us/rm/pubs/rmrs_gtr63.pdf.

Robinson, G. R., Quinn, J. F. & Stanton, M. L. (1995). Invasibility of experimental habitat islands in a California winter annual grassland. *Ecology 46*(3): 786-794.

Rocca, M.E., et al. (2014). Climate change impacts on fire regimes and key ecosystem services in Rocky Mountain forests. *Forest Ecology and Management*.

Rocchio, J. (2006). *Rocky Mountain subalpine-montane fen ecological system: Ecological integrity assessment.* Fort Collins, CO: Colorado Natural Heritage Program. Retrieved from http://www.cnhp.colostate.edu/documents/2005/ecological_integrity/Rocky%20Mountain%20Alpine-Montane%20Wet%20Meadow_EIA_Dec09_05.pdf.

Rocky Mountain Gambel Oak/Mixed Montane Shrubland in the Southwest. Retrieved 12/2015 from: http://www.fs.fed.us/database/feis/pdfs/BpS/2711070.pdf

Rocky Mountain Subalpine-Montane Mesic Meadows. Retrieved 12/2015 from: http://www.fs.fed.us/database/feis/pdfs/BpS/2811450.pdf

Rosenberger, R. S., Bell, L. A., Champ, P. A., Smith, E. L. (2012). *Nonmarket economic values of forest insect pests: An updated literature review* (General Technical Report RMRS-GTR-275WWW). USDA Forest Service, Rocky Mountain Research Station.

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. et al. (2000). *Canada lynx conservation assessment and strategy.* USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT, 142 pp.

Ruggiero LF, Aubry, K.B., Buskirk, S.F., Krebs, C.J., McKelvey, K.S., Squires, J.R. (ed). (2000). *The ecology and conservation of lynx in the United States.* University of Colorado Press, Denver, CO.

Ryan, M.G., Birdsey, R.A. & Hines, S.J. (2012). *Forests and carbon storage*. USDA Forest Service, Climate Change Resource Center. Retrieved from http://www.fs.fed.us/ccrc/topics/forests-carbon/index.shtml

Scherer, G., Zabowski, D., Java, B. & Everett, R. (1999). Timber harvesting residue treatment. Part II. Understory vegetation response. *Forest Ecology and Management*. 126:35-50.

Schmid, J. M., & Frye, R. H. (1976). *Stand ratings for spruce beetles* (Res. Note RM-309), Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Schmid, J.M. & Frye, R.H., (1977). *Spruce beetle in the Rockies* (General Technical Report, RM-49). Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Schoennagel, T., Veblen, T. T. & Romme, W. H. (2004). The interaction of fire, fuels, and climate across Rocky Mountain forests. *BioScience* 54.7: 661-676. Retrieved from http://bioscience.oxfordjournals.org/content/54/7/661.full

Scholes, R., J. Settele, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. Overpeck, and M. A. Taboada. (2014). Terrestrial and Inland Water Systems. Page 153 Climate Change 2014: Impacts, Adaptation, and Vulnerability. The Final Draft Report of the Working Group II contribution to the IPCC Fifth Assessment Report. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

Schultz, C. & Nie., M. (2012). Decision-making triggers, adaptive management, and natural resources law and planning. Natural Resources Journal. 52: 442-520.

Scott, J. & Burgan, R. (2005). *Standard fire behavior fuel models: A comprehensive set for use with Rothermel's surface fire spread model* (General Technical Report RMRS-GTR-153) Fort Collins, Colorado: USDA Forest Service, Rocky Mountain Research Station.

Shenk, T. (2005). *General locations of lynx* (*Lynx Canadensis*) *reintroduced to Southwestern Colorado from February 4, 1999 through February 1, 2005.* Fort Collins, CO: Colorado Division of Wildlife, Wildlife Research Center.

Shenk, T.M. (2009). *Lynx update, May 25, 2009*. Colorado Division of Wildlife. Available online: http://wildlife.state.co.us/Research/Mammal/Lynx/.

Shenk, T.M. (2010). *Lynx annual report 2009-2010*. Colorado Parks and Wildlife, 26 pgs. Available online: http://wildlife.state.co.us/Research/Mammal/Lynx/Pages/Lynx.aspx

Shepperd, W. D. (1993). Initial growth, development, and clonal dynamics of regenerated aspen in the Rocky Mountains. Utah State University.

Shepperd, W. & Smith, F. (2013). *Applied silvicultural assessment: Quaking aspen affected by sudden aspen decline in Southwestern Colorado.* USDA Forest Service, Rocky Mountain Research Station, in cooperation with Colorado State University.

Shepperd, W. D., Smith, F. W. & Pelz, K.. (2015). Group clearfell harvest can promote regeneration of aspen forests affected by Sudden Aspen Decline in western Colorado. *Forest Science* 61:1-6.

Shinneman, D.J., Baker, W.L., Rogers, P.C., & Kulakowski, D. (2013). Fire regimes of quaking aspen in the Mountain West. *Forest Ecology & Management 299*: 22-34.

Sibold, J. S., Veblen, T. T., Gonzalez, M.E. (2006). Spatial and temporal variation in historic fire regimes in subalpine forests across the Colorado Front Range in Rocky Mountain National Park, Colorado, USA. *Journal of Biogeography* 32:631-647.

Smith, F.W. and A. Smith. 2004. Apsen persistence on the Uncompahgre Plateau, Colorado. Department of Forest, Rangeland and Watershed Stewardship. Colorado State University. Fort Collins, CO. 29 pp.

Smith, Helen Y., Ed. (2000). The Bitterroot Ecosystem Management Research Project: What we have learned: symposium proceedings; 1999 May 18-20; Missoula, MT. Gen. Tech. Rep. RMRS-GTR-17. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 154p

Smucker, K. and T. Smucker. (2001). Olive-sided flycatcher nesting success in western Montana: 2001 pilot study final report. Unpublished Report

Squires, J. R., DeCesare, N.J, Kolbe, J.K and Ruggiero, L.F. (2010). Seasonal resource selection of Canada lynx in managed forests of the Northern Rocky Mountains. *Journal of Wildlife Management 74*:1648-1660.

Stednick, J.D. (2010). Effects of fuel management practices on water quality [Chapter 8]. (pp. 149-163) In: Elliot, W. J., Miller, I.S., & Audin, L., (Eds.). *Cumulative watershed effects of fuel management in the western United States* (General Technical Report RMRS-GTR-231). Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Stewart, I. T., Cayan, D. R., & Dettinger, M. D. (2005). Changes toward earlier streamflow timing across western North America. *Journal of Climate 18*(8): 1136-1155. Retrieved from http://dx.doi.org/10.1175/JCLI3321.1.

Stockmann, K, Anderson, N., Young, J., Skog, K., Healey, S., Loeffler, D…. Morrison, J. (2014) *Estimates of carbon stored in harvested wood products from United States Forest Service Rocky Mountain Region, 1906-2012*. Unpublished report. Missoula, MT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Forestry Sciences Laboratory.

Stohlgren, T. J. & Chong, G. W. (2002). Assessing vulnerability to invasion by nonnative plant species at multiple spatial scales. *Environmental Management* 29(4): 566-577.

Streufert, R. K. (1999). *Geology and mineral resources of Gunnison County, Colorado.* (Resource Series 37). Denver, Colorado: Colorado Geological Survey, Department of National Resources.

Sudworth, G.B. 1900. Battlement Mesa Forest Reserve, in The White River Plateau and Battlement Mesa Forest Reserves. USDI U.S. Geological Survey. Washington Government Printing Office. Pages 181-243.

Sutherland, S. & Nelson, C. R. (2010). Nonnative plant response to silvicultural treatments: A model based on disturbance, propagule pressure, and competitive abilities. *Western Journal of Applied Forestry 25*(1): 27-33.

Tausch, R. J., Nowak, C. L. & Mensing, S. A. (2004). Climate changes and associated vegetation dynamics during the Holocene: The paleoecological record. pp. 24-48. In: Chambers, Jeanne C. and J.R. Miller (Eds.). Great Basin Riparian Ecosystems: *Ecology, management and restoration.* Washington D.C.: Island Press.

Theobald, D.M., & Shenk, T.M. (2011). *Areas of high habitat use from 1999-2010 for radio-collared Canada lynx reintroduced to Colorado*. Colorado State University and Colorado Parks and Wildlife, 19 pgs. Available online: http://wildlife.state.co.us/Research/Mammal/Lynx/Pages/Lynx.aspx

Thomas, J.W., Miller, R.J., Maser, C.et al. (1979). Plant communities and successional stages. In: J.W. Thomas, tech. ed. *Wildlife habitats in managed forests, the Blue Mountains of Oregon and Washington*. U.S. Department of Agriculture, Forest Service. Agriculture Handbook 553

Thysall, D. R., & Carey, A. B. (2001). Manipulation of density of *Psuedotusuga menziesii* canopies: Preliminary effects on understory vegetation. *Canadian Journal of Forest Restoration* 31: 1513-1525.

Troendle, C. A. & King, R. M. (1987). The effect of partial and clearcutting on streamflow at Deadhorse Creek, Colorado. *Journal of Hydrology 90*:145-157.

Troendle, C. A. & Nankervis, J. M. (2000). *Estimated additional water yield from changes in management of national forests in the North Platte Basin*. Final Report. Lakewood, Colorado: Bureau of Reclamation.

Troendle, C.A., L.H. MacDonald, C.H. Luce, and I.J. Larsen. (2010). Fuel management and water yield [Chapter 7]. (pp. 126-148) In: Elliot, W. J., Miller, I.S., & Audin, L., (Eds.). *Cumulative watershed effects of fuel management in the western United States* (General Technical Report RMRS-GTR-231). Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Turchi G. M, Kennedy, P. L., Urban, D., & Hein, D. (1995). Bird species richness in relation to isolation of aspen habitats. *The Wilson Bulletin 107*(3): 463-474. http://www.jstor.org/stable/4163570.

Uchytil, R. J. 1991. *Picea engelmannii*. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Retrieved from http://www.fs.fed.us/database/feis/

United States Bureau of Mines. (1911). *Mineral resources of the United States,* Vol. 2. Washington D.C.: Government Printing Office.

USDA. (1990). *Policy of noxious weed management* (Departmental Regulation No. 9500-10). Washington, DC: U. S. Department of Agriculture. Retrieved from http://www.fsa.usda.gov/Internet/FSA_File/dr9500-010.pdf.

USDA. (2006). Timber sale contract form 2400-6. National Headquarters, Washington, D.C.: U.S. Department of Agriculture

USDA & USDI. National Cohesive Wildland Fire Management Strategy website. Accessed online 6 May 2015. http://www.forestsandrangelands.gov/strategy/.

USDA Forest Service (n.d.) Digital Photo Series website. Accessed 5/19/2014. Retrieved from http://depts.washington.edu/nwfire/dps/

USDA Forest Service (n.d.) GMUG NF Heritage Program, accessed online May 21, 2014. Retrieved from http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5430745

USDA Forest Service. (1981). Forest Service Manual (FSM) 5100, Supplement No. 5, 5156. Washington, DC: Author.

USDA Forest Service. (1983). *Land and resource management plan.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (1991a). *Final supplemental environmental impact statement: Grand Mesa, Uncompahgre, and Gunnison National Forests.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (1991b). Forest Service Manual 2620 – Wildlife, fish, and sensitive plant habitat management. Amendment No. 2600-91-5 11 pp. Washington, DC: Author.

USDA Forest Service. (1991c). *Grand Mesa, Uncompahgre and Gunnison National Forests amended land and resource management plan*. Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (1993). Forest Service Manual (FSM) 5100, Chapter 5150, R2 Supplement No. 5100-93-2 (Sept. 30, 1993). Washington, DC: Author.

USDA Forest Service. (1998). Economic and social conditions of communities: Economic and social characteristics of Interior Columbia Basin communities and an estimation of effects on communities from the alternatives of the Eastside and Upper Columbia River Basin DEIS. Portland, OR: Pacific Northwest Research Station.

USDA Forest Service. (1999). Fire management. Forest Service Manual 5100. Chapter 5150. (June 18, 1999). Washington, DC: Author.

USDA Forest Service. (2000 - 2012). Traffic Count Data. Internal electronic files. Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (2001). *Guide to noxious weed prevention practices*. [Place of publication not stated]: Retrieved from http://www.fs.fed.us/rangelands/ftp/invasives/documents/GuidetoNoxWeedPrevPractices_07052001.pdf.

USDA Forest Service. (2005a). *Aquatic, riparian, and wetland ecosystem assessment, San Juan National Forest, Colorado.* Vol. II, Ch. 5. Rocky Mountain Region.

USDA Forest Service. (2005b). *Management indicator species forest plan amendment to the Grand Mesa, Uncompahgre and Gunnison National Forests Land and Resource Management Plan*. Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests. Retrieved from http://www.fs.usda.gov/detail/gmug/landmanagement/resourcemanagement/?cid=stelprdb5199918

USDA Forest Service. (2005c). Record of decision and finding of no significant impact. *Forest plan amendment, management indicator species, Grand Mesa, Uncompahgre, and Gunnison National Forests.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (2005d, March). *Rocky Mountain Region invasive species management strategy.* Rocky Mountain Region.

USDA Forest Service. (2005e). Comprehensive assessment of existing vegetation conditions on the Grand Mesa, Uncompahgre and Gunnison National Forests. Volume III, Chapter 2b – *Uncompahgre, Grand Mesa, North Fork, San Juan and Gunnison Geographic Areas.* Delta, CO: Author.

USDA Forest Service. (2006a). GMUG forest plan revision. Invasive species of the Gunnison Basin. (Chapter 3). In: *Volume III. Terrestrial Comprehensive Assessment.* Accessed 18 Sept. 2013. Retrieved from http://www.fs.fed.us/outernet/r2/gmug/policy/plan_rev/final/comp_assess/CH3LandDisturb/chap3_gb_invasive_plants.pdf>

USDA Forest Service. (2006b). *Watershed conservation practices handbook*. Chapter 10: Amendment No. 2509.25-2006-2 & Chapter 20: Amendment No. 2509.25-2006-3. Denver, CO: Rocky Mountain Region.

USDA Forest Service. (2006c). *Watershed conservation practices handbook.* Forest Service Handbook R-2 FSH 2509.25, 58 pp. Amendment No. 2509.25-2006-1, approved April 20, 2006. Denver, CO: Rocky Mountain Region.

USDA Forest Service. (July 2006d). *Proposed land management plan comprehensive evaluation report: Grand Mesa, Uncompahgre, and Gunnison National Forests.* Rocky Mountain Region.

USDA Forest Service, 2006e. Comprehensive Assessment for the Grand Mesa, Uncompahgre and Gunnison National Forests. Chapter 2, Section B. Existing Vegetation for the Grand Mesa, Gunnison, North Fork, San Juan and Uncompahgre Plateau Geographic Areas. Internal Document.

USDA Forest Service, (2007a). *Fire use forest plan amendment to the Grand Mesa, Uncompahgre and Gunnison National Forests Land and Resource Management Plan.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (2007b). Transportation system. Forest Service Manual 7733.12 pp. Washington, DC: Author.

USDA Forest Service. (2008). Southern Rockies lynx management amendment direction and record of decision. National Forests in Colorado & Southern Wyoming, October 2008. Rocky Mountain Region. Retrieved from http://www.fs.usda.gov/detail/r2/landmanagement/planning/?cid=stelprdb5356865

USDA Forest Service. (2009a, January). *Climate change considerations in project level NEPA analysis.* Retrieved from http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_nepa_guidance.pdf

USDA Forest Service. (2009b, September). *Water quality protection on National Forests in the Pacific Southwest Region: Best management practices evaluation program, 2003 – 2007*. Pacific Southwest Region.

USDA Forest Service. (2009c). *White River National Forest air resource management plan.* Retrieved from http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_000960.pdf

USDA Forest Service. (2009d). *Implementation guide – Southern Rockies Lynx Amendment. Rocky Mountain Region*, internal document.

USDA Forest Service. (2010a, May). *Inventory and monitoring protocols for groundwater dependent ecosystems: Level 2 sampling protocol for springs and groundwater dependent wetlands.* Version 2.4. Author.

USDA Forest Service. (2010b, November 23). Watershed and air management: Soil management. Forest Service Manual 2500, Chapter 2550. Washington, DC: Author.

USDA Forest Service. (2011a). *Cochetopa Hills vegetation management project environmental assessment.* (pp 36). Gunnison, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests, Gunnison Ranger District.

USDA Forest Service. (2011b). Forest health protection and its partners. *2011 Forest health annual survey report*, Retrieved from : http://www.fs.usda.gov/detail/r2/forest-grasslandhealth/?cid=stelprdb5348787) .

USDA Forest Service. (2011c). *Grand valley spruce beetle and sudden aspen decline treatments environmental assessment.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (2011d). Invasive species management. Forest Service Manual 2900, 28 pp. Washington, DC: Author.

USDA Forest Service. (2011e). Management of fish and wildlife habitat. Forest Service Manual 2630 –FSM Supplement 2600-2011-2, 5 pp. Denver, CO: Rocky Mountain Region.

USDA Forest Service. (2011f). Public safety, hazard trees. Forest Service Manual 2332.11 8 pp. Washington, DC: Author.

USDA Forest Service. (2011g, May). Watershed condition framework: A framework for assessing and tracking changes to watershed condition. FS-977.

USDA Forest Service. (2011h, July). Watershed condition classification technical guide. FS-978.

USDA Forest Service. (2011i). *Western bark beetle strategy: Human safety, recovery and resiliency.* Retrieved from: http://www.fs.fed.us/publications/bark-beetle/bark-beetle-strategy-appendices.pdf

USDA Forest Service. (2012a). Code of Federal Regulations, part 294, Title 36 subpart D. Special Areas, Colorado Roadless Area Management (Colorado Roadless Rule). Washington, DC: Author.

USDA Forest Service. (2012b). Forest health protection and its partners. *2012 Forest health annual survey report.* Retrieved from: http://www.fs.usda.gov/detail/r2/forest-grasslandhealth/?cid=stelprdb5408531

USDA Forest Service. (2012c). *National best management practices for water quality management on national forest system lands,* (Volume 1-National Core BMP Technical Guide. FS-990a.) Washington, DC: Author. Retrieved from http://www.fs.fed.us/biology/resources/pubs/watershed/FS_National_Core_BMPs_April2012.pdf

USDA Forest Service. (2013a). Burned Area Emergency Response (BAER) Report. Monte Vista, CO: Rio Grande National Forest. Retrieved from http://www.fs.usda.gov/detailfull/riogrande/alerts-notices/?cid=stelprdb5431473&width=full

USDA Forest Service. (2013b). Ecological restoration and resilience. Forest Service Manual 2020. Interim directive no. 2020-2013-1. 12 pp. Washington, DC: Author.

USDA Forest Service. (2013c). Environmental restoration and resilience. Forest Service Manual 2020. Proposed Directive. Federal Register 78: 56202-56208. September 12, 2013. Washington, DC: Author. Retrieved from https://federalregister.gov/a/2013-22149

USDA Forest Service. (2013d). Forest health protection and its partners. *2013 Forest health annual survey report.* Retrieved from http://www.fs.usda.gov/main/r2/forest-grasslandhealth

USDA Forest Service. (2013e). Forest Service travel routes data dictionary, Version 3.1. Forest Service, Travel Routes Road User Board.

USDA Forest Service. (2013f). *La Garita beetle response: Vegetation management project environmental assessment.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service. (2014). Forest Service Directive System, Forest Service Manuals and Handbooks, 7700 Series: Travel Management. Retrieved from http://www.fs.fed.us/im/directives/

USDA Forest Service. (2014a). *Forest transportation atlas – GIS spatial and INFRA tabular data.* Delta, CO: Grand Mesa, Uncompahgre, and Gunnison National Forests.

USDA Forest Service (2014b). Piled fuels biomass and emissions calculator. Fire and Environmental Research Applications Team, Pacific Wildland Fire Sciences Laboratory, USDA Forest Service Pacific Northwest Research Station. Retrieved from http://depts.washington.edu/nwfire/piles/

USDA Forest Service. (2014c). *White River National Forest oil and gas lease forest plan amendment EIS.* Air Quality section. Retrieved from http://www.fs.usda.gov/detail/whiteriver/home/?cid=STELPRDB5391635

USDA Forest Service. (2014d). Forest health protection and its partners. Aerial Survey Highlights for Colorado 2014. Retrieved from http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3828662.pdf

USDA Forest Service. 2014e. Synthesis on Crown Fire Behavior in Conifer Forests. Fire Management Today, Vol. 73. No. 4, 52 pp. Available online: http:// http://www.fs.fed.us/fire/fmt/fmt_pdfs/FMT73-4.pdf

USDA Forest Service. 2015a. R2 Sensitive plant species effects matrix. Rocky Mountain Regional Office (R2), Lakewood, CO.

USDA Forest Service. (2015b). Chapter 2670 - Threatened, endangered and sensitive plants and animals. forest service manual (Supplement 2600-2007-1), Rocky Mountain Region (Region 2), Lakewood, CO.

USDA Forest Service. 2015c – Land Management Planning Handbook Chapter – Zero code. FSH 1909.12, 35 pp. Denver, Colorado: USDA Forest Service, Rocky Mountain Region.

USDA Forest Service and CDPHE. (2014). *Memorandum of Understanding between the State of Colorado, Department of Public Health and Environment and the USDA Forest Service, Rocky Mountain Region.* Forest Service Agreement No. 14-MU-11020000-053.

USDA Forest Service & USDI Fish and Wildlife Service. (2000, Feb. 7). Canada Lynx conservation agreement. USFS Agreement #00-MU-11015600-013. Washington, DC: Authors.

USDA Forest Service and USDI Fish and Wildlife Service. (2008). Memorandum of understanding between the U.S. Department of Agriculture Forest Service and the U.S. Fish and Wildlife Service to promote the conservation of migratory birds. FS Agreement# 08-MU-1113-2400-264. Washington, DC: Authors.

USDA National Resource Conservation Service. (n.d.) Soil interpretations rating guide. *National soil survey handbook*. 430-VI-NSSH, Part 620. Retrieved from http://www.soils.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242

USDI Fish and Wildlife Service (2008, July 25). Southern Rockies lynx amendment, biological opinion of effects. Rocky Mountain Region. Retrieved from: (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5357385.pdf

USDI National Park Service. (2003). *Fire monitoring handbook*. Boise (ID): Fire Management Program Center, National Interagency Fire Center. 274p.

U.S. Department of Commerce. (2013a). Census Bureau, American Community Survey Office, Washington, D.C. Accessed through EPS-HDT from Headwaters Economics.

U.S. Department of Commerce. (2013b). Bureau of Economic Analysis, Regional Economics Information System. Washington, D.C. Tables CA25N, CA30, CA05, CA05N. Accessed through EPS-HDT from Headwaters Economics.

U.S. Department of Labor. (2013). Bureau of Labor Statistics, *Quarterly census of employment and wages.* Washington, D.C.

U.S. Fish and Wildlife Service. (n.d.). IPaC – Information, planning and conservation system. Retrieved from http://ecos.fws.gov/ipac/

U. S. Fish and Wildlife Service. (1999). *Peatland mitigation policy considerations*. Report to U.S. Fish and Wildlife Service Region 6. Lakewood, CO: pp 35

U.S. Fish and Wildlife Service. (2008). Biological opinion on the effects of the Southern Rockies Lynx Amendment on the Distinct Population Segment of Canada lynx (Lynx canadensis) in the contiguous United States, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). Denver, CO: USFWS Ecological Services, Colorado Filed Office,. ES/CO: USFS/SRLA Tails: 65412-2008-F-00370 BO ES/LK-6-CO-08-F-024. Retrieved from: http://www.fs.fed.us/r2/projects/lynx/documents/index.shtml

U.S. Fish and Wildlife Service. (2008). *Birds of conservation concern*. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. [Online version available at http://www.fws.gov/migratorybirds/]

U. S. Fish and Wildlife Service. (2009, Sept. 15). Endangered and threatened wildlife and plants; Taxonomic change of *Sclerocactus glaucus* to three separate species; Final rule. Federal Register 74(177): 47112-47117.

U. S. Fish and Wildlife Service. (2010a, June 23). Endangered and threatened wildlife and plants; Listing *Ipomopsis polyantha* (Pagosa skyrocket) as endangered throughout its range, and listing *Penstemon debilis* (Parachute beardtongue) and *Phacelia submutica* (De Beque phacelia) as threatened throughout their range; Proposed rule. Federal Register 75(120): 35721-35746.

U. S. Fish and Wildlife Service. (2010b, Dec. 15). Twelve-month finding on a petition to list *Astragalus microcymbus* and *Astragalus schmolliae* as endangered or threatened; Proposed Rule. Federal Register 75(240): 78514-78556.

U. S. Fish and Wildlife Service. (2013a, Nov. 22, 2013). Review of native species that are candidates for listing as endangered or threatened; Annual notice of findings on resubmitted petitions; Annual description of progress on listing actions. Federal Register 78(226): 70104-70162.

U. S. Fish and Wildlife Service. (2013b). National wetlands inventory. Retrieved from http://www.fws.gov/wetlands/index.html.

U.S. Fish and Wildlife Service. (2013c). *Endangered and threatened wildlife and plants; Threatened status for the distinct population segment of the North American wolverine occurring in the contiguous United States.* Federal Register 78(23):7864-7890.

U.S. Government Publishing Office. (2013). Code of Federal Regulations. Washington, DC: Author. Retrieved from http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR ,

Vaillant, N. M., Fites-Kaufman, J., Reiner, A.L., Noonan-Wright, E.K. & Dailey, S.N. (2009). Effect of fuel treatments on fuels and potential fire behavior in California, USA, National Forests. *Fire Ecology* 5(2):14-29.

Vaillant, N. M., Reiner, A.L., Noonan-Wright, E.K. (2013). Prescribed fire effects on field-derived and simulated forest carbon stocks over time. *Forest Ecology and Management, 310:* 711-719.

Vasquez, M. (2014). Personal communication. District Biologist, Gunnison Ranger District. Grand Mesa, Uncompahgre and Gunnison National Forest.

Vasquez, M., Jupuntich, R, & Speas, C. (2013). *La Garita spruce beetle response biological evaluation/biological assessment*. Gunnison Ranger District, Grand Mesa, Uncompahgre and Gunnison National Forests. Gunnison Field Office, Bureau of Land Management.

Vitt, D. H. (2000). Peatlands: Ecosystems dominated by bryophytes. (pp. 312-343) In: Shaw, A. J., & Goffinet, B.(Eds.) *Bryophyte biology*. Cambridge, UK: Cambridge University Press.

Walker, B. & Meyers, J. A. (2004). Thresholds in ecological and social–ecological systems: a developing database. *Ecology and Society 9*(2): 3.

Watson R.T. *et al*., (2001). *Climate change 2001: The synthesis report*., Cambridge, MA: Cambridge Univ. Press.

Weatherhead, E. C. & Andersen, S. B. (2006). The search for signs of recovery of the ozone layer. 2006. *Nature*, *441* doi:10.1038/nature04746.

Weinmayor, G., Romeo, E., De Sario, M., Weiland, S. K. & Forastiere, F. (2010). Short-term effects of PM10 and NO2 on respiratory health among children with asthma or asthma-like symptoms: A systematic review and meta-analysis. *Environmental Health Perspectives,118* (4), April 2010.

Weixelman, David. (2014). Personal communication. Range Ecologist, 631 Coyote Street, Nevada City, California, 95959.

Wells, F. H., Laurenroth, W.K., & Bradford, J. B. (2012). Recreational trails as corridors for alien plants in the Rocky Mountains, USA. *Western North American Naturalist 72*(4): 507-533. Retrieved from https://ojs.lib.byu.edu/spc/index.php/wnan/issue/view/2061.

Western Forestry Leadership Coalition (WFLC). (2010). *The true cost of wildfire in the Western U.S.* Report of the WFLC.

Westerling, A.L., Hildalgo, H.G., Cayan, D.R. , & Sweatnam, T.W. (2006). Warming and earlier spring increase Western U.S. forest wildfire activity. *Science,313* 940-943.

White, J. W.C., Alley, R. B., Archer, D. E., el al., (2013). Abrupt impacts of climate change: Anticipating surprises. 223 pp. Washington, DC: National Academy Press. Retrieved from https://nas-sites.org/americasclimatechoices/other-reports-on-climate-change/2013-2/abrupt-impacts-of-climate-change/.

Williams, A. P, Allen, C. D., Macalady, A. K. et al. (2012). Temperature as a potent driver of regional forest drought stress and tree mortality. *Nature Climate Change* 3: 292-297. Retrieved from http://dx.doi.org/10.1038/nclimate1693.

Wilson, B. T., Woodall, C. W., & Griffith, D. M. (2013). *Carbon balance and management – Imputing forest carbon stock estimates from inventory plots to a nationally continuous coverage.* St. Paul, MN: USDA Forest Service, Northern Research Station, Forest Inventory and Analysis, doi:10.1186/1750-0680-8-1

Wilson, W.E. & Moor J.E. (Eds.). (1998). *Glossary of hydrology.* Alexandria, VA: American Geological Institute.

Wohlgemuth, P. M., Hubbert, K. & Arbaugh, M. J. (2006). Fire and physical environment interactions: Soil, water, and air. In: Sugihara, N.G. (Ed). *Fire in California's ecosystems*. (pp. 75-92) Berkeley, California: University of California Press.

Wolk, B. & Rocca, M. E. (2009). Thinning and chipping small-diameter ponderosa pine changes understory plant communities on the Colorado Front Range. *Forest Ecology and Management 257*(1): 85-95. Retrieved from http://dx.doi.org/10.1016/j.foreco.2008.08.014.

Worrall, James J. (2010). Sudden aspen decline and climate change. In: *Predicting behavior of forest diseases as climate changes.* Pp. 45-62. Janice Alexander, Presenter. University of California, Cooperative Extension. Webinar, November 3 and December 2, 2010 http://www.fs.fed.us/wwetac/workshops/PDFs/ForestDisease_ClimateChange_2DecWebinar.pdf.

Worrall, J. J. (2013). *Sudden aspen decline*. Report to spruce beetle epidemic and aspen decline management response interdisciplinary team, Delta, Colorado: Gunnison Service Center, 12 pp. October 31, 2013.

Worrall J. J., Egeland, L., Eager, T., Mask, R. A, Johnson E. W, et al. (2008). Rapid mortality of *Populus tremuloides* in southwestern Colorado, USA. *Forest Ecology and Management* 255(3-4): 686-696. Retrieved from http://dx.doi.org/10.1016/j.foreco.2007.09.071.

Worrall, J. J., Marchetti, S. B., Egeland, L., Mask, R.A., Eager, T., & Howell, B. (2010). Effects and etiology of sudden aspen decline in southwestern Colorado, USA. *Forest Ecology and Management* 260(5): 638-648. http://dx.doi.org/10.1016/j.foreco.2010.05.020.

Worrall, J., Marchetti, S. & Rehfeldt, G. (2014). *Climate change projections for Picea engelmannii: Report for spruce beetle epidemic and aspen decline management response EIS.* Delta, Colorado: USDA Forest Service, Grand Mesa, Uncompahgre, and Gunnison National Forests.

Worrall J. J, Rehfeldt G. E, Hamann, A., Hogg, E. H, Michaelian M, *et al.* (2013). Recent declines of *Populus tremuloides* in North America linked to climate. *Forest Ecology and Management* 299: 35-51. Retrieved from http://dx.doi.org/10.1016/j.foreco.2012.12.033.

Wright, C. S., Balog, C. S. & Kelly, J. W. (2009). *Estimating volume, biomass, and potential emissions of hand-piled fuels* (General Technical Report PNW-GTR-805). Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 23 p. Retrieved from http://www.treesearch.fs.fed.us/pubs/34607

Zouhar, K., Smith, J. K., & Sutherland, S. (2008). In: Zouhar, K., Smith, J. K., Sutherland, S., Brooks, M. L. (Eds.) *Wildland fire in ecosystems: fire and nonnative invasive plants.* (pp. 7-32) (General Technical Report RMRS-GTR-42-vol. 6.) Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.