United States Department of Agriculture

Caribou-Targhee National Forest and Curlew National Grassland

Integrated Weed Management Analysis

Draft Environmental Impact Statement

Forest Service Caribou-Targhee National Forest **December 2020**

Front Cover: Black Canyon comparison in 1993 and 2018, respectively, showing results of the Integrated Weed Management Program in the area.

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Abstract:

The purpose of the Proposed Action is to reduce the negative effects of existing and future invasive plants on the structure and function of native plant communities and on other natural resource values that may be adversely impacted. The proposal is to treat invasive plants on infested areas within the administrative boundaries of the Curlew National Grassland and Caribou-Targhee National Forest including the Jedediah Smith Wilderness and Winegar Hole Wilderness. Proposed control methods include biological control, such as pathogens, insects, and targeted grazing; chemical control using herbicides that target invasive plant species; and manual and mechanical techniques such as cutting and pulling. Activities would be implemented with partners at the federal, state, and local level where opportunities exist. Two alternatives are considered. The No Action alternative describes the Current Management which identifies the use of biological controls; ground-based herbicide treatment; and mechanical/manual treatment

methods and the Proposed Action (which is also the Preferred Alternative), which would utilize biological controls; aerial, aquatic, and ground-based herbicide treatment; and mechanical/manual treatment methods.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this Proposed Action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative or judicial reviews.

Send comments to:

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Comments must be received by: February 8, 2021

SUMMARY

The US Forest Service (USDA Forest Service) has prepared this draft environmental impact statement (EIS), in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations, to document analysis of potential environmental effects associated with implementation of an adaptive-management strategy to control or reduce the presence of nonnative invasive plants within the Caribou-Targhee National Forest (CTNF) and Curlew National Grassland (CNG).

This draft EIS has been prepared in compliance with NEPA guidelines as set by the Council of Environmental Quality in 40 CFR 1500-1508 and USDA Forest Service (FSH) Handbook 1909.15. The document describes the purpose and need for action, the alternatives, including the Proposed Action, the affected environment, and the effects of the alternatives.

Purpose and Need

The overall purpose of the Proposed Action is to reduce the negative effects of existing and future invasive plants on the structure and function of native plant communities and on other natural resource values that may be adversely impacted. The Proposed Action is a response to an underlying need to implement policy and direction provided at the national, regional, state, and National Forest System (NFS) levels, which includes control and containment of invasive plants within the CTNF and CNG (Executive Order 13112—(Executive Order 13751 [2016] amended EO 13112 [1999]— Forest Service Manual 2900- Invasive Species Management [2011]); Invasive Species, National Strategy and Implementation Plan for Invasive Species Management [USDA Forest Service 2004]; replaced by Forest Service National Strategic Framework for Invasive Species Management [USDA Forest Service 2013]; 2016-2018 National Invasive Species Management Plan [NISC 2016]; 2009 Invasive Species Management Strategy [USDA Forest Service 2009]; Idaho Invasive Species Strategic Plan 2012–2016 [IDA 2012]; Idaho's 10 Year Strategic Plan for Managing Noxious and Invasive Weeds 2008–2018 [USDI BLM et al. 2008]; the Utah Strategic Plan for Managing Noxious Weeds and Invasive Plants [UWCA 2004]; CNF Land and Resource Management Plan [USDA Forest Service 2003]; TNF Land and Resource Management Plan [USDA Forest Service 1997]; and Curlew Land and Resource Management Plan [USDA Forest Service 2002]).

The need of the Proposed Action is multifaceted, as described below.

Invasive plants are diminishing natural resource values of NFS lands. National Forest System resources are negatively impacted by existing and expanding invasive plant populations. Invasive plant species are known to out-compete native plant species, which can reduce productivity and biodiversity, cause habitat loss, and result in negative economic impacts.

Aquatic invasive species are gaining a foothold in Idaho and have the potential to cause substantial ecological and economic impacts. Although the presence of aquatic invasive plant species within the CTNF or CNG has been limited, there is a threat that aquatic invasive plants could become established within these NFS lands. Removing invasive plants is critical to preventing them from reaching surrounding waterbodies. Once established, aquatic invasive plant species are extremely difficult to eradicate, and they pose a serious threat to the ecological integrity of aquatic environments.

A timely response to new infestations, new invasive plant species, and landscape-scale disturbances is necessary. Landscape-level tree mortality and insect, disease, and wildfire disturbance have increased and are likely to continue to increase the potential for invasive-plant infestations. The CTNF and CNG require the flexibility to treat expanded and/or newly identified invasive plant infestations in a timely manner. Existing policies for invasive plant management on these NFS lands do not address new invasive plant species, nor do they provide new tools for managing infestations. Updating existing policies would allow the CTNF and CNG to satisfy the need to incorporate Early Detection and Rapid Response (EDRR) into the adaptive, integrated-management strategy.

Existing invasive plant populations within the CTNF and CNG require active and integrated management. Invasive plant infestations already exist throughout the CTNF and CNG and, without management, they will increase in density and distribution. An active and adaptive treatment strategy is necessary to contain invasive plants within existing boundaries, reduce infestation densities, and retard the establishment of new infestations. Control efforts should be focused on infestations that can realize the greatest resource benefits—those with the highest risk of spread, those that have not become broadly established, and those with the best likelihood of control success. New analyses and planning are needed to take advantage of the most current tools and guide their best use.

Federal, state, and USDA Forest Service laws, regulations, policies, and direction relating to invasive plant management must be implemented and followed. Implementing laws and policies regarding invasive plant species requires an aggressive and adaptive-management approach. Criteria to prioritize invasive plant species and treatment areas must be developed and utilized within the CTNF and CNG. This analysis identifies the strategies that the CTNF and CNG would use to implement and comply with laws and policies pertaining to the management of invasive plants.

The Proposed Action

The CTNF and CNG propose to implement an Integrated Weed Management (IWM) plant treatment on currently and susceptible to invasion areas within the boundaries of the CTNF and CNG, including the Jedediah Smith Wilderness and the Winegar Hole Wilderness. Treatment activities would include inventory and assessment designed to support EDRR, control methods, rehabilitation and restoration, and implementation and effectiveness monitoring. Activities would be implemented with partners at federal, state, and local levels where opportunities exist.

To provide for EDRR, the CTNF and CNG would design a plan that allows treatment of invasive-plant infestations located outside of currently identified infested areas. These infestations may include new sites that arise in the future or sites that currently exist but have not yet been identified by NFS inventories. The intent of EDRR is to allow timely control so that new infestations can be treated when they are small, which prevents establishment and spread while reducing treatment costs and potential side effects. Planning for EDRR includes analyzing the risk for new invasions associated with the characteristics of the species and determining areas in the CTNF and CNG where new invasions are likely to occur.

Proposed control methods would be based on integrated pest-management principles and methods known to be effective for each target species. These methods include, but are not limited to, (1) biological control, such as the release of host-specific natural enemies or targeted

grazing; (2) chemical control using EPA registered herbicides that target invasive plant species; and (3) mechanical techniques, such as cutting and pulling. The EIS describes commonly used, species-specific, integrated-control measures that would be applied to known invasive plant species in the CTNF and CNG. Control methods would be employed alone or in combination to achieve the most effective control. Treatment methods would be based on the extent, location, type, and character of an infestation and would be implemented using design criteria.

Management priority would be based on risk factors such as the number and size of known infestations; vectors for spread; proximity to susceptible habitat; threat to important resources (e.g., wilderness, endangered species habitat); and ability to out-compete desirable plant species. The priority of species to be treated would vary based on these factors and could change over time. These priorities would be used to guide selection of specific management activities for each infestation.

Rehabilitation and restoration actions would be designed and implemented based on the conditions found in and around infested areas. Passive vegetation (allowing plants on site to fill in treated areas) and active revegetation would be considered. Rehabilitation techniques would be assessed and implemented to promote native plant communities that are resistant to infestation by invasive plants.

Monitoring is proposed and necessary for implementing an adaptive-management strategy. Information collected from monitoring may be used by managers to evaluate the efficacy of EDRR, treatment, and rehabilitation and restoration actions, and subsequently used to adapt and update management actions. Two basic types of monitoring would occur: implementation monitoring and effectiveness monitoring. Implementation monitoring answers the question, “Did we do what we said we would do?” Effectiveness monitoring answers the questions, “Were prevention, treatment, and restoration actions effective?” and “Were intended goals accomplished?”

See Chapter 2 for a detailed description of alternatives.

Decisions to be Made

The Responsible Official is the CTNF supervisor, who will make the following decisions based on the results of the interdisciplinary analysis:

- Whether to select the Proposed Action or No Action/Current Management alternative.
- What modifications, if any, to the selected alternative are needed.
- Which project design criteria are needed.

Public Involvement

The Notice of Intent (NOI) was published in the Federal Register on November 6, 2019. The NOI requested public comment on the proposal. As part of the public-involvement process, a detailed description of the Proposed Action was sent to an extensive mailing list via e-mail on November 5, 2019.

Personnel from the CTNF and CNG met with representatives of the Shoshone-Bannock Tribe at Fort Hall, Idaho, to discuss the Proposed Action, which has been published in the Caribou-Targhee National Schedule of Proposed Actions as "ongoing" since December 2019.

Key Issues

Seven organizations and individuals provided comments during scoping. These comments were analyzed, and public issues were identified. Many important public issues were addressed in the design of the Proposed Action, but these did not require new or separate alternatives. An example is human health, which is discussed throughout this document because it is of such great importance to the public, but is not a basis for alternative comparison because both of the alternatives developed for this project address this issue in the same ways. Both alternatives were designed to avoid exposing workers and the public to herbicides.

The USDA Forest Service separated the key issues into two groups: significant and non-significant. Significant issues were defined as those directly or indirectly caused by implementing the Proposed Action. Non-significant issues were identified as those that (1) fall outside the scope of the Proposed Action; (2) are already decided by law, regulation, Forest Plan, or other, higher-level decision; (3) are irrelevant to the decision to be made; or (4) are conjectural and not supported by scientific or factual evidence. Non-significant issues, identified in the project record, were eliminated from detailed study. Significant issues, as determined by the USDA Forest Service, are discussed below.

Issue 1. Wildlife

Herbicide exposure resulting from invasive plant treatment may harm terrestrial wildlife species. The effects of invasive plant treatment on the following species will be analyzed: (1) wildlife species listed as threatened, endangered, or candidate under the Endangered Species Act; (2) Forest Service Region 4 sensitive wildlife species; (3) migratory birds and their habitat; and Ungulate big game species.

Measurement indicators:

- Herbicide toxicity potential of herbicides being used.
- Direct and indirect effects of invasive plant species treatment activities (disturbance).

Issue 2. Fisheries

The use of herbicides to control invasive species in riparian areas can adversely impact water quality and aquatic species. Herbicides could negatively affect water quality, fish, aquatic plants, and aquatic insects.

Measurement indicators:

- Effects of herbicide to be used within riparian areas on aquatic organisms.
- Adequacy of design criteria that apply to water quality and aquatic organisms.

Issue 3. Water Resources

Controlling invasive species can potentially improve riparian health and function by restoring natural vegetation composition, which can improve ground cover and reduce erosion, thereby protecting water quality and stream health. The use of herbicides can also adversely impact the quality of surface and ground water through direct contact or runoff and leaching through the soil.

Measurement indicators:

- Riparian health and function—estimate changes in invasive plant-infested areas within riparian areas as a measure of riparian and stream health and function.
- Surface and ground water quality—evaluate the potential impact of herbicide concentrations on the quality of surface and ground water.

Issue 4. Vegetation

Herbicide exposure resulting from herbicide drift, residue, or direct application may cause harm to non-target plants and their pollinators. The effect of the invasive plant treatments on the following species will be analyzed: Ute ladies'-tresses (a threatened species), sensitive plant species, and non-target native plants. Potential impacts on native vegetation, biological diversity, production and structure if invasive plants are not treated through an integrated pest management strategy.

Measurement indicators:

- Potential impact of herbicides to non-target resources and their pollinators.
- Potential for spread or reduction of invasive plant infestations measured in acres.

Issue 5. Human Health

Herbicide exposure, resulting from herbicide drift, residue, or direct application, may affect human health because of herbicide toxicity.

Measurement indicators:

- Toxicity potential of herbicide being used to worker.
- Toxicity potential of herbicides being used to public.

Issue 6. Wilderness

The project area includes the Jedediah Smith Wilderness and the Winegar Hole Wilderness. The Wilderness Act, Section 2(c) defines wilderness as "an area where the earth and its community of life are untrammeled by man … protected and managed so as to preserve its natural conditions". Furthermore, Section 4(b) of the Act mandates "…each agency administering wilderness ... shall be responsible for preserving the wilderness character of the area". While treating nonnative species may affect the natural quality of wilderness character by maintaining a naturally functioning ecosystem, the intentional control or manipulation of the components, processes or ecological systems (e.g., treatment of plant species) may also affect the untrammeled quality of wilderness character.

Measurement indicators:

- Natural Quality Measure—acres of nonnative species

Description of Alternatives

Alternative 1—No Action/Current Management

The No Action/Current Management Alternative includes the following array of standard invasive plant management practices currently used within the CTNF and CNG:

- Biological control through the use of predators, parasites, and pathogens
- Herbicide control using ground-based, spot- and broadcast-application methods
- Mechanical and manual methods such as hand-pulling, mowing, cutting, and torching

Twelve herbicide formulations are currently in use within the CTNF and CNG, and the range of application rates for each chemical has been derived from Human Health and Ecological Risk Assessments and the respective herbicide label.

Acreage of invasive plants treated each year can vary considerably based on funding allocation and response to events such as wildfires (Table S-1). Neither the CTNF nor CNG have approval for aerial application of herbicides or treatment of aquatic invasive plant species.

Table S-1. Acres treated annually by treatment method. Based on 3-year average for treatment years 2015–2018.

TREATMENT METHOD	ACRES
Mechanical control	60
Biological control	32
Herbicide control	5,334
Target grazing	1,700

The No Action/Current Management Alternative includes an array of standard, invasive-plant management practices: information and education programs, cooperative partnerships and coordination, inventory and early detection, control methods, implementation of a broad range of best management practices (BMPs) and design criteria, restoration and revegetation where appropriate, and monitoring to track treatment effectiveness, as detailed in the Alternative 1 description in Chapter 2 of this EIS.

Alternative 2—Proposed Action

The Proposed Action is to treat noxious and invasive plants, prevent the spread of existing invasive plants, and eradicate existing populations where possible to maintain native plant communities. The Proposed Action would implement an IWM strategy within the CTNF and CNG to eradicate or control existing and newly discovered invasive plants over the next 10 to 15 years as budgets allow; the Proposed Action would also allow for an additional treatment emphasis on burned areas at high risk of infestation following wildfire.

The proposed adaptive, IWM program would use a variety of tools, alone or in combination, to treat invasive plants within the CTNF and CNG. The following treatment methods are proposed:

- Biological control through the use of host-specific predators, parasites, and pathogens and through targeted grazing.
- Herbicide control using ground-based spot and broadcast application methods.
- Herbicide control using aerial application methods (excluding designated Wilderness).
- Herbicide control using aquatic application methods.
- Manual and mechanical methods such as hand-pulling, mowing, cutting, or torching.
- Rehabilitation and restoration methods such as site preparation and seeding.

Treatments would abide by an extensive list of design criteria, as detailed in the Alternative 2 description in Chapter 2 of this draft EIS, the purpose of which is to reduce or eliminate the potential adverse impacts of the various invasive plant treatments. Implementing the design criteria is mandatory to ensure treatments are conducted according to environmental standards and effects are within the scope of those predicted in this EIS.

The following is a summary of the key components of the Proposed Action. A detailed description of the Proposed Action can be found in Chapter 2 of this EIS.

Integrated Invasive Species Management

The Proposed Action contains an integrated-management strategy to deal with constantly changing invasive plant infestations. An adaptive-management strategy provides the means to describe and evaluate the consequences of changing or new invasive plant infestations and new treatment options. The adaptive-management strategy consists of the following three principle components: (1) early detection, control, and management; (2) restoration and rehabilitation; and (3) monitoring. Provided that the results of treating new infestations and the impacts of new treatment methods remain within the effects described in this draft EIS, the results of this analysis would remain valid.

Early Detection and Rapid Response (EDRR)

Early Detection and Rapid Response allows for discovering and treating invasive plant infestations located outside of currently identified infested areas, including new sites of invasive plants known to exist within the CTNF or CNG, invasive plant species not yet known to exist within the CTNF or CNG, or existing invasive plant infestations that have not yet been identified during Forest inventories. The intent of EDRR is to allow timely control so that new infestations can be identified and treated when they are small, preventing establishment and spread while reducing the costs, potential treatment side effects, and impacts from the invasive plant. Early Detection and Rapid Response is based on the premise that the impacts of similar treatment methods are predictable, even though the exact location or timing of the treatment may be unpredictable.

Treatment priorities would be based on factors such as the current abundance and distribution of the invasive plant species, type and values of the site affected, and risk for spread of the plants into other areas. Other program management considerations may affect priorities. For example, priority may be given to areas where ground-disturbing management activities are proposed. In

addition, opportunities for special funding or cooperative projects with other landowners, agencies, and organizations may be considered. Treatment priorities do not necessarily refer to the order in which an infestation is treated during a given fiscal year. They are part of an adaptive, IWM strategy used by managers in determining how to allocate resources.

The CTNF and CNG criteria for determining treatment priority of invasive plant infestations are assigned at the ranger district level. Higher priority is generally given to those new invasive plant infestations where reduction or eradication of infestations is likely to be successful. For established infestations, suppression strategies play a much more important role. In general, the vast majority of currently inventoried infested acres are associated with human-caused disturbance such as travel routes. Because they are common to infestations at all potential priority levels, spread vectors such as trailheads, roadways, campgrounds, and parking areas are not explicitly considered when setting priorities.

Control and Management

Biological Control Treatments

Biological control is the use of plant predators, parasites, or pathogens to weaken and reduce the ability of an invasive plant species to compete and/or reproduce. Classical biological control, hereafter biocontrol, is the intentional introduction of an exotic, usually co-evolved, natural enemy, called a biocontrol agent, for permanent establishment and long-term control. Biocontrol agents typically include host- specific insects, mites, nematodes, and pathogens of a targeted plant species and the introduction and interstate transport of biocontrol agents is regulated by United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ).

Biocontrol agents would be used in conjunction with other management actions when the target species occupies extensive portions of the landscape and other methods of control are prohibitive based on cost and location. Biocontrol is the preferred method for remote areas where access is limited, for extensive populations where other control methods may not be appropriate, for species for which biocontrol agents are available and have been shown effective, and in conjunction with other control methods to reduce density of the target species. The objective of biocontrol is not to eradicate the target species but to reduce target plant densities to tolerable levels, allowing desired plants to compete for space, water, and nutrients.

Areas with invasive plants would continue to be inventoried and monitored to determine biocontrol agent establishment and when the released biocontrol agents distribute with the target species as its range expands. Several repeat visits may be needed during a season and over a series of years to determine if additional releases are needed or if a different or additional biocontrol agents need to be released at a site.

Control may require 5–10 years for biocontrol agent establishment and subsequent effects to targeted invasive plants. As biocontrol agent impacts reduce target weed density and vigor, simultaneous increases of native or desirable vegetation may increase and eliminate the need for additional restoration inputs; however, in some instances, additional inputs may be required to reach desired vegetation conditions.

Targeted grazing is also a form of biological control and is another tool for constructing desirable ecosystems. Targeted grazing is the application of livestock grazing at a specified

season, duration, and intensity to accomplish specific vegetation management goals. The term "targeted" refers to the specific plant or landscape that is the aim of controlled grazing practices (Launchbaugh et al. 2006).

Herbicide Application

This invasive plant management method involves the use of Environmental Protection Agency (EPA) registered herbicides and associated adjuvants. Ground-based or aerial application of herbicides would be used based on (1) treatment objective and priority of the target invasive plant species; (2) accessibility, topography, and the size of treatment area, (3) the expected efficiency and effectiveness of the method selected; (4) the risk for spread or invasion into other locations, and (5) the potential to harm priority habitats and vegetation complexes such as those associated with threatened, endangered, or sensitive species.

In all, five types of herbicide application would be used: spot spraying, hand selective, broadcast, aquatic application, and aerial application.

Fourteen herbicide formulations are proposed for use under the Proposed Action. The range of application rates for each chemical is derived from Human Health and Ecological Risk Assessments and from the herbicide label. Additional herbicides may be added in the future, at either the forest plan or project level, through appropriate risk analysis, NEPA procedures, and Endangered Species Act consultation (Forest Service Handbook 2109.14 [2016]).

Mechanical and Manual Control

Mechanical and manual treatments are typically used to remove seed heads and individual plants. These techniques may be used in sensitive areas to avoid impacts to non-target plant species or water quality, and also to prevent seed production. Mechanical and manual approaches are slow and very labor intensive; they are effective only for small infestations.

The term "manual control" refers to treatments such as hand-pulling or using hand tools (e.g., hand clippers, hoes, rakes, shovels) to remove plants or seed heads. Manual treatments can be effective for annual invasive plant species and some tap-rooted invasive plant species, but are ineffective against perennial invasive plants with deep, underground stems or roots or those with fine rhizomes that can be easily broken and dispersed to re-sprout. This method might need to be repeated several times throughout the growing season, depending on the plant species, and may require digging below the soil surface to remove primary root systems.

The term "mechanical control" refers to the use of equipment and power tools, including mowers, propane-fueled torches, and power weed trimmers. Choosing the appropriate equipment is based on characteristics of the target invasive plant species (e.g., stem size and sprouting ability); density of the infestation; size of the infestation; location and condition of the infestation; and soil and topographic considerations. Mechanized treatments are typically used to remove flowering stems as a way to prevent seed production or to reduce or remove aboveground biomass.

Rehabilitation and Restoration

Severely damaged treatment sites, or sites where few desirable plant species remain, may not be able to recover without intervention. Rehabilitation and restoration are vital components of a treatment program. Rehabilitation in this case is defined as short-term mitigation to ensure

minimum site stability and functionality. Rehabilitation may include site preparation and seeding of desirable vegetation in areas where passive restoration is not likely to be successful.

Monitoring

Monitoring is the process of observing invasive plant populations and documenting the progress or quality of invasive plant treatments over a period of time; it is an integral part of any adaptive, IWM program. Monitoring enables EDRR and effective treatment, informing future decision-making and strategy. Both quantitative and qualitative monitoring efforts are included in the overall monitoring program. Post-treatment reviews of monitoring data would occur on a sample basis to determine the following: (1) whether treatments were effective, (2) the type and extent of damage that may have occurred to non-target plant species, (3) whether design criteria were applied correctly, and (4) if recovery occurred as expected.

Re-treatment and active rehabilitation or restoration prescriptions would be developed as needed and based on post-treatment monitoring data. Treatment methods may be modified based on an assessment of monitoring data collected after the invasive treatment. For example, an invasive plant population first treated with a broadcast herbicide may later be hand-pulled or re-treated once the size of the infestation and density of the seed bank were reduced.

Comparison of Alternatives

Comparison of Treatment Methods and Acres between Alternatives

Table S-2 shows the difference between treatment methods and acres treated between alternatives. Measurement indicators specific to different resources are discussed in Chapter 3 of this EIS.

Comparison of Issues by Alternative

Tables S-2–S-6 compare the alternatives by their effects to the key issues identified above.

Table S-2. Comparison of alternatives by wildlife issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Toxicity Potential of Herbicides	No change would occur from current invasive plant management effects.	**Minimal to no adverse effects** are expected from direct exposure to, or primary or secondary ingestion of, herbicide- treated vegetation or prey animals that have been exposed to herbicides. Design criteria would further minimize potential for effects from herbicide exposure to wildlife species.
Direct and indirect effects of invasive plant species treatment activities (disturbance)	No change would occur from current invasive plant management effects.	**Minimal to no adverse effects** are expected from temporary and localized disturbance caused by invasive plant-treatment activities. Design criteria would further minimize potential for effects from herbicides and disturbance to wildlife species.

Table S-3. Comparison of alternatives by fisheries and water resource and issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Effects of herbicide to be used within riparian areas on aquatic organisms	No direct or indirect effects as no aquatic herbicide applications are anticipated.	No direct effects. Indirect effects possible through accidental spills but not likely.
Adequacy of design criteria that apply to water quality and aquatic organisms	No direct effects as no aquatic applications are anticipated. Indirect effects possible through increased sedimentation, loss of riparian vegetation, or decreased water quality with increase in aquatic invasive species.	All herbicides application rates used would be below the level of concern for fish. Project design criteria would limit negative effects to aquatic organisms.
Riparian Health and Function	Minimal direct effect/indirect gradual long- term decline in riparian function. Short-term localized disturbance to existing riparian vegetation would occur as a result of mechanical methods and rehabiltiation/restoration methods that take place within riparian areas.	Minimal direct effect/indirect gradual long-term improvement in riparian function. Short-term localized disturbance to existing riparian vegetation would occur as a result of treatment and rehabiltiation/restoration methods that take place within riparian areas. Monitoring and integrated weed management would ensure overall improvement in stream health and function over time.
Surface and ground water quality	Herbicide applications have the potential to directly affect concentrations of herbicide in surface water and ground water. There would be no direct effect to surface or ground water quality as no aquatic herbicide applications would be anticipated. Indirect effects could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover. Design criteria would limit these effects.	Herbicide applications have the potential to directly affect concentrations of herbicide in surface water and ground water. The effects could be more under alternative 2 with the ability to implement aquatic applications but would be mitigated by strictly adhering to label directions. Indirect effects could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover. Design criteria would limit these effects.

Table S-4. Comparison of alternatives by treatment method effect on vegetation.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Potential impact of herbicides to non-target resources and their pollinators.	Native vegetation and special-status plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed. Potential impacts to non-target species would be limited due to methods of control.	Invasive plant treatements would have relatively short-lived detrimental effects and long-term beneficial effects. Detrimental effects would be minimized through implementation of design criteria. Integrated invasive plant management approach would allow for more effective weed management. Native vegetation and special-status plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed. However,

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
		adverse effects to populations would be negligible. Design criteria require surveys to determine if special status species are present. If special status species are present, the treatment would be modified to minimize impacts. Potential impacts to non-target species would be limited due to methods of control. Non-selective herbicides would not be used with aerial applications. There would be an increased short-term risk due to aerial spraying, but a long term benfecial effect due to increased weed control.
Potential for spread or reduction of invasive plant infestations measured in acres.	Alternative 1 would result in invasive weed treatment similar to what has been done in the past. The acres of weed treatment has varied from year to year depending on the severity and emphasis on weed management and available budgets. This scenario as described in this document would be expected to continue in the future under Alternative 1.	Under Alternative 2, the potential for the spread of invasive plants would be less than under Alternative 1 due to increased flexibility to respond to invasive plants and a more comprehensive approach to prevention and treatment of invasive species. With a new emphasis on EDRR and IWM, it is reasonable to predict that over time, the number of acres affected by invasive species would be fewer than Alternative 1, though it is not possible to accurately quantify the difference in terms of acres due to the number of natural and management variables that affect the spread of invasive species and the level of effort directed at treating their occurrence in the project areas.

Table S-5. Comparison of alternatives by human health issues.

MEASUREMENT INDICATOR	ALTERNATIVES 1 AND 2 WORKER HEALTH	ALTERNATIVES 1 AND 2 PUBLIC HEALTH
Toxicity Potential of Herbicides being Used	2,4-D amine, Chlorsulfuron, Picloram, Sulfometuron methyl, and Triclopyr TEA with scenarios exceeding the hazard quotient (HQ) level of concern (LOC) for workers at some rate of application, four (Chlorsulfuron, Dicamba, Sulfometuron methyl, and Triclopyr TEA) did not exceed any level of concern at typical application rates. 2,4-D amine exceeded the chronic exposure level of concern at typical application rates. EPA requires LOC to be mitigated with Personal Protective Equipment identified on the label. **Design criteria would minimize all worker exposure** scenarios by following safe work practices and label advisories.	2,4-D amine, Chlorsulfuron, Clopyralid Dicamba, Glyphosate, Sulfometuron methyl, and Triclopyr TEA exhibited scenarios exceeding the HQ LOC at some rate of application. **Design criteria would minimize public exposure** by increasing notification of the public efforts regarding areas where herbicide applications are planned reducing risk that the general public would be exposed to harmful levels of any herbicides used in the implementation of this project.

Adequacy of Design Criteria to Protect Human Health	**Design criteria would minimize all worker exposure** scenarios by following safe work practices and label advisories. The **general public would not be exposed** to harmful levels of any herbicides used in the implementation of this project. Design criteria and enhanced public notification protocols significantly reduce the opportunity for members of the public to be exposed to harmful levels of toxic compounds (herbicides, adjuvants, petroleum products, etc.) used in the implementation of this project. Few plausible scenarios exist that exceed even the most conservative threshold of concern for public health and safety.

Table S-6. Comparison of alternatives by wilderness issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Natural Quality Measure: Acres of nonnative species	Alternative 1 would **negatively affect** the untrammeled and solitude qualities of wilderness character by manipulating vegetation and creating encounters with the public during treatment activities. Treatment activities would be limited in scope and would be of limited duration in any given year. Alternative 1 would beneficially affect the natural and other features of value qualities of wilderness character by reducing nonnative plant infestations, thus preserving high quality habitat. Both direct and indirect adverse effects from Alternative 1 would be short-term and minimal on the qualities of wilderness character. Overall long-term effects to qualities of wilderness character would be positive, although controlling invasive plants on a broad landscape scale would not be addressed.	Alternative 2 would **negatively affect** the untrammeled and solitude qualities of wilderness character by manipulating vegetation and creating encounters with the public during treatment activities. However, activities would be limited in scope and would be of limited duration in any given year. Alternative 2 would beneficially affect the natural and other features of value qualities of wilderness character by reducing nonnative plant infestations, thus preserving high quality habitat. The variety of treatment methods available in Alternative 2, including aerial application (outside designated wilderness areas), would allow some measure of control for existing invasive plant populations in terms of density and potential spread to wilderness areas thus preventing new invasive infestations if identified early enough (EDRR). Alternative 2 would best preserve wilderness characteristics of the resource because of the variety of treatment methods available, including aquatic and aerial application (outside designated wilderness areas), which allows for more effective control.

Preferred Alternative

The agency's preferred alternative is Alternative 2, the Proposed Action.

Based upon the effects of the alternatives, the responsible official will decide which alternative to choose.

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1 PURPOSE OF AND NEED FOR ACTION

1.1 Introduction

The US Forest Service (USDA Forest Service) has prepared this environmental impact statement (EIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. This EIS discloses the direct, indirect, and cumulative environmental impacts that would result from the Proposed Action and alternatives. The following summaries explain the structure of content of the EIS.

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

Chapter 2, Alternatives, including the Proposed Action provides a more detailed description of the USDA Forest Service's Proposed Action as well as alternative methods for achieving the stated purpose and need and proposed design criteria. The alternatives were developed based on significant issues raised by the public and other agencies. Finally, this chapter provides a summary table of the environmental consequences associated with each alternative.

Chapter 3, Affected Environment and Environmental Consequences describes the direct and indirect effects, commitment of resources, and cumulative effects associated with the alternatives.

Chapter 4, Consultation and Coordination provides a list of preparers and agencies consulted during the development of the draft EIS.

The ***Appendices*** provide more detailed information to support the analyses presented in the draft EIS. The following appendices are included:

- Appendix A: Maps
- Appendix B: Treatment Options by Target Species
- Appendix C: Forest-wide Integrated Weed Management Prevention Plan
- Appendix D: Aquatic Invasive Plant Control Framework Strategy
- Appendix E: Species Treatment Monitoring Plan
- Appendix F: Compliance with Forest Plan and Other Relevant Direction for the Caribou-Targhee National Forest and Curlew National Grassland Integrated Weed Management Analysis
- Appendix G: Common Injuries to Non-target Species by Herbicide Active Ingredients
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- Appendix I: Aerial Spray Guidelines and Drift Model Results
- Appendix J: Adjuvants Treatment

- Appendix K: Caribou-Targhee National Forest and Curlew National Grassland Personnel Safety and Emergency Spill Response Plan for the use of Herbicides in the Control of Invasive Plants
- Appendix L: Glossary

Additional documentation, including more detailed analyses of project-area resources, may be found in the project planning record located at the Caribou-Targhee National Forest Headquarter Office in Idaho Falls, Idaho.

1.2 Background

This draft EIS has been prepared to disclose the environmental effects of a proposal to implement an adaptive-management strategy, which includes early detection, control and management, restoration and rehabilitation elements, and monitoring to control or reduce the presence of nonnative invasive plants within the Caribou-Targhee National Forest (CTNF) and the Curlew National Grassland (CNG). The effects of the No-Action Alternative are also disclosed. The strategy proposed would be applied on lands administered by the CTNF and CNG, including lands within the Jedediah Smith Wilderness (which comprises 123,451 acres) and the Winegar Hole Wilderness (which comprises 10,721 acres).

The CTNF encompasses 2.9 million acres in Eastern Idaho within Bannock, Bear Lake, Bonneville, Butte, Caribou, Clark, Franklin, Fremont, Lemhi, Madison, Oneida, Power, Teton counties in Idaho; Lincoln and Teton counties in Wyoming; and Cache and Rich counties in Utah. The CTNF comprises the following seven ranger districts: Dubois, Ashton Island Park, Palisades, Teton, Soda Springs, Montpelier, and Westside (Figure 1-1). The CTNF and CNG share boundaries with the following National Forest s: Beaverhead Deer Lodge, Bridger-Teton, Salmon-Challis, and Uinta-Wasatch-Cache. The CTNF and CNG also share boundaries with privately owned lands and lands administered by the US Bureau of Land Management (BLM), State of Idaho, and State of Utah. For invasive plant management purposes, the CTNF and CNG have been divided into the following six cooperative weed-management areas (CWMAs): Continental Divide, Henrys Fork, Highlands, Jackson Hole, Upper Snake, and Utah-Idaho (Figure 1-1). The CWMAs help determine treatment objectives and priorities on each ranger district.

Invasive plants, which include invasive grasses such as cheatgrass or bulbous bluegrass are defined as “a nonnative plant whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order [EO] 13112). Invasive plants have been identified as a major threat to the biological diversity and ecological integrity within and outside the CTNF and CNG. Invasive plants cause numerous adverse environmental effects, including displacing native plants; reducing the functionality of habitat and forage for wildlife and livestock; threatening populations of threatened, endangered, and sensitive (TES) species; altering physical and biological properties of soil, including soil productivity; changing the intensity and frequency of fires; and affecting wilderness character.

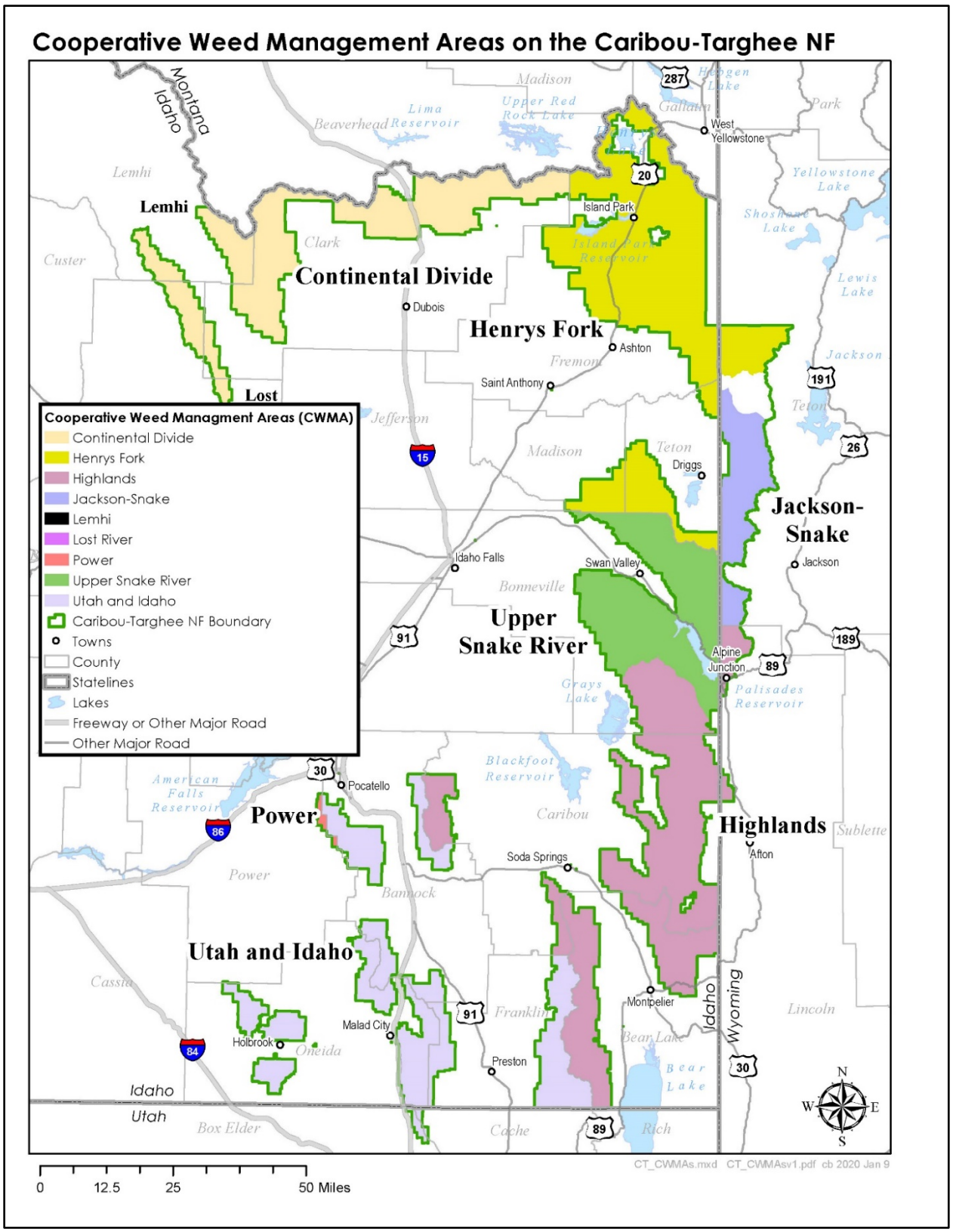

Figure 1-1. Cooperative Weed Management Areas within the Caribou-Targhee National Forest (CTNF) and Curlew National Grassland (CNG).

Noxious weeds belong to a subset of the broader category of invasive plants. According to the Plant Protection Act of 2000 (PL 106–224), the term "noxious weed" refers to any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment. The term typically describes plant species that have been determined to be undesirable or injurious in some capacity. Federal noxious weeds are regulated by the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), under the Plant Protection Act of 2000 (USDA Forest Service 2011). In the State of Idaho, noxious weeds are designated by the director of the Department of Agriculture (ID Code § 22-2402). In the State of Utah, a noxious weed is any plant the commissioner determines to be especially injurious to public health, crops, livestock, land or other property (Utah Code 4-17-2). Within the state of Wyoming, designated noxious weeds refers to the weeds, seeds, or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within this state, and are on the designated list (Wyoming Weed and Pest Control Act of 1973).

Nonnative invasive plant infestations have a high potential for expanding on lands within and adjacent to the CTNF and CNG, and thereby degrading desired plant communities and the values provided by those communities. National Forest System (NFS) lands are also threatened by "potential invaders"—invasive plants that have not been found within the CTNF and CNG but are known to occur in adjacent lands, counties, or states.

Infestations of nonnative plants and noxious weeds can be prevented, eliminated, or controlled using specific management practices. A clear and comprehensive integrated invasive plant management strategy would allow for implementing timely and effective invasive plant management for projects and programs on NFS lands. In the absence of an aggressive invasive-plant management program, the number, density, and distribution of invasive plants within the CTNF and CNG would continue to increase.

The proposal discussed in this draft EIS includes treating invasive plants annually with an effective combination of treatments, including biological, manual and mechanical, chemical (herbicide), and restoration methods (competitive seeding and planting).

1.2.1. Targeted Invasive Species

Approximately 98,842 acres within the CTNF and CNG (Table 1-1) have been identified as infested with nonnative invasive plant species. Within or adjacent to the CTNF and CNG, 36 state- and county-listed noxious weed species are known to occur. Acres of infestations are provided in Tables 1-1 and 1-2, and known infestations of noxious weeds by district are displayed in maps included in Appendix A. Some species occur across NFS lands, while others are localized (Table 1-1 and Table 1-2).

Table 1-1. Inventoried nonnative invasive plant species infestations.

INVASIVE PLANT SCIENTIFIC NAME	INVASIVE PLANT COMMON NAME	PLANT CODE	NUMBER OF INFESTATIONS	TOTAL INFESTED ACRES
Acroptilon repens	hardheads	ACRE3	13	2
Arctium minus	lesser burdock	ARMI2	82	11
Berteroa incana	hoary alyssum	BEIN2	2	1
Carduus acanthoides	spiny plumeless thistle	CAAC	18	9
Cardaria draba	whitetop	CADR	40	30
Carduus nutans	Nodding plumeless thistle	CANU4	1,783	13,975
Centaurea diffusa	diffuse knapweed	CEDI3	5	34
Centaurea stoebe	spotted knapweed	CEST8	2,136	6,991
Chrysanthemum leucanthemum	oxeye daisy	CHLE80	35	4
Cirsium arvense	Canada thistle	CIAR4	1,906	15,004
Cirsium vulgare	bull thistle	CIVU	66	7
Convolvulus arvensis	field bindweed	COAR4	74	249
Conium maculatum	poison hemlock	COMA2	25	66
Cynoglossum officinale	gypsyflower	CYOF	462	6,150
Elaeagnus angustifolia	Russian olive	ELAN	1	94
Euphorbia esula	leafy spurge	EUES	10,745	31,672
Hieracium [a]	hawkweed	HIERA	6	1
Hyoscyamus niger	black henbane	HYNI	175	821
Hypericum perforatum	common St. Johnswort	HYPE	270	939
Isatis tinctoria	Dyer's woad	ISTI	385	13,592
Lepidium latifolium	broadleaved pepperweed	LELA2	2	0
Linaria dalmatica ssp. *dalmatica*	Dalmatian toadflax	LIDAD	24	294
Linaria	toadflax	LINAR	1	0
Linaria vulgaris	butter and eggs	LIVU2	3,489	6,434
Onopordum acanthium	Scotch cotton thistle	ONAC	75	353
Senecio jacobaea	stinking willie	SEJA	2	0
Sonchus arvensis	field sowthistle	SOAR2	1	0
Solanum rostratum	buffalobur nightshade	SORO	1	0
Tamarix ramosissima	saltcedar	TARA	1	2,088
Tanacetum vulgare	common tansy	TAVU	25	4
Verbascum thapsus	common mullein	VETH	148	16
Xanthium	cocklebur	XANTH2	2	0
TOTALS			**22,000**	**98,842**

[a] See Table 3-24 for species.

The total acreage of inventoried infestations shown in Table 1-1 and 1-2 is an over-estimate. The USDA Forest Service Natural Resource Information System (NRIS) database protocols require that a site-identified, invasive-plant infestation may consist of only one species. When more than one invasive-plant species occupies a site (e.g., spotted knapweed and hoary alyssum), two infestations are recorded in the NRIS database, one for each species of invasive plant present, which results in double-counting infested acreage.

Table 1-2. Inventoried nonnative invasive plant species infestations by ranger districts.

RANGER DISTRICT	TOTAL INFESTED ACRES
Ashton/Island Park Ranger District	37,169
Dubois Ranger District	1,918
Montpelier Ranger District	24,624
Palisades Ranger District	13,626
Soda Springs Ranger District	11,860
Teton Basin Ranger District	850
Westside Ranger District	8,795

Treatment would not be limited to species known to infest the CTNF and CNG. If new invasive plant species were discovered, they would be treated with one or more of the methods described in this document. Species that do not currently occur within the CTNF and CNG but are on the Early Detection Rapid Response (EDRR) watch list, are identified in Chapter 3.

Thousands of acres of non-native, invasive plants (e.g., cheatgrass and bulbous bluegrass), which are not identified by the states as being noxious, are known to occur within the CTNF and CNG. While treatment activities within the scope of this program would be prioritized for noxious weed species, sites may be treated for other invasive plant species, especially if they are associated with noxious weeds. Cheatgrass risk models were used to disclose potential treatments (Appendix A).

1.3 Purpose and Need for Action

The overall purpose of the Proposed Action is to reduce the negative effects of existing and future invasive plants on the structure and function of native-plant communities and on other natural-resource values that may be adversely impacted. The Proposed Action is a response to an underlying need to implement policy and direction provided at the national, regional, state, and NFS levels, which includes control and containment of invasive plants within the CTNF and CNG (Executive Order 13112—(Executive Order 13751 [2016] amended EO 13112 [1999]—Forest Service Manual 2900- Invasive Species Management [2011]); Invasive Species, National Strategy and Implementation Plan for Invasive Species Management [USDA Forest Service 2004]; replaced by Forest Service National Strategic Framework for Invasive Species Management [USDA Forest Service 2013]; 2016-2018 National Invasive Species Management Plan [NISC 2016]; 2009 Invasive Species Management Strategy [USDA Forest Service 2009]; Idaho Invasive Species Strategic Plan 2012–2016 [IDA 2012]; Idaho's 10-Year Strategic Plan for Managing Noxious and Invasive Weeds 2008–2018 [USDI BLM et al. 2008]; the Utah Strategic Plan for Managing Noxious Weeds and Invasive Plants [UWCA 2004]; CNF Land and Resource Management Plan [USDA Forest Service 2003]; TNF Land and Resource Management Plan [USDA Forest Service 1997]; and Curlew Land and Resource Management Plan [USDA Forest Service 2002).

The need of the Proposed Action is multifaceted, as described below.

Invasive plants are diminishing natural resource values of NFS lands. National Forest System resources are negatively impacted by existing and expanding invasive plant species populations. Invasive plant species are known to out-compete native plants, which can reduce productivity and biodiversity, cause habitat loss, and result in negative economic impacts.

Aquatic invasive plant species are gaining a foothold in Idaho and have the potential to cause substantial ecological and economic impacts. Although the presence of aquatic invasive plant species within the CTNF and CNG is limited, there is a threat that aquatic invasive plants could become established. Removing invasive plants is critical to preventing them from reaching surrounding waterbodies. Once established, aquatic invasive plant species are extremely difficult to eradicate, and they pose a serious threat to the ecological integrity of aquatic environments.

A timely response to new infestations, new invasive plant species, and landscape-scale disturbances is necessary. Landscape-level tree mortality and insect, disease, and wildfire disturbance have increased and are likely to continue to increase the potential for invasive-plant infestations. The CTNF and CNG require the flexibility to treat expanded and/or newly identified invasive plant infestations in a timely manner. Existing policies for invasive plant management on these NFS lands do not address new invasive plant species, nor do they provide new tools for managing infestations. Updating existing policies would allow the CTNF and CNG to satisfy the need to incorporate EDRR into the adaptive, integrated-management strategy.

Existing invasive-plant populations within the CTNF and CNG require active and integrated management. Invasive plant infestations already exist throughout the CTNF and CNG and without management, they will increase in density and distribution. An active and adaptive treatment strategy is necessary to contain invasive plants within existing boundaries, reduce infestation densities, and retard the establishment of new infestations. Control efforts should be focused on infestations that can realize the greatest resource benefits—those with the highest risk of spread, those that have not become broadly established, and those with the best likelihood of control success. New analyses and planning are needed to take advantage of the most current tools and guide their best use.

Federal, state, and USDA Forest Service laws, regulations, policies, and direction relating to invasive plant management must be implemented and followed. Implementing laws and policies regarding invasive plant species requires an aggressive and adaptive-management approach. Criteria to prioritize invasive plant species and treatment areas must be developed and utilized within the CTNF and CNG. This analysis identifies the strategies that the CTNF and CNG would use to implement and comply with laws and policies pertaining to the management of invasive plants.

1.4 Proposed Action

The CTNF and CNG propose to implement an IWM plant treatment on currently and susceptible to invasion areas within the boundaries of the CTNF and CNG, including the Jedediah Smith Wilderness and the Winegar Hole Wilderness. Treatment activities would include inventory and assessment designed to support EDRR, control methods, rehabilitation and restoration, and implementation and effectiveness monitoring. Activities would be implemented with partners at federal, state, and local levels where opportunities exist.

To provide for EDRR, the CTNF and CNG would update Caribou-Targhee Weed Strategy that includes treatment of invasive-plant infestations located outside of currently identified infested areas. These infestations may include new sites that arise in the future or sites that currently exist but have not yet been identified by NFS inventories. The intent of EDRR is to allow timely control so that new infestations can be treated when they are small, which prevents establishment and spread while reducing treatment costs and potential side effects. Planning for EDRR includes

analyzing the risk for new invasions associated with the characteristics of the species and determining areas in the CTNF and CNG where new invasions are likely to occur.

Proposed control methods would be based on integrated pest-management principles and methods known to be effective for each target species. These methods include, but are not limited to, (1) biological control, such as the release of host-specific natural enemies or targeted grazing; (2) chemical control using EPA registered herbicides that target invasive plant species; and (3) mechanical techniques, such as cutting and pulling. Appendix B includes the commonly used species-specific integrated control measures that would be applied to known invasive plant species in the CTNF and CNG. Control methods would be employed alone or in combination to achieve the best results. Treatment methods would be based on the extent, location, type, and character of an infestation and would be implemented using design criteria.

Management priority would be based on risk factors such as the number and size of known infestations; vectors for spread; proximity to susceptible habitat; threat to important resources (e.g., wilderness, endangered species habitat); and ability to outcompete desirable plant species. The priority of species to be treated would vary based on these factors and could change over time. These priorities would be used to guide selection of specific management activities for each infestation.

Rehabilitation and restoration actions would be designed and implemented based on the conditions found in and around infested areas. Passive vegetation (allowing plants on site to fill in treated areas) and active revegetation would be considered. Rehabilitation techniques would be assessed and implemented to promote native plant communities that are resistant to infestation by invasive plants.

Monitoring is proposed and necessary for implementing an adaptive-management strategy. Information collected from monitoring may be used by managers to evaluate the efficacy of EDRR, treatment, and rehabilitation and restoration actions, and subsequently used to adapt and update management actions. Two basic types of monitoring would occur: implementation monitoring and effectiveness monitoring. Implementation monitoring answers the question, “Did we do what we said we would do?” Effectiveness monitoring answers the questions, “Were prevention, treatment, and restoration actions effective?” and “Were intended goals accomplished?”

See Chapter 2 for a detailed description of the alternatives.

1.5 Management Direction

This draft EIS process and documentation has been completed according to direction contained in the National Forest Management Act (NFMA) (PL 94-588), NEPA (PL 91-190), the Federal Land Policy and Management Act (FLPMA) (PL 94-579), the Clean Water Act (CWA) (PL 92-500), the Endangered Species Act (ESA) (PL 93-205), Federal Actions to Address Environmental Justice to Minority Populations and Low-Income Populations (EO 12898), and the Council on Environmental Quality (CEQ) regulations, which provide general direction regarding land management and environmental analysis.

The following other federal laws were also considered:

- ***Carlson-Foley Act of 1968 (PL 90-583).*** Authorizes and directs federal agencies to permit control of noxious plants by state and local governments on a reimbursement basis in connection with similar weed-control programs carried out on adjacent, nonfederal land.
- ***Plant Protection Act (PL 106-224).*** Consolidates and modernizes all major statutes pertaining to management and control of noxious weeds.
- ***Noxious Weed Control and Eradication Act of 2004 (PL 108-412).*** Provides financial and technical assistance to control or eradicate noxious weeds.
- ***36 CFR Subpart A, Section 222.8.*** Directs the USDA Forest Service to cooperate with local weed-control districts to develop control programs where national forests and national grasslands exist.
- ***Executive Order 13112 (1999) as amended by EO 13751 (2016).*** Directs federal agencies to:
  - develop and coordinate a management program for the control of undesirable plants that are noxious, harmful, injurious, poisonous, or toxic on federal lands under the agency's jurisdiction,
  - establish and adequately fund the program, to complete and implement cooperative agreements and/or memorandums, and
  - establish Integrated Weed Management (IWM) to control or contain species identified and targeted under cooperative agreements and/or memorandums.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (1947) established the US system of pesticide regulation to protect applicators, consumers, and the environment. The EPA and the appropriate environmental agencies of the respective states administer FIFRA, which requires registration for all herbicides after extensive testing to evaluate whether a pesticide has the potential to cause adverse effects to humans, wildlife, fish, or plants. This includes endangered species and non-target organisms, as well as possible contamination of surface water or groundwater from leaching, runoff, or spray drift. When a herbicide is registered, a label is created to instruct the applicator on the proper usage of the material and required personal protective equipment. The EPA must also approve the language that appears on each pesticide label, and the product can be used legally only according to the directions on the label accompanying it at the time of sale. The USDA Forest Service is authorized by FIFRA and the Cooperative Forestry Assistance Act to use pesticides for multiple-use resource management and maintenance of the quality of the environment if the actions comply with NEPA and CEQ regulations. USDA Forest Service Manual (FSM) 2150 (Pesticide Use Management and Coordination) and USDA Forest Service Handbook (FSH) 2109.14 (Pesticide Use Management and Coordination) provide direction on safe use of pesticides, including direction on storage, transport, and the development of safety plans and emergency spill plans.

USDA Forest Service Manual 2900 (Invasive Species Management) directs the USDA Forest Service to use an IWM approach to control and contain the spread of invasive plant species on NFS lands and from NFS lands to adjacent lands. USDA Forest Service Handbook 2109.14 (Pesticide—Use Management and Coordination) provides additional direction related to implementing invasive-plant management, and FSM 2150 (Pesticide—Use Management and Coordination) provides policy direction.

The National Strategic Framework for Invasive Species Management (USDA Forest Service 2013) provides broad strategic direction for USDA Forest Service programs and incorporates the

Invasive Species Systems Approach, which includes the following four elements: (1) prevention, (2) detection, (3) control and management, and (4) restoration and rehabilitation.

The National Strategy and Implementation Plan for Invasive Plant Species Management (USDA Forest Service 2004a) focuses on the following four elements: (1) preventing invasive species before they arrive; (2) finding new infestations before they spread and become established; (3) containing and reducing existing infestations; and (4) rehabilitating and restoring native habitats and ecosystems.

The National Invasive Species Council Management Plan 2016–2018 (NISC 2016) EO 13112 (1999) established the National Invasive Species Council (NISC) to "provide national leadership regarding invasive species." The NISC Management Plan 2016–2018 identifies high-priority, interdepartmental actions for the federal government and its partners to take to prevent, eradicate, and control invasive species, as well as restore ecosystems and other assets adversely impacted by invasive species.

The Forest Service Guide to Noxious Weed Prevention Practices (USDA Forest Service 2001a) provides management guidance in the form of goals along with prevention practices. USDA Forest Service policy identifies prevention of the introduction and establishment of invasive plant infestations as an agency objective. This guide provides a comprehensive directory of weed prevention practices for use in USDA Forest Service planning and wildland resource management activities and operation.

At the regional level, the Intermountain Region of the USDA Forest Service, headquartered in Ogden, Utah, issued an Invasive Species Management Strategy (USDA Forest Service 2009) that outlines a regional plan for complying with national direction.

The intent of the Idaho Plant Pest Act of 2002 is to prevent the introduction and spread of plant pests in the state of Idaho by regulating plant material and plant pests. The Idaho Invasive Species Act of 2008 provides policy direction, planning, and authority to combat invasive species infestations throughout the state and to prevent the introduction of new species that may be harmful by implementing strategies that requires the State of Idaho to enhance its capacity to prioritize risks, prevent new invasions, employ EDRR techniques, apply state-of-the-art control and management strategies, coordinate multiple public and private efforts, and involve the public.

The Idaho Invasive Species Strategic Plan 2012–2016 (IDA 2012) is a strategic plan that outlines a framework for how Idaho can continue at the forefront of state efforts to cost- effectively prevent and manage invasive species. This strategy focuses on the following three goals: (1) prevent the introduction of new invasive species to Idaho, (2) limit the spread of existing invasive species populations in Idaho, and (3) abate ecological and economic impacts that result from invasive species populations in Idaho.

The purpose of the Wyoming Weed and Pest Control Act of 1973 (W.S. 11-5-101-11-5-119) is to control designated invasive plants and pests regardless of land ownership.

Wyoming Weed and Pest Special Management Program (W.S. 11-5-301-11-5-303) authorizes development of county weed and pest-control districts and an "integrated management system" for planning and implementation of a coordinated program utilizing all proven methods of control.

This draft EIS complies with forest-wide desired conditions, goals, objectives, and standards and guidelines related to noxious weed and invasive species in the applicable land and resource management plans for the CTNF and CNG (USDA Forest Service 2003, 2002, and 1997) and all associated amendments. See also Appendix C.

The desired future condition for noxious weeds and invasive plant species in the Revised Forest Plan for the Caribou National Forest (USDA Forest Service 2003, p. 3-20) is as follows:

- The introduction and spread of noxious weeds and other invasive plant species is contained, and ecologically sound methods of control are applied across NFS lands. New infestations of noxious weeds are rare across the landscape and existing large infestations are slowly declining.

The goals stated in the Revised Forest Plan for the Caribou National Forest (USDA Forest Service 2003, pp. 3-20 to 3-21) are to:

- Minimize the establishment and spread of noxious weeds and other invasive plant species through the application of USDA Forest Service direction, integrated pest management, and best management practices (BMPs).
- The CTNF and CNG are active members of cooperative weed management areas established in that vicinity.

The standards outlined in the Revised Forest Plan for the Caribou National Forest (USDA Forest Service 2003, p. 3-21) are as follows:

- Only weed-free hay, straw, pellets, and mulch shall be used within the CTNF and CNG.
- All seed used shall be certified to be free of noxious weed seeds from weeds listed on the current All States Noxious Weeds List.
- Gravel or borrow material sources shall be monitored for noxious weeds and other invasive species. Sources infested with noxious weeds shall be closed until the weeds are successfully controlled.
- Noxious weeds shall be aggressively treated throughout NFS lands, unless specifically prohibited, following the Caribou Noxious Weed Strategy. Using IWM methods of control and access shall be consistent with the goals of each prescription area.

The guidelines included in the Revised Forest Plan for the Caribou National Forest (USDA Forest Service 2003, p. 3-21) are:

- Weed treatment projects, especially those using herbicides, should be timed to achieve desired effects on target vegetation, while having minimal effects on non-target vegetation.
- Protect biological control insectories and allow harvest for distribution to other weed infestations, providing the original insectory can be maintained.
- Monitor, as needed, disturbed areas, such as landings, skid trails, roads, mines, burned areas, etc., for noxious weeds or invasive species and treat where necessary.
- Evaluate the potential for invasion by noxious weeds into proposed vegetation units and wildland fire use plan areas and modify units or mitigate where necessary.

A desired future condition stated in the Curlew National Grassland Plan for Terrestrial Ecosystems—Vegetation is as follows:

- Management direction is proactive to avoid introduction or spread of exotic and noxious weeds (USDA Forest Service 2002, p. 3-8).

A standard related to noxious weeds and invasive species found in the Curlew National Grassland Plan for Terrestrial Ecosystems—Vegetation is as follows:

- Invasive species such as noxious weeds will be treated to contain or control as appropriate using integrated pest-management methods and following the most recent version of the Caribou-Targhee Noxious Weed Strategy (USDA Forest Service 2002, p. 3-9).

The Revised Forest Plan for the Targhee National Forest (USDA Forest Service 1997) does not include direction specific to management of noxious weeds or invasive species.

1.6 Decision Framework

Given the purpose and need, the deciding official reviews the Proposed Action, the other alternatives, and the environmental consequences in order to make the following decisions:

The responsible official is the forest supervisor, who will make the following decisions based on the results of the interdisciplinary analysis:

- Whether to select the Proposed Action or one of the alternatives.
- What modifications, if any, to the selected alternative are needed.
- Which project design criteria are needed.

1.7 Public Involvement

The Notice of Intent (NOI) was published in the Federal Register on November 6, 2019. The NOI asked for public comment on the proposal. As part of the public involvement process, a detailed Proposed Action was sent to an extensive mailing list via e-mail on November 6, 2019.

Personnel from the CTNF met with representatives of the Shoshone-Bannock Tribe at Fort Hall, Idaho, to discuss the Proposed Action, which has been published in the Forest Schedule of Proposed Actions as “ongoing” since November 2019.

Using the comments from the public, other agencies, and others (see Issues section, below), the interdisciplinary team developed a list of issues to address.

1.8 Issues and Measurement Indicators

Issues serve to highlight effects or unintended consequences that may occur from the Proposed Action or alternatives and provide opportunities during the analysis to reduce adverse effects and compare trade-offs for the decision-maker and public to understand. Issues for the Proposed Action were identified through the process known as scoping. Significant issues were defined as those that were directly or indirectly caused by implementing the Proposed Action, may involve potentially significant effects, and could be meaningfully and reasonably evaluated and addressed within the scope of this proposal. Alternatives were developed around those significant issues that involved unresolved conflicts concerning alternative uses of available resources (40 CFR 1500.2(e)).

As for significant issues, the USDA Forest Service identified six topics raised during scoping, which are described below. A list of non-significant issues and reasons for their categorization are in the project record located at the Forest Supervisor's office in Idaho Falls, Idaho. The USDA Forest Service identified potentially significant issues during scoping, which are described below.

1.8.1 Issue 1: Wildlife

Herbicide exposure, resulting from herbicide toxicity, may harm terrestrial wildlife species. The effects of invasive plant treatment on the following species will be analyzed: (1) wildlife species listed as threatened, endangered, or candidate under the ESA; (2) Forest Service Region 4 sensitive wildlife species; (3) migratory birds and their habitat; and (4) ungulate big game species.

Measurement Indicators:

- Toxicity potential of herbicides being used.
- Direct and indirect effects of invasive plant species treatment activities (disturbance).

1.8.2 Issue 2: Fisheries

The use of herbicides in riparian areas can adversely impact water quality and aquatic species. Herbicides could contaminate water, harm fish through exposure to chemicals, and negatively affect aquatic plants and insects.

Measurement Indicators:

- Effects of herbicide to be used within riparian areas on aquatic organisms.
- Adequacy of design criteria that apply to water quality and aquatic organisms.

1.8.3 Issue 3: Water Resources

Controlling invasive species can potentially improve riparian health and function by restoring natural vegetation composition, which can increase ground cover, reduce erosion, and protect water quality and stream health. The use of herbicides can also adversely impact surface- and ground-water quality through direct contact or through runoff or leaching through the soil.

Measurement Indicators:

- Riparian health and function—estimate changes in weed infestations within riparian areas as a measure of riparian and stream health and function.
- Surface and ground water quality—evaluate the potential impact of herbicide concentrations on surface- and ground-water quality.

1.8.4 Issue 4: Vegetation

Herbicide exposure, resulting from herbicide drift, residue, or direct application, may cause harm to non-target plants and their pollinators. The effect of the invasive plant treatments on Ute ladies'-tresses (a threatened species), sensitive plant species, and non-target native plants will be analyzed. There is a potential for impacts to native vegetation, biological diversity, production,

and structure if weeds and invasive plants are not treated through an integrated pest-management strategy.

Measurement Indicators:

- Potential impact of herbicides to non-target resources and their pollinators.
- Potential for spread or reduction of invasive plant infestations measured in acres.

1.8.5 Issue 5: Human Health

Herbicide exposure, resulting from herbicide drift, residue, or direct application, may affect human health because of herbicide toxicity.

Measurement Indicators:

- Toxicity potential of herbicides to worker.
- Toxicity potential of herbicides to public.

1.8.6 Issue 6: Wilderness

The project area includes the Jedediah Smith Wilderness and the Winegar Hole Wilderness. The Wilderness Act, Section 2(c) defines wilderness as "an area where the earth and its community of life are untrammeled by man … protected and managed so as to preserve its natural conditions". Furthermore, Section 4(b) of the Act mandates "…each agency administering wilderness... shall be responsible for preserving the wilderness character of the area..." While treating nonnative species may affect the natural quality of wilderness character by maintaining a naturally functioning ecosystem, the intentional control or manipulation of the components, processes or ecological systems (e.g., treatment of plant species) may also affect the untrammeled quality of wilderness character.

Measurement Indicator:

- Natural Quality Measure—acres of nonnative species.

2 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 Introduction

Chapter 2 describes and compares alternatives considered for invasive plant treatment on the approximate 2.9-million-acre CTNF, including designated wilderness, and within the approximate 47,600 acres of the CNG. Inventoried noxious weed infestations have been mapped and are displayed in Appendix A. Proposed treatment sites are inventory sites and other locations where invasive plant species occur on the Forest following the appropriate design criteria. Based on current treatment inventories, 36 state-listed noxious weed species exist, covering approximately 98,842 acres across the CTNF and CNG.

Untreated invasive plant infestations have the potential to expand at an average rate of 1.3–25 percent each year (Duncan and Clark 2005). Increases are due to growth of existing plants and spread by a variety of vectors, such as wind, water, animals, and humans. Not all inventoried invasive plant populations receive treatment annually, due to budget and personnel constraints. Re-treatment is often necessary to maintain the control level of initial treatment depending on the invasive plant species, the size and density of an infestation, seed bank viability, and site conditions. Thus, multiple treatments may be necessary over the next 15 years to achieve control objectives on known infestation sites. This draft EIS considers two alternatives in detail:

- No Action/Current Management (Alternative 1)
- Proposed Action, which is also the Preferred Alternative (Alternative 2)

The USDA Forest Service developed the action alternatives in response to issues raised by the public and to meet legal requirements.

The Proposed Action includes treating invasive plant species and/or sites not present or yet inventoried. As described in Chapter 1, detecting and treating new infestations when they are small (using the EDRR strategy) increases the effectiveness of the invasive plant program and minimizes adverse effects. The Proposed Action includes treating newly detected infestations, utilizing the same control methods used on known sites.

2.2 Alternatives Considered in Detail

The USDA Forest Service developed two alternatives, including the No Action/Current Management and Proposed Action alternatives, in response to issues raised by the public.

2.2.1 Alternative 1—No Action/Current Management

Under the No Action/Current Management Alternative, current management plans would continue to guide invasive plant management of the project area. This includes the following array of standard, invasive-plant management practices, which are used within the CTNF and the CNG.

- Biological control through the use of predators, parasites, and pathogens, including classical biocontrol and target grazing.
- Herbicide control using ground-based spot and broadcast-application methods.
- Mechanical and manual methods such as hand-pulling, mowing, cutting, or torching.

Acres treated for invasive-plant management each year can vary considerably based on funding allocation and response to events such as wildfires (Table 2-1). As this proposal is being developed, neither the CTNF nor the CNG have approval for aerial application of herbicides or treatment of aquatic invasive plant species.

Table 2-1. Acres treated annually, by treatment method, based on a 3-year average during treatment years 2015–2018.

TREATMENT METHOD	ACRES
Mechanical control	60
Biological control	32
Herbicide control	5,334
Target grazing	1,700

A detailed description of NFS-specific current management components can be found in the project record.

2.2.1.1 Treatments

2.2.1.1.1 Biological Control

- Use of classical biocontrol agents, host specific natural enemies including insects, pathogens approved by APHIS.
- Targeted grazing with herbivorous animals including cattle, sheep, or goats.

2.2.1.1.2 Herbicide Control

- All herbicide treatments conducted for controlling invasive plants and noxious weeds would be performed in accordance with established USDA Forest Service policy and regulations and would follow EPA-label restrictions. All herbicide label instructions regarding application would be strictly enforced. Table 2-2 shows herbicide active ingredients approved for use within the CTNF and CNG, along with each active ingredient's approved application rate and general location for use.
- Application of herbicides to treat weeds shall be performed by, or directly supervised by, a state-licensed applicator.
- Herbicide applications would treat only the minimum area necessary to control noxious weeds.
- A daily pesticide application log would be maintained for each project area, detailing the chemical application, treatment area, target species distribution and density, weather conditions, and recommendations for follow-up treatments or rehabilitation.
- Herbicide applications would continue to be scheduled and designed to minimize potential impacts to non-target plants and animals, while remaining consistent with the objectives of the vegetation-treatment program.

Table 2-2. Herbicides and application settings currently used in the Caribou-Targhee National Forest (CTNF) and Curlew National Grassland (CNG).

HERBICIDE (ACTIVE INGREDIENT)	COMMONLY USED BRAND NAMES [a]	MAXIMUM LABEL APPLICATION RATE (OZ OR LBS a.i. [b] OR a.e.[c]/ACRE)	TYPICAL APPLICATION RATE (OZ OR LBS a.i. [b] OR a.e.[c]/ACRE)	LOCATION OR SETTING [d]	
				VEGETATION AWAY FROM WATER	VEGETATION NEAR WATER
2,4-D amine	Milestone	2.0 lbs a.e./acre/app 2 apps per year	1.0–2.0 lbs/acre	X	X
Aminopyralid	Amine 4, Weedar 64	0.11	0.078–0.11	X	
Chlorsulfuron	Telar	2.6 oz product/acre /year (0.12 lb a.i./acre/year)	0.01–0.02 oz/acre	X	
Clopyralid	Transline	0.5 lb a.e./acre/year	0.1–0.5 lb/acre	X	
Dicamba	Banvel	2.0	0.5–2.0	X	
Diflufenzopyr	Overdrive	0.1	0.05–0.1	X	
Glyphosate	Rodeo, Roundup, Accord	1.7 lbs a.e./acre/app ≤8.0 lbs a.e./acre/year	0.5–3.0 lbs/acre	X	X
Imazapic	Plateau	0.19 lbs a.i./acre/year	0.09–0.16 lb/acre	X	
Metsulfuron methyl	Escort	0.15 lbs a.i./acre/year	0.01–0.02 lb/acre	X	
Picloram	Tordon	1.0 lbs a.i./acre/year	0.25–1.0 lb/acre	X	
Sulfometuron methyl	Oust Weed Killer and DPX 5648	8.0 oz product/acre/year (0.37 lbs a.i./acre/year)	2.0–6.0 oz./acre (0.09–0.28.lb/acre)	X	
Tebuthiuron	Spike 20P Spike 80DF	4.0 lbs. a.i.	2.5 lbs	X	
Triclopyr: triethylamine salt (TEA)	Element 3A, Garlon 3A	2.0 lb a.e./acre	1–2.0	X	X

[a] The list represents brands most commonly used, although brands other than those listed may also be used.
[b] a.i.=active ingredient.
[c] a.e.=acid equivalent.
[d] Some formulations are suitable for riparian vegetation application near live water while others are only suitable in upland vegetation away from live water; suitability for c application is noted on product labels.
Note: Atrazine and Medfludle are authorized but not used.

- Ground-based application for treating noxious weed-infested areas may utilize the following:
  - Vehicle-mounted sprayers such as spot-guns (most common method).
  - Spot-spraying with hand-held spray nozzles, mounted on a vehicle (slip tank) or attached to a backpack system (very common method).
  - Hand-spreading granular formulations (least common method) and wicking, wiping, dripping, painting, or injecting target weeds (uncommon method).
- The following BMPs would be required during mixing, loading, and disposal of herbicides:
  - Applicators would mix only those quantities of herbicides that could be reasonably used in 1 day.
  - All empty containers would be triple-rinsed by spraying near the treatment site at rates that do not exceed those on the treatment site.
  - Herbicide label requirements would be strictly followed during the mixing, loading, and disposal of herbicides.

- Non-hazardous dyes would be used, as necessary, to ensure uniform coverage. Signs would be posted at visible sites (campgrounds, trailheads, road intersections) to notify the public of herbicide application in the area.
- Spill contingency plans would be used for all herbicide applications. Individuals involved in herbicide handling or application would receive instruction regarding the spill contingency plan and spill control, containment, and cleanup procedures.

2.2.1.1.3 Mechanical Control

- Workers would cut plants above ground level or pull out plant-root systems to prevent subsequent sprouting and growth; competing invasive plants would be removed around desired vegetation; or mulch would be placed around desired vegetation to limit the growth of competing vegetation.
- Workers also may use power tools such as chainsaws, power brush saws, and line trimmers (i.e., "weed eaters").
- Disposal of noxious weed debris would be in accordance with proper methods. For example, plants with developed seeds would be bagged and burned.

2.2.2 Alternative 2—Proposed Action

The CTNF and CNG are proposing to implement adaptive, IWM strategy to prevent the establishment of new invasive plant species populations and eradicate or control existing or newly discovered invasive plants over the next 10 to 15 years, as budgets allow. The IWM strategy is derived from the Forest Service National Strategic Framework for Invasive Species Management (2013), Forest Service National Strategy and Implementation Plan for Invasive Species Management (2004a), Strategy for Noxious and Nonnative Invasive Plant Management (USDA Forest Service 1998), and the Forest Service Invasive Species Management Manual (USDA Forest Service 2011), all of which direct national forests to implement adaptive, IWM programs with nationally established program components, which are described below.

2.2.2.1 Integrated Weed Management Program Components

2.2.2.1.1 Prevention

Prevention is the "first line of defense" and is a crucial element of IWM. The goal is to prevent the introduction and establishment of new invasive plant species. External and internal education and outreach is essential for the success of this component. A variety of educational materials such as signage, exhibits, presentations, and workshops would be used by the CTNF, CNG, and cooperative partners to raise public awareness of invasive plants and the ecological and economic damage created by their establishment and spread. Internal training would be used to educate personnel to recognize invasive plant species, understand vectors and preventive measures, incorporate preventive measures into the project design of all projects and activities, follow procedures for reporting and mapping invasive plant infestations, and communicate with other programs and agencies. This is a non-treatment tactic of the IWM approach. Other examples may include opportunities for check stations or cleaning stations.

2.2.2.1.2 Early Detection/Rapid Response

Early Detection and Rapid Response is a critical component of an IWM program. As new invasive plant infestations are detected, a quick and coordinated inventory and eradication response would reduce negative environmental and economic impacts.

Early Detection and Rapid Response is intended to find new invasive plant infestations at the earliest stages of invasion so they can be quickly eradicated resulting in decreased control costs and the need for repeated treatments. New invasive species may not be listed as noxious weeds on the statewide list; however, these plants are typically identified on statewide watch or EDRR lists.

The Proposed Action includes new national direction on the control of new detections of invasive plants. New invasive plant sites that are discovered subsequent to the current invasive plant inventory would be treated following Integrated Invasive Species Management.

2.2.2.1.3 Control and Management

The proposed IWM strategy would allow the use of a variety of treatment options and combinations intended to minimize the effect of invasive plants and limit their spread.

Control techniques include manual/mechanical removal, chemical treatment (including aerial application), and biological control methods. Areas infested by invasive plants within the CTNF and CNG may exhibit a wide range of site conditions.

Effective control relies on a clear understanding of the target species, its biology, the ecosystem it has infested, associated introduction pathways, and effective control methods. Control often requires repeat treatments and monitoring of control efficacy over multiple years.

A variety of treatment options and combinations that could be applied to a wide range of site conditions are necessary so that flexibility is provided to increase effectiveness, reduce cost, and minimize the potential for adverse effects from treatments. As monitoring identifies effective treatments, control measures are adjusted.

The control and management aspect of the IWM strategy will be the focus of the analysis in this EIS.

2.2.2.1.4 Rehabilitation and Restoration

Ultimately, the goal for invasive plant management efforts is to restore and maintain healthy native or desired plant communities that are resistant to invasive plant establishment, recover quickly from disturbances, and provide ecosystem functionality. Many invasive plant-infested plant communities are able to successfully re-establish without intervention after control efforts. However, sites that are severely damaged or, at which few desirable species remain, may not be able to recover without help.

Rehabilitation and restoration are vital components of an adaptive, IWM program. Rehabilitation is defined as short-term mitigation to ensure minimum site stability and functionality. This may include site preparation and seeding of desirable vegetation. Restoration is a long-term objective and involves returning sites to natural functions and native species.

2.2.2.1.5 Monitoring

Monitoring is a necessary part of implementing an adaptive, IWM program. Monitoring provides the data for IWM. Information collected from monitoring may be used by managers to evaluate the efficacy of prevention, EDRR, treatment, and rehabilitation and restoration actions. There are two basic types of monitoring essential to an adaptive, IWM plan: (1) implementation monitoring and (2) effectiveness monitoring. Implementation monitoring answers the question, "Did we do what we said we would do?" Effectiveness monitoring answers the questions, "Were prevention, treatment and restoration actions effective?" and "Were intended goals accomplished?"

Managers may use monitoring data from one site or set of sites to predict the effects of similar actions on other parts of the project area. This information can be used to promote the use of the most effective techniques for prevention, detection, treatment, and restoration, and avoid the use of ineffective methods.

2.2.2.1.6 Wilderness

Within the Jedediah Smith Wilderness and the Winegar Hole Wilderness, three primary strategies would be used to achieve the overall purpose of this project: (1) prevention, (2) IWM, and (3) minimum tool requirements necessary for the administration of the Wilderness. The proposed action inside of the wilderness would continue the use of manual (e.g., hand-pulling), cultural (planting native species to prevent establishment of invasive species), herbicide, and biological treatment methods that are ground-based and selective to control and reduce the presence of weeds. Aerial application would not be considered. Use of each treatment type would focus on weed locations; generally, this is near trails, trailheads, and campsites.

Manual treatments, such as hand-pulling and grubbing, would occur on sensitive areas or in very small infestations. Cultural treatments would enhance desirable vegetation. Herbicide treatments would consist of ground-applied herbicides and surfactant/adjuvant. Non-motorized equipment, such as horse and backpack sprayers, would be used inside the Wilderness. Classical biocontrol agents, primarily insects, would continue to be introduced, where appropriate, and newly USDA APHIS approved biocontrol agents would be considered for use where environmental conditions would support their use.

2.2.2.2 Treatment Methods and Design Criteria

The proposed adaptive, IWM program would utilize a variety of tools, used alone or in combination, to treat invasive plants within the CTNF and CNG. Proposed treatment methods include the following:

- Biological control through the use of USDA APHIS approved host specific predators, parasites, pathogens, and targeted grazing.
- Manual and mechanical methods, such as hand-pulling, mowing, cutting, or torching.
- Herbicide control using ground-based application (spot spraying, broadcast), aerial application, or aquatic application methods as appropriate to the location.
- Rehabilitation and restoration methods such as seeding sites to improve competition or prevent establishment of nonnative invasive plant species.

Treatments would abide by design criteria, the purpose of which is to reduce or eliminate the potential adverse impacts of the invasive plant treatments. Design criteria are a set of required implementation features applied to projects to ensure that the project is conducted according to environmental standards and that adverse effects are within the scope of those to be disclosed during this analysis.

2.2.2.2.1 Biological Control

Biological control is the use of plant predators or pathogens that attack and weaken targeted invasive plant species and reduce their ability to compete or reproduce in order to reduce or eliminate invasive plant infestations. Biological controls would be used when the target species occupies extensive portions of the landscape, other methods of control are prohibitive based on cost and location, and an effective biological control regime exists. Biological control activities typically include the release of parasitic and “host specific" insects, mites, nematodes, and pathogens. Biological treatments do not eradicate the target species, but rather reduce target plant densities to the point where competition with desired plant species for space, water, and nutrients keep populations in check. Biological control treatments are not consistent with an eradication objective but are an integral part of an IWM approach.

The USDA APHIS regulates, and the State of Idaho, Wyoming, and Utah approved invertebrate plant feeders and plant pathogens that are proven natural control agents that suppress, inhibit, or control specific target invasive plant species. Biocontrol activities include collection of USDA APHIS approved biocontrol agents, development of insectaries for collection, redistribution of biocontrol agents, and augmentation of biocontrol agent populations. Biocontrol agents are transported in containers that safely enclose the biocontrol agent until release. Releases can be ground-based or aerial. Interstate transport of biocontrol agents is regulated by USDA APHIS through a permit process.

Biocontrol areas would be inventoried and monitored to determine the success of the treatments and when the released bio-control agents have reached equilibrium with the target species. Repeat visits may need to be made several times a season and over a series of years to determine if additional biocontrol agent releases are needed or if a different biocontrol agent needs to be released.

The use of biocontrol agents usually results in delayed impact, often requiring 5 to 10 years for biocontrol agent’s activity to result in successful reduction of target invasive plant infestations. However, simultaneous increase of native vegetation often eliminates the need for restoration. Biocontrol is the preferred method of invasive plant control in remote areas where access is limited; on high-density, extensive invasive plant populations where other control methods may not be appropriate; on target species for which biocontrol agents are available and proven effective; and in conjunction with other control methods to reduce density of the target species.

The design criteria for the use of classical biological control in this project are as follows:

- Refer to the International Code of Biological Practices for Biological Control of Weeds (Balciunas 2000) guidelines.
- Obtain APHIS permit to Move Live Plant Pests, Noxious Weeds, or Soil for those agents when transportation across state lines is involved.
- Use only APHIS and state-approved biocontrol agents (for Idaho, Utah, and Wyoming).

- Use Forest Service protocols for documentation of releases and monitoring; share release information with the appropriate State Department of Agriculture.
- To the extent practicable, to maximize successful establishment, collect biocontrol agents locally or from areas with similar climatic and weather conditions, land and soil types, and cover types.
- Distribute biocontrol agents at the optimal season and life cycle stage to optimize the likelihood of successful establishment. Distribute quantities sufficient to optimize successful short-term establishment.
- For those biocontrol agents that self-disperse poorly, actively redistribute throughout target invasive plant infestations (collecting and moving the biocontrol agents to new locations).

Targeted grazing is a form of biocontrol and is another method to help develop a desirable ecosystem. It is the application of livestock at a specified season, duration, and intensity to accomplish specific vegetation management goals. The term "targeted" refers to the specific plant or landscape that is the aim of the controlled for grazing practices (Launchbaugh et. al 2006).

Targeted grazing may include livestock grazing under a term grazing permit and/or livestock grazing conducted under a livestock use permit. In either situation, the specific vegetation or plant species to be reduced by grazing will be identified and monitored to determine effectiveness. Targeted grazing may or may not be associated with a grazing allotment. The numbers of livestock and grazing season will be designed on a site-specific basis to achieve management objectives.

- Prior to treatment within designated Wilderness, put into place and follow Minimum Requirements Analysis.
- Use targeted grazing practices that have shown to be effective for treating the targeted nonnative invasive plant species.
- Maintain enough separation between domestic sheep or goats and Bighorn Sheep to prevent disease transmission. (Identified in the USDA Forest Service Region 4 Bighorn Sheep Core Herd Home Ranges).

2.2.2.2.2 Manual and Mechanical Treatment

Manual and mechanical treatments are typically used to remove seed heads, individual plants, or small infestations. They may be used in sensitive areas to avoid impacts to non-target species or water quality, or to prevent seed production. Manual and mechanical approaches are slow and very labor intensive; they are effective only for small infestations.

The term "manual" defines treatments such as hand-pulling or using hand tools, such as hand clippers, hoes, rakes, and shovels, to remove plants or cut off seed heads. Manual treatments can be effective for annual invasive plants but are ineffective against perennial invasive plants with deep underground stems or roots, or fine rhizomes that can be easily broken and left behind to re-sprout. Use of manual methods might need to be repeated several times throughout the growing season depending on the targeted species. Manual treatments may require digging below the soil surface to remove the main roots of plants.

The term "mechanical" refers to the use of equipment and power tools, including mowing, torching (using a propane burner to kill invasive plants with heat), steaming, and weed whipping.

Choosing the appropriate power tool depends on factors such as characteristics of the target weed species (e.g. stem size or sprouting ability), the density of the target species and size of the infestation, site location and condition, and soil or topographic considerations. Mechanized treatments are typically used to remove flowering stems to prevent seed production or to reduce or remove aboveground biomass. The use of manual and mechanical treatment methods is common to all alternatives.

The design criteria for the use of manual and mechanical treatments in this project are:

- Necessary state and federal permits would be obtained, when and where required.
- Prior to any use of torching devices to treat invasive species, a prescribed-burn plan would be completed in compliance with FSM 5140 and the Interagency Prescribed Fire Planning and Implementation Procedures Guide, PMS 484.
- Torching within the grizzly bear PCA would be avoided to prevent the possibility of burning outside of prescription.
- An archaeologist would be consulted prior to initiation of work to determine whether an archaeological survey is needed.
- Soil disturbance would be minimized to prevent the germination of invasive plant seeds.
- Non-target species damage would be avoided to the extent practicable.
- Mechanical removal would be used only when it can effectively control the target species (e.g., grubbing/hoeing is inappropriate for rhizomatous species and may increase the density of the invasive plant population as root fragments sprout and become new plants).
- Mechanical treatments would be used at the proper stage of plant growth, when treatment is most effective for controlling the target invasive plant.
- All equipment and clothing would be cleaned to remove invasive plant seeds or vegetative propagules and prevent the movement of the invasive plant to other sites.
- Clipping and removal of seed stalks would be conducted to the extent possible prior to seed maturity or when seeds are easily picked up and transported by vectors such as wind, humans, or animals to reduce inputs to the seed bank.
- Specific to aquatic invasive plants, hand-pulling and/or smothering may be used when an infestation is limited in extent and occurs close to the shoreline of a waterbody but has not yet infested deeper waters.
- No treatments in occupied breeding or nesting sage grouse habitat until after June 15.

2.2.2.2.3 Herbicide Application Methods

The following four types of herbicide application would be used in this project:

1. ***Spot spraying*** targets individual plants and the immediate area around them. Spot spraying is usually conducted with a backpack sprayer. However, spot spraying may also be applied using a hose from a truck-mounted or OHV-mounted tank, or tanks mounted on pack animals. This is the most common herbicide application method used on the Forest and Grassland.
2. ***Broadcast application*** is distributing herbicide over an area of ground rather than individual plants. This method may employ a spray system mounted on a truck or OHV. Broadcast

applications are used in areas where invasive plants occupy a large percentage of plant cover on the site, making spot spraying impractical.

3. ***Aerial application*** would be used in areas where physical features, such as topography, restricted access, size and/or rate of spread of infestation, personnel safety, or other factors such as prohibitive unit cost of ground application occur.
4. ***Aquatic application*** would be used in response to EDRR associated with aquatic invasive plant species. This method may employ spot or broadcast spray over the surface of or into water. Application methods may be from shore using backpacks, truck-mounted or OHV-mounted tanks, or from watercraft.

Herbicide formulations and mixtures could contain one or more of the active ingredients shown in Table 2-3. The range of application rates for each herbicide active ingredientis derived from the US Forest Service Human Health and Ecological Risk Assessments and the herbicide label. Additional herbicide active ingredients may be added in the future at either the Forest Plan or project level through appropriate risk analysis, NEPA procedures, and ESA consultation.

Table 2-3. Herbicides and application settings under the Proposed Action.

HERBICIDE (ACTIVE INGREDIENT)	MAXIMUM LABEL APPLICATION RATE (a.i. [a] OR a.e. [b]/ACRE)	TYPICAL FOREST APPLICATION RATE (LBS a.i.[a] OR a.e.[b]/ACRE)	APPLICATION SETTING			
			UPLAND	RIPARIAN	AERIAL	AQUATIC
2,4-D amine	2.0 lbs a.e./acre/app 2 apps per year	0.5–2.0 lbs/acre	X	X		
Aminopyralid	0.11 lbs a.e./acre/year	0.06–0.11 lb/acre	X	X	X	
Chlorsulfuron	2.6 oz. product/acre/year (0.12 lb a.i./acre/year)	0.5–2.0 oz/acre (0.02–0.09 lb/acre)	X	X	X	
Clopyralid	0.5 lb a.e./acre/year	0.28–0.5 lb/acre	X	X	X	
Dicamba	1.0 lb a.e./acre/app 2 apps per year	0.75–2.0 lbs/acre	X			
Glyphosate	1.7 lbs a.e./acre/app ≤8.0 lbs a.e./acre/year	0.35–5.0 lbs/acre	X	X		X
Imazamox	0.5 lb a.e./acre/year	0.25–0.5 lb/acre		X		X
Imazapic	0.19 lb a.i./acre/year	0.1–0.19 lb/acre	X	X	X	
Imazapyr	1.5 lbs a.e./acre/year	0.5–1.0 lb/acre	X	X		X
Metsulfuron methyl	4.0 oz. product/acre/year (0.15 lb a.i./acre/year)	1.0–3.0 oz./acre (0.04–0.11 lb/acre)	X	X	X	
Picloram	1.0 lb a.i./acre/year	0.5–0.75 lb/acre	X		X	
Rimsulfuron	0.0469 lbs a.i. 4 oz/year	0.0469 lbs a.i. 3 oz	X		X	
Sulfometuron methyl	8.0 oz product/acre/year (0.37 lbs a.i./acre/year)	2.0–6.0 oz/acre (0.09–0.28 lb/acre)	X	X	X	
Triclopyr: triethylamine salt (TEA)	9.0 lbs a.e./acre/year	4.5–6.0 lbs/acre	X	X		X

[a] a.i.=active ingredient.
[b] a.e.=acid equivalent.

The design criteria for all herbicide applications in this project are as follows:

- Herbicide application shall comply with applicable laws (Idaho Statute Title 22, Chapter 34 and Idaho Administrative Code Rule 02.03.03, Wyoming Weed and Pest Control Act of 1973 (W.S. 11-5-101-11-5-119)), USDA Forest Service policy and guidelines (FSH 2109 and FSM 2150), ESA Section 7 consultation requirements, National Pollutant Discharge Elimination System (NPDES) permit requirements, and with product label directions for the herbicide being used to assure worker safety and to manage potential impacts of herbicide application.
- Always read and follow label directions, including instructions for herbicide use, application rates, equipment and techniques, personal protective equipment for applicators and mixers, and container disposal.
- Prior to implementation, program managers would ensure proper permitting is in place.
- Make sure Safety Data Sheets, safety plans, spill prevention plans and cleanup kits are available to applicators and mixers, per the requirements of FSH 2109.14 (Pesticide Use Management and Coordination).
- Keep accurate and detailed application records, per appropriate state Department of Agriculture Rules Governing Pesticide and Chemigation Use and Application and EPA requirements identified in the NPDES.
- Perform herbicide applications by or under the supervision of licensed professional herbicide applicators for forest and contract crews, per appropriate state Department of Agriculture Rules Governing Pesticide and Chemigation Use and Application.
- Monitor wind speed and direction and equipment and spray parameters throughout an herbicide application.
- Conduct equipment and personnel inspections, equipment maintenance and equipment calibration as needed to ensure proper herbicide application and to meet regulatory requirements. Regularly check equipment and components for wear. Attend to repairs and parts replacement promptly.
- Vehicles used to transport, or spray herbicides are administratively allowed to travel off designated motorized routes as authorized by the line officer.
- Follow the procedures in the Spill Plan in the event of a spill. Keep the Spill Plan compliant with NPDES.
- Equip water-drafting equipment with back-siphoning-prevention devices.
- Grazing permittees will be made aware of annual treatment actions at the permittee annual operating instruction meetings and/or if requested, notified in advance of spray dates.
- To the extent practicable, apply herbicides to infestations containing biocontrol agents at times when the effects of herbicides to the host plants would not interfere with the biocontrol agent's life cycle.
- Ensure that contracts and agreements include all design criteria as appropriate for the activity contracted or authorized.
- No treatments in occupied breeding or nesting sage grouse habitat until after June 15.

The design criteria for herbicide applications for this project in areas with sensitive plant species present are as follows:

- Evaluate sites considered for herbicide treatment for sensitive plant habitat suitability. Survey suitable habitat as necessary prior to treatment. The need for field surveys in suitable habitat is based on factors such as plant phenology at the time of treatment and species' susceptibility to the herbicide(s) being used.
- Mechanical treatment, individual plant treatment (e.g. wiping), or spot herbicide application are preferred methods when treating invasive plant infestations associated with sensitive plant populations.
- For identified sensitive plant populations, the default no-spray-zone would be 300 feet for all herbicides applied by broadcast-type spray equipment with the potential of site-specific changes depending on the species or environmental conditions.
- Glyphosate would not be applied closer than 50-foot buffer to sensitive plants. Other herbicides may be applied following label instructions.

The design criteria for the use of aerial herbicide application in this project are as follows:

- Provide a minimum buffer of 300 feet for aerial herbicide application around developed campgrounds and private land (unless otherwise authorized by adjacent private landowners).
- Aerial herbicide applications would not occur in Research Natural Areas (RNAs) or wilderness areas.
- Herbicide control using aerial application methods in designated municipal watersheds, and State designated source water protection areas will be review by the Forest Hydrologist and/or the Forest Fisheries Biologist and coordinated with State DEQ and other federal agencies.
- Within known or potential sage-grouse nesting/early brood-rearing habitat, aerial herbicide application would occur after June 30.
- Avoid recurring aerial flight lines within the grizzly bear PCA to avoid adverse impacts to secure habitat. Use of aerial application within the grizzly bear PCA is allowed but should be short in duration and fixed wing application is preferred.
- If recommended by the Forest Biologist, no aerial application would occur during the breeding season within specific known active/occupied raptor territories.
- Herbicide applicators would obtain a weather forecast for the area prior to initiating a spraying project to ensure no extreme precipitation or wind events were predicted to occur during or immediately after spraying that could allow runoff or drift into water bodies.
- Considerations for choosing sites for aerial application would include the extent of the invasive plant infestation, the cumulative size of the infestation (many small sites in close relative proximity of each other), and the density of the invasive species.
- Aerial treatment areas could be treated recurrently on a 2- or 3-year rotation to ensure effective control. Post-treatment implementation and effectiveness monitoring would identify areas to be re-treated or if treatment areas can be reduced based on effectiveness of previous treatment.
- Public notification would be conducted through press releases in local newspapers and the use of social media and websites that identify the potential windows of treatment for specific areas. Signing and on-site layout would be performed 1–2 weeks prior to actual aerial treatment.

- No aerial application staging, storage, refueling, or mixing would take place within 300 feet of perennial streams.
- Temporary area, trail, and road closures would be used to ensure public safety during aerial spray operations.
- Aerial spray units would be identified using a GPS system for each treatment unit mapped before the flight to ensure that only areas marked for treatment are treated and areas to be avoided are not treated. If needed, drift monitoring cards would be placed at avoidance areas to make sure drift does not reach these areas.

The design criteria for the use of aquatic herbicide application in this project are as follows:

- Allow herbicide applications by or under the direct supervision of licensed professional herbicide applicators with Aquatic Pest Control certifications.
- Use only aquatic-approved adjuvant when the product label recommends its use.
- Evaluate the infested site to determine the best control method, including (a) location, number and extent of infestations, (b) depth, flow, substrate, water quality and configuration of the waterbody involved, (c) density and diversity of native flora, and (d) direct and indirect effects to native flora and fauna and to people (e.g. domestic water use).
- Follow the applicable sections of Idaho's Aquatic Nuisance Species Plan (ID ISCTC 2007) in the event of a detection of an aquatic nuisance plant species.
- Follow steps as outlined in the Aquatic Invasive Plan Control Framework Strategy (Appendix D).

The design criteria for herbicide application for this project in designated Wilderness areas are as follows:

- Follow the requirement outlined in the MRA for treatment methods within Wilderness.
- No aerial herbicide applications will be used in designated Wilderness areas.

2.2.2.2.4 Rehabilitation and Restoration

For sites that have been severely impacted by invasive plants and are devoid of desirable plant species, rehabilitation and restoration should take place. Establishing a healthy, functioning plant community that is resilient to disturbance and resistant to invasive plant re-invasion is a key component of the IWM strategy when passive restoration is not likely to be successful. Potential sites for rehabilitation and restoration will be assessed and a site-specific plan will be developed following the design criteria listed below.

The design criteria for rehabilitation and restoration for this project are as follows:

- Assess soil processes that may be affecting the site productivity.
- Consider the most effective, practical and suitable means of providing rehabilitative or restorative measures, whether eliminating sources of disturbance other than invasive plants, or taking actions such as seeding and/or mulching.
- Determine whether additional assistive measures may be required, such as cover crops, hydraulic mulches, and mycorrhizal inoculums.
- Follow policy in FSM 2070 Vegetation Ecology concerning the selection, use and storage of native and nonnative plant materials. By policy, native plant material will be the first choice

in revegetation for restoration and rehabilitation of native ecosystems where timely natural regeneration of the native plant community will not occur.

- If it is determined that nonnative species are the best choice for interim or permanent revegetation, be sure to select species that do not behave invasively under conditions similar to those at the site to be revegetated.
- Seed purchased must have a complete seed-analysis tag or label on each bag including results of a current test. Federal and state laws mandate that seed cannot be legally sold without a completed analysis label. To reduce the chance of invasive-plant introduction from seed mixes, purchase seed only after reviewing the seed-analysis reports for each seed lot and purchase only seed of high pure-live seed (PLS) values. Independent seed-analysis tests are recommended prior to purchasing or approving seed.
- When seeding, determine the need for site preparation and protective measures that may need to be taken to allow the seeding to establish successfully.
- Plan revegetation activities for the optimal season and site conditions for successful establishment.
- Design seed mixes that are adapted to site conditions (including soil type, precipitation patterns, plant hardiness zones, etc.).
- Sites where restoration and rehabilitation treatments have been applied may need to be protected from grazing use through temporary fencing, livestock exclusion or other method appropriate to the sites to allow seeded plant establishment.
- Following establishment, continue to practice proper vegetation management to maintain a healthy, functioning plant community.
- Use only invasive plant seed-free mulches and other products for uses such as erosion control and improved seed germination.
- Ensure that treatment tools and other equipment are free of invasive plant seed before moving to or using on the project site.
- Minimize ground-disturbing activities to the extent possible during re-seeding efforts.
- Consult an archaeologist prior to initiation of work to determine if an archaeological survey is needed.

2.2.2.3 Treatment Priority and Strategy

Treatment priorities are based on factors such as the current abundance and distribution of the species, type and values of the site affected, and risk for spread or infestation into other areas. Other program management considerations may affect priorities. For example, priority may be given to sites located in areas proposed for ground-disturbing management activities. In addition, opportunities for special funding or cooperative projects with other landowners, agencies, and organizations may be considered. Treatment priorities do not necessarily refer to the order in which an infestation is treated during a given fiscal year. Treatment priorities are part of an adaptive, IWM strategy used by managers in determining how to allocate resources.

The criteria for determining treatment priority of invasive plant infestations are found in Table 2-4. Higher priority is generally given to those new invasive plant infestations where reduction or eradication of infestations is likely to be successful (in line with the CTNF CNG EDRR focus).

For established invasive plant infestations, suppression strategies play a much more important role. In general, most currently inventoried infested acres are associated with human-caused disturbance such as travel routes. Because they are common to infestations at all potential priority levels, spread vectors such as trailheads, roadways, campgrounds, and parking areas are not explicitly considered when setting priorities.

Table 2-4. Descriptions and objectives for herbicide treatment priorities.

PRIORITY	DESCRIPTION	TREATMENT OBJECTIVE
Highest	Infestations of invasive plant species new to the project area (EDRR).	Inventory and Eradication of small populations of invasive plant species new to the project area using EDRR.
Second priority	Infestations of invasive plant species that occur rarely within the project area. Infestations of invasive plant species that occur rarely within a given zone. Infestations that pose substantial risk of infestation to priority areas currently free of the invasive plant species Areas identified as having specific resource values needing protection from nonnative invasive plants species such as proclaimed wilderness areas, sage-grouse habitat, etc.	Eradicate or control by direct means or suppression of existing invasive plant infestations and reduce or eliminate new invasive plant infestations.
Third priority	Infestations in or near areas that experience disturbance due to human activity, such as designated travel routes, recreation sites, emergency staging areas, and gravel pits. Infestations in or near areas that experience disturbance due to natural forces, such as those recently affected by wildfire. Infestations with the potential to spread across ownership boundaries onto lands that are not currently infested. Infestations for which treatment has a high probability of success.	Control by direct suppression. Utilize indirect suppression where practical for achieving control.
Fourth priority	Infestations in or near areas that contain desirable plant communities, such as intact native plant communities and sensitive, threatened, or endangered plant or animal habitat. Infestations of established invasive plant species occurring in an otherwise uninfested area.	Control by direct suppression.
Fifth priority	Infestations in habitat susceptible to invasion by and spread of invasive plants. Infestations of established invasive plants in generally infested areas. Large infestations of established invasive plants.	Control by direct suppression when possible. Emphasis placed on indirect suppression.

Table 2-5 summarizes commonly used, species-specific, integrated control measures that would be applied to known noxious weed species in the CTNF and CNG. The table displays a range of effective treatment options. Different treatment choices may be selected based on circumstances, such as new ESA consultation requirements, information on treatment effectiveness, and availability of new products. The priority and intensity of required treatment varies widely based on site conditions, resources at risk from invasion, and the range and aggressiveness of individual target species.

Table 2-5. Range of effective treatment options by target species.

NOXIOUS WEED	TREATMENT METHOD [a]		
	Biological	Chemical	Mechanical
Russian Knapweed	Jaapiella ivannikovi, Aulacidea acroptilonica	triclopyr + clopyralid; picloram; clopyralid + 2,4-D; clopyralid; aminopyralid; aminopyralid + metsulfuron; aminopyralid + 2,4-D; glyphosate; 2,4-D; chlorsulfuron	Pulling and hoeing
Hoary Alyssum	None currently available	metsulfuron; chlorsulfuron	Pulling
Whitetop	Aceria drabae	metsulfuron; chlorsulfuron; metsulfuron + chlorsulfuron; 2,4-D	Not effective
Musk Thistle	None currently available	chlorsulfuron; metsulfuron; Part A [b]: metsulfuron, Part B: dicamba + 2,4-D; metsulfuron + chlorsulfuron; triclopyr + clopyralid; clopyralid; aminopyralid; aminopyralid + metsulfuron; aminopyralid + 2,4-D; picloram; clopyralid + 2,4-D; dicamba; 2,4-D; glyphosate + 2,4-D	Mowing and hoeing
Diffuse Knapweed	Cyphocleonus achates, Larinus minutus, Larinus obtusus, Sphenoptera jugoslavica, Urophora affinis, Urophora quadrifasciata, Bangasternus fausti	clopyralid + triclopyr; picloram; clopyralid; aminopyralid; aminopyralid + metsulfuron; aminopyralid + 2,4-D; clopyralid + 2,4-D; glyphosate; 2,4-D	Pulling and hoeing, grazing
Spotted Knapweed	Agapeta zoegana, Bangasternus fausti, Chaetorellia acrolophi, Cyphocleonus achates, Larinus minutus, Larinus obtusus, Metzneria paucipunctella, Sphenoptera jugoslavica, Terellia virens, Urophora affinis, Urophora quadrifasciata	triclopyr + clopyralid; picloram; clopyralid + 2,4-D; clopyralid; aminopyralid; aminopyralid + 2,4- D; 2,4-D; glyphosate	Pulling and hoeing, grazing
Rush Skeletonweed	Cystiphora schmidti, Eriophyes chondrillae, Puccinia chondrillina, Bradyrrhoa gilveolella	clopyralid; aminopyralid; aminopyralid + metsulfuron; picloram; metsulfuron + chlorsulfuron; 2,4-D	Mowing
Oxeye Daisy	None currently available	metsulfuron; aminopyralid; aminopyralid + metsulfuron; aminopyralid + 2,4-D; picloram; clopyralid	Pulling and hoeing
Canada Thistle	Urophora cardui, Hadroplontus litura, Puccinia punctiformis	clopyralid + triclopyr; clopyralid; aminopyralid; aminopyralid + metsulfuron; aminopyralid + 2,4-D; picloram; metsulfuron + chlorsulfuron; Part A: metsulfuron,	Not effective
Cheatgrass – annual brome	None currently available	Rimsulfuron; Imazapyr; Glyphosate	Pulling, grazing

[a] Sources: Prather et al. 2011, Prather 2012, Prather 2013, Newton et al. 2013.
[b] Part A and Part B refer to tank mixes.

2.2.2.4 Integrated Invasive Species Management

The Proposed Action, which incorporates EDRR, contains an integrated invasive species management strategy to deal with invasive plant infestations that are constantly changing. An adaptive-management strategy offers the means to describe and evaluate the consequences of changing or new invasive plant infestations and new treatment options. The adaptive-management strategy consists of three principle components.

1. In order to quickly and effectively treat newly discovered invasive plant infestations while still addressing other resource concerns, a flowchart based on infestation size, location, site characteristics, and consultation with specialists would be used to select treatment methods (Figure 2-1). All new sites would be mapped and inventoried. Appropriate design criteria must be applied to any invasive plant treatment.
2. New technology, biocontrols, herbicide active ingredients, herbicide formulations, supplemental labels, and adjuvants are likely to be developed within the lifetime of this project. These new treatment methods would be considered when their use would be consistent with or less than the effects of treatment methods analyzed in this process. The adaptive-management strategy would allow incorporation of these new treatment methods if they meet the following criteria:
   - Herbicide products must have an EPA-approved herbicide label.
   - A risk assessment must be completed for the herbicide by the Natural Resources Conservation Service (NRCS), USDA Agriculture Research Station (ARS), EPA, Forest Service, BLM, or another federal land-management agency.
   - New biocontrol agents must be approved by APHIS and state (Idaho, Wyoming, or Utah) prior to their introduction. This approval indicates that the biocontrol agent has undergone a thorough review by USDA APHIS and the Technical Advisory Group for weed biocontrol.
   - Endangered Species Act, Section 7 consultation would be completed prior to the use of new herbicides (if needed).

2.2.2.5 Monitoring

Monitoring is an integral part of any IWM program. Monitoring helps with future decision-making and strategy. Both quantitative and qualitative monitoring efforts are included in the overall monitoring program. Post-treatment monitoring helps determine whether treatments were effective.

Re-treatment and active rehabilitation or restoration prescriptions would be developed as needed based on post-treatment results. Changes in treatment methods would occur based on effectiveness of treating the invasive plant infestations. The detailed monitoring plan can be found in Appendix E.

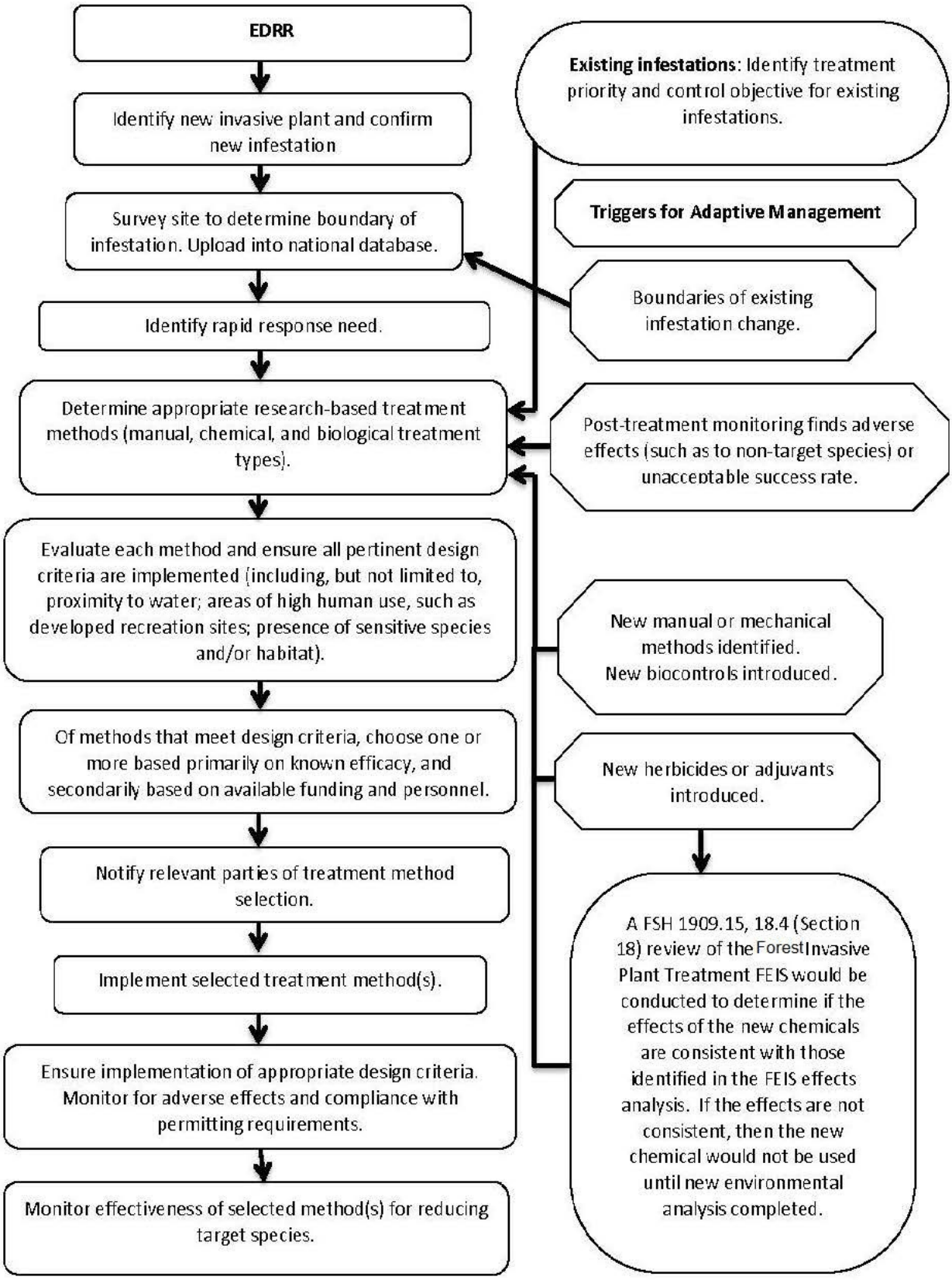

Figure 2-1. Integrated weed management flow chart.

2.2.2.5.1 Implementation Monitoring

Program elements and site-specific projects should include the following to accomplish implementation monitoring:

- Develop a project work plan for herbicide use as described in FSH 2109.14.3.
- Document and report herbicide use, certified-applicator information recorded to state standards, invasive infestation information and inventories, and invasive treatments using the database of record to record the amount, type, and location of herbicide use annually.
- For biocontrol releases, monitor a selection of biocontrol release sites annually, tracking biocontrol agent establishment and target species' response, to determine the efficacy of the release.
- For mechanical treatments, monitor rehabilitative and restoration measures throughout the recovery process to quickly identify and correct any problems that may impede successful revegetation.

2.2.2.5.2 Effectiveness Monitoring

Effectiveness monitoring generates data that aids managers in (1) assessing trends in infestation number, size, and density, (2) effect of noxious and invasive plant infestations on native vegetation, (3) effect of treatments on target and non-target species, and (4) effectiveness of treatments as implemented.

Effectiveness monitoring must be conducted at multiple scales in order to provide the best insight into the effects of treatment actions. All treatment methods (i.e., biological, chemical, and manual) are subject to the following effectiveness monitoring.

- Monitor the size, density, and other biological characteristics of invasive plant infestations.
  - Maintain noxious and invasive plant inventories in the appropriate database of record.
- Evaluate the immediate and short-term impacts of treatment on target invasive plants and non-target vegetation.
- Evaluate the long-term effects of treatment on target invasive plants and non-target vegetation and the persistence of biocontrol agents.
  - Establish the permanent monitoring plots for long-term site assessment, such as photo points.
  - Monitor the survival, distribution, and effectiveness of biocontrol agents. Monitor adjacent target infestations to see if biocontrol agents are dispersing to new infestations.

2.3 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 invasive plant treatment, duplicative of the alternatives considered in detail, or determined to be components that would

cause unnecessary environmental harm. Therefore, several alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

2.3.1 Ecosystem Resilience

This alternative concentrates on preventing conditions that favor exotic and invasive vegetation problems and restoring ecological integrity. The alternative identifies site selection and treatment priorities; vegetation-prevention treatments by land use activity; vegetation-restoration treatments by land use activities; eliminating or reducing specific land use activities to prevent the spread of invasive plants; revegetation; monitoring and evaluation; and public coordination, education, and awareness. The intent of this alternative is to address and take action on human activities that promote the spread of weeds. The alternative proposed closing roads, modifying authorized livestock grazing permits, and altering or eliminating existing timber, mining, and recreational OHV activities. These human uses and activities are authorized in the records of decision for three land and resource management plans. The three plans meet the requirements of several public land laws and regulations authorizing multiple uses on NFS lands. Taking action on activities previously authorized under existing laws, regulations, permits, and the three land and resource management plans is beyond the scope of this EIS; this alternative was not considered further.

Many of the active and passive restoration actions suggested involved programs and activities beyond the treatment of invasive plants. This alternative was not analyzed in detail because making changes to land use, Forest Plan direction, travel management, and permitted activities within the CTNF and CNG are outside the scope of this analysis.

2.3.2 No Herbicide

Some commenters believe herbicides may present risks to humans, wildlife, and native vegetation. Although herbicides proposed for invasive plant control in the analysis have gone through rigorous scientific testing and government approval, some commenters perceived use of these herbicides as unsafe.

For several noxious weeds found within the CTNF and CNG, no effective mechanical and/or biocontrols are available. Other areas have extensive infestations where mechanical treatment is not physically possible. The cost of mechanical treatments, such as hand-pulling or mowing, would be prohibitively expensive, and not enough acres could be treated to address the Purpose and Need. A No-Herbicide Alternative does not comply with the USDA Forest Service's Integrated Pest-Management direction and is not consistent with regulations that noxious weeds be managed on NFS lands.

2.3.3 No Controlled (Target) Grazing

One commenter believed targeted livestock grazing is an untested method with the potential to inflict widespread ecological damage without any corresponding benefit. Using livestock grazing to target invasive species as part of an IWM program has been tested and is a widely used technique. For example, the Black Canyon and Dry Canyons of the Westside Ranger District has used livestock grazing as part of an IMW Program to control leafy spurge since 1998. Monitoring has demonstrated targeted grazing was associated with a considerable reduction in

leafy spurge. The photos shown on the cover of this EIS are from 1993 and 2018, respectively, showing results of the Black Canyon IWM Program.

A literature review demonstrated target grazing is a well-tested vegetation method supported by extensive and ongoing research (Target Grazing Literature review). The evolution of targeted grazing as an invasive plant management tool is ongoing and ongoing research will continue to identify grazing techniques that benefit invasive species control efforts.

2.4 Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Tables 2-6 through 2-10 summarize and compare the anticipated impact of proposed alternatives on significant issues identified through scoping. The summaries are focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Table 2-6. Comparison of alternatives by wildlife issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Toxicity Potential of Herbicides	No change would occur from current invasive plant management effects.	**Minimal to no adverse effects** are expected from direct exposure to, or primary or secondary ingestion of, herbicide- treated vegetation or prey animals that have been exposed to herbicides. Design criteria would further minimize potential for effects from herbicide exposure to wildlife species.
Direct and indirect effects of invasive plant species treatment activities (disturbance)	No change would occur from current invasive plant management effects.	**Minimal to no adverse effects** are expected from temporary and localized disturbance caused by invasive plant-treatment activities. Design criteria would further minimize potential for effects from herbicides and disturbance to wildlife species.

Table 2-7. Comparison of alternatives by fisheries and water resource and issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Effects of herbicide to be used within riparian areas on aquatic organisms	No direct or indirect effects as no aquatic herbicide applications are anticipated.	No direct effects. Indirect effects possible through accidental spills but not likely.
Adequacy of design criteria that apply to water quality and aquatic organisms	No direct effects as no aquatic applications are anticipated. Indirect effects possible through increased sedimentation, loss of riparian vegetation, or decreased water quality with increase in aquatic invasive species.	All herbicides application rates used would be below the level of concern for fish. Project design criteria would limit negative effects to aquatic organisms.
Riparian Health and Function	Minimal direct effect/indirect gradual long- term decline in riparian function. Short-term localized disturbance to existing riparian vegetation would occur as a result of mechanical methods and rehabiltiation/restoration	Minimal direct effect/indirect gradual long-term improvement in riparian function. Short-term localized disturbance to existing riparian vegetation would occur as a result of treatment and rehabiltiation/restoration methods that take place within riparian areas. Monitoring and integrated weed

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
	methods that take place within riparian areas.	management would ensure overall improvement in stream health and function over time.
Surface and ground water quality	Herbicide applications have the potential to directly affect concentrations of herbicide in surface water and ground water. There would be no direct effect to surface or ground water quality as no aquatic herbicide applications would be anticipated. Indirect effects could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover. Design criteria would limit these effects.	Herbicide applications have the potential to directly affect concentrations of herbicide in surface water and ground water. The effects could be more under alternative 2 with the ability to implement aquatic applications but would be mitigated by strictly adhering to label directions. Indirect effects could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover. Design criteria would limit these effects.

Table 2-8. Comparison of alternatives by treatment method effect on vegetation.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Potential impact of herbicides to non-target resources and their pollinators.	Native vegetation and special-status plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed. Potential impacts to non-target species would be limited due to methods of control.	Invasive plant treatements would have relatively short-lived detrimental effects and long-term beneficial effects. Detrimental effects would be minimized through implementation of design criteria. Integrated invasive plant management approach would allow for more effective weed management. Native vegetation and special-status plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed. However, adverse effects to populations would be negligible. Design criteria require surveys to determine if special status species are present. If special status species are present, the treatment would be modified to minimize impacts. Potential impacts to non-target species would be limited due to methods of control. Non-selective herbicides would not be used with aerial applications. There would be an increased short-term risk due to aerial spraying, but a long term benfecial effect due to increased weed control.
Potential for spread or reduction of invasive plant infestations measured in acres.	Alternative 1 would result in invasive weed treatment similar to what has been done in the past. The acres of weed treatment has varied from year to year depending on the severity and emphasis on weed management and available budgets. This scenario as	Under Alternative 2, the potential for the spread of invasive plants would be less than under Alternative 1 due to increased flexibility to respond to invasive plants and a more comprehensive approach to prevention and treatment of invasive species. With a new emphasis on EDRR

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
	described in this document would be expected to continue in the future under Alternative 1.	and IWM, it is reasonable to predict that over time, the number of acres affected by invasive species would be fewer than Alternative 1, though it is not possible to accurately quantify the difference in terms of acres due to the number of natural and management variables that affect the spread of invasive species and the level of effort directed at treating their occurrence in the project areas.

Table 2-9. Comparison of alternatives by human health issues.

MEASUREMENT INDICATOR	ALTERNATIVES 1 AND 2 WORKER HEALTH	ALTERNATIVES 1 AND 2 PUBLIC HEALTH
Toxicity Potential of Herbicides being Used	2,4-D amine, Chlorsulfuron, Picloram, Sulfometuron methyl, and Triclopyr TEA with scenarios exceeding the hazard quotient (HQ) level of concern (LOC) for workers at some rate of application, four (Chlorsulfuron, Dicamba, Sulfometuron methyl, and Triclopyr TEA) did not exceed any level of concern at typical application rates. 2,4-D amine exceeded the chronic exposure level of concern at typical application rates. EPA requires LOC to be mitigated with Personal Protective Equipment identified on the label. **Design criteria would minimize all worker exposure** scenarios by following safe work practices and label advisories.	2,4-D amine, Chlorsulfuron, Clopyralid Dicamba, Glyphosate, Sulfometuron methyl, and Triclopyr TEA exhibited scenarios exceeding the HQ LOC at some rate of application. **Design criteria would minimize public exposure** by increasing notification of the public efforts regarding areas where herbicide applications are planned reducing risk that the general public would be exposed to harmful levels of any herbicides used in the implementation of this project.
Adequacy of Design Criteria to Protect Human Health	**Design criteria would minimize all worker exposure** scenarios by following safe work practices and label advisories. The **general public would not be exposed** to harmful levels of any herbicides used in the implementation of this project. Design criteria and enhanced public notification protocols significantly reduce the opportunity for members of the public to be exposed to harmful levels of toxic compounds (herbicides, adjuvants, petroleum products, etc.) used in the implementation of this project. Few plausible scenarios exist that exceed even the most conservative threshold of concern for public health and safety.	

Table 2-10. Comparison of alternatives by wilderness issues.

MEASUREMENT INDICATOR	ALTERNATIVE 1 (CURRENT MANAGEMENT)	ALTERNATIVE 2 (PROPOSED ACTION)
Natural Quality Measure: Acres of nonnative species	Alternative 1 would **negatively affect** the untrammeled and solitude qualities of wilderness character by manipulating vegetation and creating encounters with the public during treatment activities. Treatment activities would be limited in scope and would be of limited duration in any given year. Alternative 1 would beneficially affect the natural and other features of value qualities of wilderness character by reducing nonnative plant infestations, thus preserving high quality habitat. Both direct and indirect adverse effects from Alternative 1 would be short-term and minimal on the qualities of wilderness character. Overall long-term effects to qualities of wilderness character would be positive, although controlling invasive plants on a broad landscape scale would not be addressed.	Alternative 2 would **negatively affect** the untrammeled and solitude qualities of wilderness character by manipulating vegetation and creating encounters with the public during treatment activities. However, activities would be limited in scope and would be of limited duration in any given year. Alternative 2 would beneficially affect the natural and other features of value qualities of wilderness character by reducing nonnative plant infestations, thus preserving high quality habitat. The variety of treatment methods available in Alternative 2, including aerial application (outside designated wilderness areas), would allow some measure of control for existing invasive plant populations in terms of density and potential spread to wilderness areas thus preventing new invasive infestations if identified early enough (EDRR). Alternative 2 would best preserve wilderness characteristics of the resource because of the variety of treatment methods available, including aquatic and aerial application (outside designated wilderness areas), which allows for more effective control.

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS

3.1 Introduction

This chapter describes the existing conditions of the project area by resource and the environmental effects of implementing the alternatives described in Chapter 2. Each resource section describes the current environment and analyzes alternatives that address the purpose of the project to reduce the negative effects of existing and future invasive plants on each resource that may be adversely impacted. Each resource section also addresses the issues and concerns identified during internal and public scoping with respect to control of invasive plant species.

Compliance with Forest planning documents and other relevant direction was reviewed for each resource analyzed in this document. The applicable laws, regulations, policy, and directions for each resource are found in Appendix F.

Resource specialist reports were developed for each resource included in this analysis and are maintained in the project record.

3.2 Issue 1: Terrestrial Wildlife

The terrestrial wildlife resource specialist report was developed for this analysis and is included by reference (USDA Forest Service 2020a).

3.2.1 Methodology for Analysis

3.2.1.1 Risk Assessments

The effects of herbicide use depend on the toxicity of the herbicide, the level of exposure to the herbicide, and the duration of the exposure. Risk assessments evaluate the potential effects to non-target plants, wildlife, human health, soils, and aquatic organisms from the herbicides considered for use within the CTNF and CNG. The USDA Forest Service contracted with Syracuse Environmental Research Associates, Inc., (SERA) to evaluate human health and ecological effects of herbicides using EPA studies and other peer-reviewed literature from the scientific community. Information from laboratory and field studies of herbicide toxicity, exposure, and environmental fate was used to estimate the risk of adverse effects to non-target terrestrial and aquatic organisms, humans, water, and soil. Table 3-1 identifies the risk assessments available by active ingredient.

In addition to the analysis of potential hazards to wildlife from the active ingredients in the herbicides, SERA risk assessments also evaluated available scientific studies of potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. There is usually less toxicity data available for these substances when compared to the herbicide active ingredient because they are not subject to the extensive testing required for the herbicide active ingredients under FIFRA.

Table 3-1. USDA Forest Service risk assessments for herbicides used, or proposed for use, in the project area.

HERBICIDE (ACTIVE INGREDIENT)	DATE FINAL	RISK ASSESSMENT REFERENCE[a, b]
2,4-D amine	September 30, 2006	USDA Forest Service
Aminopyralid	June 8, 2007	SERA TR-052-04-04a
Chlorsulfuron	November 21, 2004	SERA TR 04-43-18-01c
Clopyralid	December 5, 2004	SERA TR 04-43-17-03c
Dicamba	November 24, 2004	SERA TR 04-43-17-06d
Glyphosate	March 25, 2011	SERA TR-052-22-03b
Imazamox	December 10, 2010	SERA TR-052-24-02a
Imazapic	December 23, 2004	SERA TR 04-43-17-04b
Imazapyr	December 16, 2011	SERA TR-052-29-03a
Metsulfuron methyl	December 9, 2004	SERA TR 04-43-17-01c
Picloram	September 29, 2011	SERA TR-052-27-03a
Rimsulfuron	March 2014	USDI Bureau of Land Management
Sulfometuron methyl	December 14, 2004	SERA TR 03-43-17-02c
Triclopyr: triethylamine salt (TEA)	May 24, 2011	SERA TR-052-25-03a

[a] https://www.fs.fed.us/foresthealth/protecting-forest/integrated-pest-management/pesticide-management/pesticide-risk-assessments.shtml.
[b] SERA = Syracuse Environmental Research Associates, Inc.
Note: Atrazine, Hexazinone, and Medfludle are authorized but not used.

Risk assessments look at both human health and ecological aspects and contain the following information:

- ***Hazard characterization.*** What are the dangers inherent with the active ingredient?
- ***Exposure assessment.*** Who could come into contact and how much?
- ***Dose response assessment.*** How much is too much?
- ***Risk characterization.*** Is there a plausible basis for concern?

The risk assessments considered worst-case scenarios, including accidental exposures and application at maximum label rates. Although the risk assessments have limitations, they represent the best science available. The risk assessment methodologies and detailed analyses are incorporated into conclusions about herbicide toxicology in this document.

3.2.1.2 Exposure Scenarios

For each ecological risk assessment, a set of general exposure scenarios are analyzed. For wildlife, exposure scenarios included an animal being directly sprayed; ingestion of contaminated vegetation, prey species, or water; grooming activities; and indirect contact with contaminated vegetation (SERA 2007a).

Direct-spray scenarios include a 20-g mammal sprayed directly over half of its body surface. One scenario is the absorbed dose over a 24-hour period based on the relationship between bodyweight and surface area. The other scenario is complete absorption of the dose over a 24-hour period due to grooming and increased dermal permeability. Direct-spray scenarios are not given for large mammals unless toxicity data indicates that large mammals are more sensitive to the active ingredient than small mammals. The other direct-spray scenario is a honeybee with assumed complete absorption over a 24-hour period (SERA 2007a).

Indirect-contact scenarios, both acute and chronic, are based upon ingestion of contaminated vegetation or prey. One is a 20-g mammal consuming 3.6 g (18 percent of bodyweight) of contaminated vegetation per day. One is for a 70-kg mammal, with caloric requirements for the animal and the caloric content of the vegetation used in the modeling. Acute scenarios assume that the vegetation was sprayed directly and that 100 percent of the diet is contaminated. Two chronic scenarios are modeled; the animal consumes vegetation for a 90-day period after herbicide application (consisting of 30 percent of the diet), and the animal eats vegetation 25–100 feet from the application site, but 100 percent of the diet is assumed to be contaminated by drift. Both chronic exposure scenarios are modeled for large birds (4 kg) as well (SERA 2007a).

For predatory species, exposure scenarios for a small bird (10 grams) and a small mammal (20 grams) consuming contaminated insects (residue rates of 45–135 parts per million per pound per acre) were modeled. The consumption of small mammals by predatory mammals or birds was modeled; the assumption made was that the small prey mammal was directly sprayed with 100 percent absorption. Both acute and chronic exposure scenarios for the consumption of contaminated fish by predatory birds were modeled; because birds consume more food per body unit than mammals, the consumption of fish by predatory mammals was not analyzed (SERA 2007a).

The ingestion of contaminated water was modeled. A 20-g mammal consumes about 0.005 liters (L) water per day, which equates to 0.25 L per kg of bodyweight per day. The acute exposure scenario was based on the field dilution rate and the amount spilled (generally assumed to be 200 gallons) and the chronic exposure scenario was based on the water contamination rate and the application rate of the herbicide (SERA 2007a).

3.2.1.3 Factors Influencing Exposure and Dose

The exposure of an animal to an herbicide is greatly influenced by the relationships between body size and several physiological, metabolic, and pharmacological processes (allometry). For example, allometric relationship dictates that smaller animals have a larger amount of surface area for their mass than larger animals. This relationship greatly influences basic physiological properties, such as food consumption and thermoregulation. Some of the allometric factors influencing exposure to herbicides are detailed below.

3.2.1.3.1 Bodyweight

Several parameters used to estimate herbicide contact are reported on a “per-body-weight” basis, expressed in grams or kilograms. For example, both food and water ingestion rates are reported on a per-body-weight basis (such as the number of grams of fresh food or water per gram of bodyweight per day). Bodyweights, in units of mass, are reported as fresh weight that might be obtained by weighing a live animal in the field. Also, body-weight data are used in empirical models to calculate some parameters, such as surface area, when no specific measurements are available. “Potential dose to animal” is calculated using animal bodyweight.

3.2.1.3.2 Metabolic Rate

Metabolic rate is not directly calculated in this document or in the SERA risk assessments but reported values for various species were used to calculate food consumption requirements. Metabolic rate is reported on the basis of kilocalories (kcal) per kg of bodyweight per day

(kcal/kg/day). Metabolic rate is closely related to body size, with smaller animals generally having higher metabolic rates than larger animals.

3.2.1.3.3 Contact Route

Exposure involves direct contact with the herbicide, and wildlife may be exposed to herbicides by ingesting the chemical (oral) or by external contact (dermal). Oral exposures may occur from eating contaminated vegetation or prey, drinking contaminated water, or through grooming activities. Dermal exposures may occur from direct spray or contact with contaminated vegetation or water. These contact routes are influenced by allometric relationships, as well as habitat preferences and feeding behaviors.

3.2.1.3.4 Oral Routes

Food Ingestion. Small animals generally have higher caloric requirements than large animals, so a small animal ingests a greater amount of food per unit of bodyweight compared to large animals. A 20-g mouse, for example, will generally consume an amount of food equal to about 15 percent of its bodyweight every day, depending on calorie content of the diet. A value of 3.6 grams of food consumed per day for a 20-g mouse is used in the SERA risk assessments for calculating exposure from contaminated food. This calculation is equivalent to 18 percent of the bodyweight and is generated from general allometric relationships for food consumption in rodents. This value may underestimate exposure to small mammals that consume primarily vegetation rather than seeds. Food consumption is calculated from caloric requirements for different-sized animals for the various exposure scenarios in the SERA risk assessments.

Dietary Composition. Dietary composition is an important consideration in exposure assessments because different foods have varying herbicide residues. Grasses may have substantially higher residues than fruits or other vegetation. The SERA risk assessments use data from Siltanen et al. (1981) for concentrations of herbicide residues on fruit. Also, small insects may contain higher residues than large insects based on empirical relationships (Pfleeger et al. 1996). Some herbicides have the potential to bioaccumulate in fish; therefore, fish-eating birds may be exposed. Caloric content of various foods, in combination with caloric requirements of animals, was used to estimate the daily amount of food consumed based on data from EPA ORD (US EPA1993). In the USDA Forest Service/SERA risk assessments, exposure scenarios used a large herbivore consuming a 100-percent grass diet, a large bird consuming grass, a small bird consuming small insects, and a predatory bird consuming contaminated fish.

Water Ingestion. Well-established relationships exist between bodyweight and water consumption across a wide range of mammalian species. Mice, weighing about 20 g (0.02 kg) consume about 0.005 L of water per day (0.25 L/kg/day). These values were used in the exposure scenarios for small mammals. Since the body-size-to-volume relationship dictates that smaller animals will receive larger doses for a given exposure, consumption of contaminated water was not calculated for larger animals. Water ingestion is obviously influenced by environmental factors, such as heat and availability. But estimates for the variability in water consumption are not available for wildlife.

Grooming. Birds and mammals may spend a great deal of time grooming fur or feathers. If the animal has been exposed to herbicide, some chemical may be absorbed through the grooming process. However, a study by Gaines (1969) suggests that grooming is not significant in the toxic response of small mammals. At any rate, the doses received from grooming would be less than

those received through contaminated food or direct spray, given the assumptions in the exposure scenarios. See dermal exposure route information below.

3.2.1.3.5 Dermal Routes

Dermal contact can occur from direct spray, contact with contaminated vegetation, or contact with contaminated water. Because only a small portion of an applied herbicide would be available as dislodgeable residue on vegetation, or in a waterbody where it was diluted, dermal exposure was modeled only for direct-spray scenarios in USDA Forest Service/SERA risk assessments. The extent of dermal contact for an animal would depend on the application rate of the herbicide, the surface area of the animal, and the rate of absorption. Since a larger proportion of a small animal's body would be involved (relative to larger animals) direct-spray scenarios were conducted only for a small mammal and a honeybee in the USDA Forest Service/SERA risk assessments. Skin, fur, and feathers provide some protection from chemicals, and not all of the chemical on an animal would be absorbed.

3.2.1.4 Limitations Associated with Risk Assessments

Risk assessments have a degree of uncertainty in their interpretation and extrapolation of data. Uncertainty may result from a study design, data collection, data interpretation, and extreme variability associated with aggregate effects of natural and synthesized chemicals on organisms, including humans, and with ecological relationships. Numbers used, particularly in ecological realms, are uncertain, and limits exist on our ability to understand or demonstrate causal relationships. Because of data gaps, assessments rely heavily on extrapolating from laboratory animal tests (USDA Forest Service 2005). Regardless of disadvantages and limitations of ecological and human-health risk assessments, risk assessments can determine (given a particular set of assumptions) whether a basis exists for asserting whether a particular adverse effect is plausible. The bottom line for all risk analyses is that absolute safety can never be proven, and the absence of risk can never be guaranteed (SERA 2007a).

Better risk estimates could be calculated if laboratory data on the toxicity of the herbicides considered in this analysis were available for more groups of animals and more individual species. These additional data would provide more information on the comparative sensitivities of different wildlife groups and the types of adverse effects that may occur in different species.

However, because of the dynamic nature of wildlife and their habitat (e.g., behavior, weather, nutrient availability, contaminant presence), significant uncertainties would remain for predicting short- and long-term reactions to herbicide presence in natural settings even if more laboratory data were available.

Limitations notwithstanding, substantial scientific data exist on the toxicity of these herbicides to birds and mammals, as well as amphibians and some invertebrates. These data are generated by manufacturers to meet EPA regulations before an herbicide may be registered for use, and by independent researchers who have published findings in peer-reviewed literature. These data are analyzed according to standard risk-assessment methodology to reach a characterization of risk for each herbicide. The summary of the available scientific evidence and our evaluation of reasonably foreseeable impacts are detailed in the following sections.

Research has not been conducted on the effects of these herbicides to most free-ranging wildlife species, so the relevant data to specifically evaluate effects to different wildlife species are incomplete or unavailable, as noted below:

- Analysis of effects for any project involving herbicide use relies upon extrapolations from laboratory animals to free-ranging wildlife and controlled conditions to the natural environment.
- More data are available for mammals than for birds, which necessitated using mammal toxicity values in bird exposure scenarios for some of the herbicides considered in this analysis.

3.2.2 Affected Environment

3.2.2.1 Endangered, Threatened, Proposed, and Regional Forester's Sensitive Species

There are no endangered terrestrial wildlife species within the analysis area. There are however threatened and proposed species. Effects to threatened and proposed species or Regional Forester's sensitive species that are known or expected to occur within the CTNF and CNG are listed in Table 3-2. A more detaild description of the habitat requirements, threats, and status on the forest for each species carried into analysis can be found in the wildlife resource specialist report (USDA Forest Service 2020a).

Table 3-2. The habitat and threats for threatened, proposed, and sensitive wildlife species carried into analysis.

SPECIES	HABITAT	THREATS
Threatened and Proposed		
Canada Lynx (*Lynx canadensis*)	High-elevation boreal or coniferous forest.	Habitat loss and degradation, hunting, barriers to movement, and hybridization with bobcats.
Canada Lynx Critical Habitat	Not Present On CTNF	-
Grizzly Bear (*Ursos arctos horribilis*)	Woodlands, forests, alpine meadows, praries, riparian areas.	Grizzly bear/human interactions, loss of secure habitat.
Yellow-billed Cuckoo (*Coccyzus americanus*)	Dense thickets and deciduous trees near water.	Deteriorating riparian condition, fragmentation and loss of wintering habitat.
Proposed Yellow-billed Cuckoo Critical Habitat	81 Acres on the CTNF	-
Wolverine (*Gulo gulo*)	High elevation alpine habitat with mixed conifer and subalpine fir with abundant snow cover in winter.	Habitat fragmentation and reduced connectivity, winter recreational use, and climate change.
Sensitive		
Bighorn Sheep (*Ovis canadensis*)	Steep terrain in canyons, foothills and mountains with grasses and forbs.	Disease transmission from domestic sheep, habitat connectivity.
Gray Wolf (*Canis lupus*)	Habitat generalist that selects areas with abundant ungulate prey and away from human disturbance.	Hunting, trapping, vehicle collisions, loss of ungulate habitat.

SPECIES	HABITAT	THREATS
Pygmy Rabbit (*Brachylagus idahoensis*)	Sagebrush obligate.	Habitat loss from fire, grazing and invasive species and habitat fragmentation.
Spotted Bat (*Euderma maculatum*)	Habitat generalist that selects areas with large cliffs and canyons.	Habitat loss, disturbance during roosting, accumulation of pesticides.
Fisher (*Pekania pennanti*)	Mature and old-growth forested habitat with high canopy closure.	Habitat fragmentation, habitat loss, trapping and hunting.
Townsend's Big-eared Bat (*Corynorhinus townsendii*)	Forested habitats with cliffs and stream corridors near caves and rock shelters	Habitat loss, loss of hibernacula and disturbance during roosting.
Bald Eagle (*Haliaeetus leucocephalus*)	Riparian habitat and large trees near water.	Shooting and poisoning, disturbance during nesting.
Boreal Owl (*Aegolius funereus*)	Boreal forest.	Habitat loss, loss of habitat for prey species, snag removal.
Greater Sage-grouse (*Centrocercus urophasianus*)	Sagebrush and shrub habitats near sagebrush.	Habitat loss and fragmentation due to fire, grazing and invasive species.
Peregrine Falcon (*Falco peregrinus*)	Mountains, major river corridors, reservoirs and lake basins with cliffs for nesting.	Habitat loss and disturbance during nesting.
Common Loon (*Gavia immer*)	Lakes and large ponds.	Disturbance during nesting and loss of suitable shoreline habitat for nesting.
Flammulated Owl (*Psiloscops flammeolus*)	Open, mature ponderosa pine for nesting and a variety of shrub and grassland habitats for foraging.	Habitat loss and fragmentation, and snag removal.
American Three-toed Woodpecker (*Picoides dorsalis*)	Spruce forest and coniferous forests with bark beetles.	Habitat loss.
Great Gray Owl (*Strix nebulosa*)	Mature mixed-coniferous and hardwood forests with small openings.	Habitat loss and snag removal.
Northern Goshawk (*Accipiter gentilis*)	Mixed conifer forests with old-growth habitat for nesting.	Habitat loss.
Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus*)	Grass-shrub habitats.	Habitat loss, habitat fragmentation, and invasive species.
Trumpeter Swan (*Cygnus buccinator*)	Open-water habitat.	Degradation of breeding and wintering habitat and disturbance during the breeding season.
Harlequin Duck (*Histrionicus histrionicus*)	Swiftly flowing inland streams and rivers.	Habitat degradation, shooting, trapping, loss of nesting habitat.
Columbia Spotted Frog (*Rana luteiventris*)	Permanent bodies of water and riparian habitats.	Habitat loss and recreational use near aquatic habitat.
Boreal Toad (*Anaxyrus boreas boreas*)	Slow-moving or still water and riparian habitat.	Disease and parasites, habitat loss, trampling by livestock, and changes in water quality.

The federally listed, proposed, and candidate species and Regional Forester's sensitive species that are carried into analysis are based on both the 2016 Intermountain Region (R4) Threatened, Endangered, Proposed, and Sensitive Species list and the Official Species List prepared by the USFWS Environmental Conservation Online System—Information, Planning, and Consultation System (ECOS-IPaC) for the project area (Consultation Codes 01EIFW00-2020-SLI-0611

[Idaho], 06E11000-2020-SLI-0218 [Montana], 06E23000-2020-SLI-0422 [Utah], and 06E13000-2020-SLI-0145 [Wyoming]), which is dated February 28, 2020. Species that appear on the IPaC list but are not noted in the 2016 Intermountain Region (R4) Threatened, Endangered, Proposed, and Sensitive Species list as present within the Caribou or Targhee National Forests were not carried into analysis.

3.2.2.2 Resource Condition Indicators for Management Indicator Species

While numerous wildlife species occur within the proposed action area, MIS are used to assess effects of management activities on groups of species with similar habitats. Greater sage-grouse, Columbian sharp-tailed grouse, and northern goshawk are MIS for the Caribou National Forest. Greater sage-grouse, Columbian sharp-tailed grouse, and riparian breeding birds are MIS for the CNG. Since greater sage-grouse, Columbian sharp-tailed grouse, and northern goshawk are also Region IV-sensitive species, they are analyzed under the sensitive species section (see Table 3-2). Thus, riparian breeding birds are the only species analyzed under the MIS designation.

Migratory bird species are also analyzed as directed under the Migratory Bird Treaty Act (Executive Order 13186, signed January 10, 2001) and a Memorandum of Understanding between the USDA Forest Service and USFWS, signed December 2008 (USFWS 2001).

3.2.2.2.1 Riparian Breeding Birds

A more detaild description of the habitat requirements, threats, and status on the forest for each species carried into analysis can be found in the wildlife resource specialist report (USDA Forest Service 2020a).

Habitat. Riparian breeding birds were selected as indicators of riparian health. The Idaho Partners In Flight Bird Conservation Plan (Idaho PIF; Idaho PIF 2000) identified riparian areas as one of the highest-priority habitats for conservation in Idaho based on the total number of birds that utilize riparian habitat as their primary breeding habitat. While riparian habitat constitutes less than 1 percent of the western United States, more species of birds use this habitat than any other type in North America (Knopf et al. 1988, Douglas et al. 1992).

Threats. Some riparian breeding birds have experienced declining populations due to loss of high-quality riparian habitat. Riparian habitat within the CTNF and CNG has been modified by farming, livestock grazing, water diversion, spring diversion, and drilling of water wells, resulting in lower-quality riparian areas (USDA Forest Service 2002).

3.2.2.2.2 Migratory Bird Species

A more detaild description of the habitat requirements, threats, and status on the forest for each species carried into analysis can be found in the wildlife resource specialist report (USDA Forest Service 2020a).

Habitat. The entire project area provides potential breeding habitat for migratory birds. Nine migratory bird species identified as high-priority species in The Idaho PIF (Idaho PIF 2000) are known to occur or suspected to occur in the project area (in association with their primary breeding habitat (Table 3-3). Within the analysis area, the following Idaho PIF avian habitats occur and are utilized by a number of high-priority species known to occur or potentially occur within the CTNF and CNG during the breeding season (Table 3-3) (Idaho PIF 2000):

sagebrush/salt desert scrub, grassland, high-elevation mixed conifer, low-elevation mixed conifer, juniper/pinyon/mountain mahogany, and riparian.

Table 3-3. Migratory bird species identified on the US Fish and Wildlife Service (USFWS), Idaho State Wildlife Action Plan (ISWAP), Idaho Partners in Flight (PIF), Utah State Wildlife Action Plan (USWAP), and/or the Wyoming State Wildlife Action Plan (WSWAP) lists that are known to occur or suspected to occur in the action area.

SPECIES NAME	SCIENTIFIC NAME	LIST DESIGNATION				
American bittern	*Botaurus lentiginosus*		ISWAP		USWAP	WSWAP
American kestrel	*Falco sparverius*					WSWAP
American pipit	*Anthus rubescens*					WSWAP
American white pelican	*Pelecanus erythrorhynchos*		ISWAP		USWAP	WSWAP
Ash-throated flycatcher	*Myiarchus cinerascens*					WSWAP
Bald eagle	*Haliaeetus leucocephalus*	USFWS			USWAP	WSWAP
Bewick’s wren	*Thryomanes bewickii*					WSWAP
Black-backed woodpecker	*Picoides arcticus*					WSWAP
Black-chinned hummingbird	*Archilochus alexandri*					WSWAP
Black-crowned night-heron	*Nycticorax*					WSWAP
Black rosy-finch	*Leucosticte atrata*				USWAP	WSWAP
Black tern	*Chlidonias niger*		ISWAP			WSWAP
Black-throated gray warbler	*Setophaga nigrescens*					WSWAP
Blue-gray gnatcatcher	*Polioptila caerulea*					WSWAP
Bobolink	*Dolichonyx oryzivorus*					WSWAP
Boreal owl	*Aegolius funereus*				USWAP	WSWAP
Brewer's sparrow	*Spizella breweri*	USFWS				WSWAP
Burrowing owl	*Athene cunicularia*		ISWAP		USWAP	WSWAP
California gull	*Larus californicus*		ISWAP			
Calliope hummingbird	*Selasphorus calliope*	USFWS				WSWAP
Canyon wren	*Catherpes mexicanus*					WSWAP
Caspian tern	*Hydroprogne caspia*		ISWAP		USWAP	WSWAP
Cassin's finch	*Haemorhous cassinii*	USFWS		PIF		
Clark’s grebe	*Aechmophorus clarkii*		ISWAP			WSWAP
Clark's nutcracker	*Nucifraga columbiana*		ISWAP			WSWAP
Columbian sharp-tailed grouse	*Tympanuchus phasianellus*		ISWAP		USWAP	WSWAP
Common loon	*Gavia inmer*		ISWAP			WSWAP
Common nighthawk	*Chordeiles minor*		SWAP			WSWAP
Common yellowthroat	*Geothlypis trichas*					WSWAP
Evening grosbeak	*Coccothraustes vespertinus*			PIF		
Ferruginous hawk	*Buteo regalis*	USFWS	ISWAP		USWAP	WSWAP
Flammulated owl	*Psiloscops flammeolus*	USFWS		PIF	USWAP	WSWAP
Forster’s Tern	*Sterna forsteri*					WSWAP
Franklin's gull	*Leucophaeus pipixcan*		ISWAP			WSWAP

SPECIES NAME	SCIENTIFIC NAME	LIST DESIGNATION				
Golden eagle	*Aquila chrysaetos*		ISWAP		USWAP	WSWAP
Grasshopper sparrow	*Ammodramus savannarum*		ISWAP			WSWAP
Greater sage-grouse	*Centrocercus urophasianus*	USFWS	ISWAP	PIF	USWAP	WSWAP
Great gray owl	*Strix nebulosa*		ISWAP			WSWAP
Green-tailed Towhee	*Pipilo chlorurus*	USFWS				
Harlequin duck	*Histrionicus histrionicus*		ISWAP			WSWAP
Horned lark	*Eremophila alpestris*	USFWS				
Lewis's woodpecker	*Melanerpes lewis*	USFWS	ISWAP	PIF	USWAP	WSWAP
Loggerhead shrike	*Lanius ludovicianus*	USFWS				WSWAP
Long-billed curlew	*Numenius americanus*	USFWS	ISWAP			WSWAP
MacGillivray's warbler	*Geothlypis tolmiei*					WSWAP
McCown's longspur	*Rhynchophanes mccownii*			PIF		WSWAP
Merlin	*Falco columbarius*					WSWAP
Mountain plover	*Charadrius montanus*					WSWAP
Northern goshawk	*Accipiter gentilis*					WSWAP
Northern pygmy-owl	*Glaucidium gnoma*				USWAP	WSWAP
Olive-sided flycatcher	*Contopus cooperi*	USFWS	ISWAP	PIF	USWAP	
Peregrine falcon	*Falco peregrinus*	USFWS			USWAP	WSWAP
Red crossbill	*Loxia curvirostra*					WSWAP
Red-eyed vireo	*Vireo olivaceus*					WSWAP
Rufous hummingbird	*Selasphorus rufus*	USFWS		PIF		WSWAP
Sage thrasher	*Oreoscoptes montanus*	USFWS	ISWAP			WSWAP
Sagebrush sparrow	*Artemisiospiza nevadensis*		ISWAP			WSWAP
Sandhill crane	*Grus canadensis*		ISWAP			
Short-eared owl	*Asio flammeus*	USFWS	SWAP			WSWAP
Snowy egret	*Egretta thula*					WSWAP
Snowy plover	*Charadrius nivosus*	USFWS			USWAP	WSWAP
Swainson's hawk	*Buteo swainsoni*	USFWS				WSWAP
Trumpeter swan	*Cygnus buccinator*		ISWAP			WSWAP
Virginia's warbler	*Leiothlypis virginiae*	USFWS		PIF		WSWAP
Western grebe	*Aechmophorus occidentalis*		ISWAP			WSWAP
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	USFWS	ISWAP		USWAP	WSWAP
White-faced ibis	*Plegadis chihi*		ISWAP		USWAP	WSWAP
Williamson's sapsucker	*Sphyrapicus thyroideus*	USFWS				WSWAP
Willow flycatcher	*Empidonax traillii*	USFWS			USWAP	WSWAP

Threats. While migratory birds are protected under the MBTA, many species are experiencing population declines across their range. The biggest threat to migratory birds is habitat loss due to development, agriculture, forestry practices, and climate change. Additional mortality from collisions with man-made structures, feral cats, and natural processes contribute to declining populations.

The list of evaluated riparian breeding bird species and migratory bird species were those that are included on the USFWS List of Birds of Conservation Concern (USFWS 2008), Idaho PIF Birds of Conservation Concern list (Idaho PIF 2000), and/or the Idaho, Utah, and Wyoming State Wildlife Action Plan Species Of Greatest Conservation Need Lists (IDFG 2015, UDWR 2015, WGFD 2017) which are known or suspected to occur in the analysis area (Table 3-3).

3.2.2.3 Big-Game Species of Interest

Three big-game species of interest were considered for this analysis (Table 3-4).

Table 3-4. The habitat and threats for big-game species of interest carried into analysis.

SPECIES	HABITAT	THREATS
Mule Deer (*Odocoileus hemionus*)	Habitat generalist, but typically open habitat near forested cover.	Habitat loss, loss of suitable winter range, hunting, predation, and disease.
Rocky Mountain Elk (*Cervus elaphus*)	Habitat generalist, but typically open habitat near forested cover.	Habitat loss, loss of suitable winter range, hunting, predation, and disease.
Shiras Moose (*Alces alces*)	Mountainous conifer forest with riparian habitat.	Habitat loss, loss of suitable winter range, hunting, predation, and disease.

3.2.3 Environmental Consequences

In this document the effects of the alternatives are separated by issue. There are two issues that pertain to impacts on wildlife species. The first is the impact of exposure to herbicides. Impacts related to this issue are analyzed in Section 9.1. The second issue pertaining to impacts on wildlife species is the potential impacts of disturbance due to invasive plant treatments. Impacts related to this issue are analyzed in Section 9.2.

3.2.3.1 Direct and Indirect Effects of Invasive Plant Treatment Activities Related to Toxicity Potential of Herbicides and Other Chemicals Proposed for Use

Most of the herbicides proposed for use for this project pose low or no risk to wildlife. The quantitative analysis for several of the herbicides revealed that exposures over the no-adverse-effect level (toxicity threshold) are mathematically possible given extreme assumptions such as a bird or mammal feeds on nothing but contaminated vegetation that has been heavily laden with herbicide. More realistic central and lower estimates, assuming less contamination in the vegetation and less feeding, indicate exposures over the no-adverse-effect level are not likely. The analysis below focuses on possible exposures over a LOC using central values. In some cases, upper values are discussed to provide context; however, herbicides that have only one or two scenarios over a LOC for wildlife at the upper estimates are not discussed in detail because the level of exposure that would have to occur is implausible given the type of infestations that would be treated and the project design criteria that would apply to new detections and current infestations.

3.2.3.2 Alternative 1—No Action/Current Management

Under the No Action/Current Management Alternative, no change would occur from current invasive plant management efforts. This alternative would continue the same invasive plant-

management programs, treatments, and levels of effort for controlling invasive plants within the CTNF and CNG that are currently used. In general, this alternative includes treating terrestrial invasive plants using biological, mechanical, and/or herbicide treatments. Herbicide application under this alternative is limited to the treatment of terrestrial invasive plants with 14 herbicides and the utilization of ground-based application techniques exclusively. The toxicity potential of herbicides proposed in Alternative 1 are included in the Alternative 2 discussion below.

3.2.3.3 Alternative 2—Proposed Action

Under the Proposed Action, invasive plants and noxious weeds species would be eradicated, controlled, or contained using a variety of methods. Following treatment, sites would be restored (where determined to be appropriate) to native vegetation. Loss of native habitat to invasive plant infestations would decrease over time as invasive plant populations are reduced and eliminated. Wildlife species would benefit as native plant communities are restored following invasive plant treatment. Restored plant communities would provide improved forage, hiding cover, and reproductive cover for wildlife as plant density increases, plant canopy cover increases, plant diversity increases, and multi-layered grass/forb/shrub canopies develop compared to existing conditions in areas infested by invasive plants. Wildlife species with source habitats in grassland, forb communities, riparian areas, and low elevation pine and fir forests would benefit since these plant communities generally have a higher incident of invasive plant infestation than other plant communities occurring within the CTNF and CNG.

Risk from herbicide exposure was determined using data and methods outlined in the SERA risk assessments. There is insufficient data on species-specific responses to herbicides for free-ranging wildlife, so wildlife species were placed into groups based on taxa (i.e., bird, mammal, amphibian), body size (large, small), and diet (insectivore, piscivore, herbivore) for each exposure scenario considered. Quantitative estimates of dose for each animal grouping and for each herbicide are contained in the project file worksheets.

Generally speaking, mammals and birds that eat insects or grass may be harmed by some herbicides and surfactants. Amphibians also appear to be at higher risk of adverse effects because of their permeable skin and aquatic or semi-aquatic life history. Only products labeled for aquatic application would be used within or near aquatic systems.

Upper HQs calculated for taxa groups by body size and diet (Table 3-5) do not account for factors such as timing of application, method of application, animal behavior, animal feeding strategies, seasonal presence or absence within a treatment area, and implementation of design criteria. As a result, these values represent the most extreme exposure scenario to the animal, and actual exposure will likely be less because of the factors listed above.

Table 3-5. Relationship between exposure scenarios considered to calculate hazard quotients (HQs) in SERA risk assessments and species evaluated in this analysis.

SPECIES	EXPOSURE SCENARIOS CONSIDERED
Canada Lynx	Small mammal direct spray, consuming contaminated water (spill), carnivore consuming small mammal
Grizzly Bear	Small mammal direct spray, consuming contaminated vegetation, carnivore consuming small mammal
Yellow-billed Cuckoo	Small bird, consuming contaminated vegetation and insects
Wolverine	Small and large mammal scenarios considered, carnivore consuming small mammal, consuming contaminated vegetation and insects
Bighorn Sheep	Large mammal, consuming contaminated vegetation
Gray Wolf	Large mammal, carnivore consuming small mammal
Pygmy Rabbit	Small mammal direct spray, consuming contaminated water (spill), consuming contaminated vegetation
Spotted Bat	Small mammal direct spray, consuming contaminated water (spill), consuming contaminated insects
Fisher	Small mammal direct spray, consuming contaminated water (spill), consuming contaminated vegetation and insects, carnivore consuming small mammal
Townsend's Big-eared Bat	Small mammal direct spray, consuming contaminated water (spill), consuming contaminated insects
Bald Eagle	Large bird, predatory bird consuming small mammal and fish
Boreal Owl	Small bird, predatory bird consuming small mammal
Greater Sage-Grouse	Large bird, consuming contaminated vegetation and insects
Peregrine Falcon	Small and large bird scenarios considered, predatory bird consuming small mammal
Common Loon	Large bird, predatory bird consuming fish
Flammulated Owl	Small bird, consuming contaminated vegetation and insects
American Three-toed Woodpecker	Small bird, consuming contaminated insects
Great Gray Owl	Large bird, predatory bird consuming small mammal
Columbian Sharp-tailed Grouse	Small and large bird scenarios considered, consuming contaminated vegetation and insects
Northern Goshawk	Large bird, predatory bird consuming small mammal
Trumpeter Swan	Large bird, consuming contaminated vegetation
Harlequin Duck	Small bird, consuming contaminated insects
Columbia Spotted Frog	Amphibian
Boreal Toad	Amphibian
Riparian breeding birds	Large and small bird scenarios considered, consuming contaminated vegetation and insects, predatory bird consuming small mammal scenario also considered.
USFWS, SWAP, and PIF identified migratory birds	Large and small bird scenarios considered, consuming contaminated vegetation and insects, predatory bird consuming small mammal scenario also considered.
Mule Deer	Large mammal, consuming contaminated vegetation.
Shiras Moose	Large mammal, consuming contaminated vegetation.
Rocky Mountain Elk	Large mammal, consuming contaminated vegetation.

Nonetheless, caution in the design and implementation of the project is warranted. In many cases, sufficient data is not available to allow for a quantitative risk assessment. For instance, there is no quantitative scenario for a peregrine falcon, a predatory bird that eats primarily other birds. The closest surrogate was determined to be the "fish-eating bird" scenario. This scenario likely over-estimates the dose to the peregrine falcon because the hypothetical fish consumed are from a pond contaminated by a large spill of herbicide. Therefore, these hypothetical fish likely have higher concentrations of herbicide in their bodies (and thus a higher dose to the predatory bird) than would a small bird that incidentally ingested herbicide before it was preyed upon. Also, data was insufficient to assess risk of chronic exposures for insect-eating birds and mammals for several herbicides.

The spatial extent of infestations, which are often limited primarily to disturbed roadsides and the limits placed on herbicide applications, would reduce the exposure risk of wildlife to herbicides. To account for uncertainty, design criteria place restrictions on how and where herbicides are applied.

Professional judgment was used to evaluate the life-history traits (e.g., diet, habitat, activity patterns, seasonal occurrence) of each wildlife species to determine the likelihood of exposure to herbicides used to treat invasive plants. The combinations of likelihood of exposure, dose estimated from exposure scenarios, and, when available, GIS wildlife location data for the USDA Forest Service were used to conclude a risk-of-effect from herbicide treatments. The exposure scenarios result in a dose below the toxicity index for aminopyralid, chlorsulfuron, clopyralid, imazamox, imazapic, imazapyr, picloram, rimsulfuron, glyphosate and metsulfuron methyl. Results of this analysis for 2,4-D, dicamba, sulfometuron methyl, and triclopyr TEA pose still-low but comparatively greater risks.

The SERA risk assessments evaluate the potential effects to organisms by calculating the HQ. The HQ is the amount of herbicide or additives to which an organism may be exposed over a specified period divided by that estimated daily exposure level at which no adverse health effects are likely to occur. Tables 3-6 and 3-7 display the central HQs for proposed herbicides in which exposure scenarios resulted in HQs greater than 1.0. An HQ less than or equal to 1.0 indicates an extremely low level of risk; therefore, an HQ less than or equal to 1.0 is presumed to indicate a level of exposure below the LOC for adverse health effects. The potential adverse health effects for scenarios involving HQs that exceed 1.0 are discussed under each herbicide in the following section.

Proposed herbicides not included in Tables 3-6 and 3-7 (aminopyralid, chlorsulfuron, clopyralid, imazamox, imazapic, imazapyr, metsulfuron methyl, rimsulfuron glyphosate, and picloram) resulted in HQs less than 1.0 for all exposure scenarios. Please see Appendix B of the Terrestrial Wildlife Resources Specialist Report (USDA Forest Service 2020a) for exposure scenarios of all proposed herbicides. An analysis of effects to wildlife species for each proposed herbicide, regardless of the central HQ value, has been completed and is included in the following discussion.

Table 3-6. Proposed herbicides which *central* hazard quotients (HQs) exceeded 1.0 when applying median of *typical* [a] application rate (herbicides not exceeding 1.0 are not listed; see Appendix B of the Terrestrial Wildlife Resources Specialist Report for herbicides not exceeding 1.0).

EXPOSURE SCENARIOS	CENTRAL HAZARD QUOTIENTS			
	2,4-D AMINE	DICAMBA	SULFOMETURON METHYL	TRICLOPYR TEA
Application rate in pounds of acid equivalent (a.e.) or active ingredient (a.i.) per acre	1.5	1.25	0.185	1.5
ACUTE [b]				
Direct spray, small mammal	1.5	-	-	-
Amphibians	-	-	-	-
Consume contaminated vegetation [c]				
Large mammal	1.0	-	-	4.0
Small mammal	-	-	-	-
Large Bird		2.0		-
Small Bird	-	-	-	4.0
Consume contaminated water				
Spill, small mammal	-	-	-	-
Consume contaminated insects				
Small mammal	1.4	-	-	-
Small bird	-	3.0	-	-
Consume contaminated prey				
Carnivore (consuming small mammal)	3.0	-	-	-
Pred. bird (consuming small mammal)	-	-	-	-
Pred. bird (consuming fish)	-	-	-	-
CHRONIC [d]				
Consume contaminated vegetation [c]				
Large mammal	-	-	-	7.0
Small mammal	-	-	-	-
Large Bird	-	-	-	-
Small bird	-	-	-	7.0
Consume contaminated water				
Small mammal	-	-	-	-
Consume contaminated insects				
Small mammal	-	-	-	-
Small bird	-	-	-	-
Consume contaminated prey				
Carnivore (small mammal)	-	-	-	-
Predatory bird (small mammal)	-	-	-	-
Predatory bird (fish)	-	-	-	-

[a] Typical application rate is the median of the typical application rate range proposed for the CTNF and CNG.
[b] Acute scenarios—single exposures or exposures that occur over a short period, typically 10 days or less.
[c] Includes the largest hazard quotients for either contaminated grass and fruit.
[d] Chronic scenarios—longer-term exposure, intended to estimate dose levels associated with a negligible or at least defined level of risk over a lifetime of exposure.

Table 3-7. Proposed herbicides which central hazard quotients (HQs) exceeded 1.0 when applying yearly maximum application rates (herbicides not exceeding 1.0 not listed, see Appendix B of the Terrestrial Wildlife Resources Specialist Report for herbicides not exceeding 1.0).

EXPOSURE SCENARIOS	CENTRAL HAZARD QUOTIENTS			
	2,4-D AMINE	DICAMBA	SULFOMETURON METHYL	TRICLOPYR TEA
Application rate in pounds of acid equivalent (a.e.) or active ingredient (a.i.) per acre	4.0	2.0	0.38	2.0
ACUTE [b]				
Direct spray, small mammal	4.0	1.1	-	-
Amphibians	2.0	-	1.1	-
Consume contaminated vegetation [b]				
Large mammal	3.0	-	-	5.0
Small mammal	2.0	-	-	-
Large bird		4.0		-
Small bird	-	-	-	6.0
Consume contaminated water				
Spill, small mammal	-	-	-	-
Consume contaminated insects				
Small mammal	4.0	1.0	-	-
Small bird	-	6.0	-	-
Consume contaminated prey				
Carnivore (consuming small mammal)	8.0	-	-	-
Predatory bird (consuming small mammal)	-	-	-	-
Predatory bird (consuming fish)	-	-	-	-
CHRONIC [d]				
Consume contaminated vegetation [b]				
Large mammal	-	-	-	9.0
Small mammal	-	-	-	1.3
Large bird	-	-	-	1.1
Small bird	-	-	-	9.0
Consume contaminated water				
Small mammal	-	-	-	-
Consume contaminated insects				
Small mammal	-	-	-	-
Small bird	-	-	-	-
Consume contaminated prey				
Carnivore (small mammal)	-	-	-	-
Predatory bird (small mammal)	-	-	-	-
Predatory bird (fish)	-	-	-	-

[a] Acute scenarios—single exposures or exposures that occur over a short period, typically 10 days or less.
[b] Includes the largest hazard quotients for either contaminated grass and fruit.
[c] Chronic scenarios—longer term exposure, intended to estimate dose levels associated with a negligible or at least defined level of risk over a lifetime of exposure.

The SERA risk analyses calculate upper-bound HQs to represent the "worst case" of each exposure scenario and lower, "best-case" HQs. The calculation of upper-bound HQs do not account for factors such as timing of application, method of application, animal behavior, animal feeding strategies, seasonal presence or absence within a treatment area, and implementation of project design criteria. Therefore, risk is over-estimated when the proposed application methods for this project are considered. While some discussion of upper-bound HQs occurs in this analysis, central HQs are considered to be more accurate estimates of risk associated with the project. All upper- and lower-bound HQs can be found in the full SERA worksheets in the project record.

The SERA risk analyses include hazard HQs for acute and chronic exposure scenarios. Acute scenarios are single exposures or exposures that occur over a short period of time, typically 10-days or less. Chronic scenarios, or longer-term scenarios, are intended to estimate dose levels associated with a negligible or at least defined level of risk over a lifetime of exposure.

3.2.3.3.1 Risk Descriptions of Herbicides

The following analysis provides a detailed description of each herbicide proposed for use and its potential impacts on all species analyzed in this report. For wildlife in general, the risk characterization is limited by the relatively few species on which data is available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments. To account for this limitation, wildlife species were placed into groups based on taxa (i.e., mammal, bird, and amphibian), body size, and diet (i.e., insectivore, piscivore, herbivore).

The following species were analyzed under the mammal subheading: Canada lynx, grizzly bear, wolverine, bighorn sheep, gray wolf, pygmy rabbit, spotted bat, fisher, Townsend's big-eared bat, mule deer, elk, and moose. The following species were analyzed under the bird subheading: bald eagle, boreal owl, greater sage-grouse, peregrine falcon, common loon, flammulated owl, American three-toed woodpecker, great gray owl, northern goshawk, trumpeter swan, harlequin duck, riparian breeding birds and migratory birds. The following species were analyzed under the amphibian subheading: spotted frog and boreal toad.

3.2.3.3.1.1 2,4-D Amine

2,4-D amine is used in three formulations (acid, salts, and esters). All three formulations are treated as equally toxic to terrestrial animals. Terrestrial animals might be exposed to any applied herbicide from direct spray, ingestion of contaminated media (vegetation, prey species, or water), grooming activities, or indirect contact with contaminated vegetation. The highest exposure for terrestrial vertebrates would occur after consuming contaminated vegetation or prey.

Mammals

In general, 2,4-D is considered to be moderately toxic to mammals based on criteria specified by US EPA (1985). In acute dermal toxicity studies, the effects range from slightly toxic to practically non-toxic through dermal exposures (USDI 1989; WSDOT 2003). Chronic toxicity of 2,4-D was tested in dietary studies on dogs (canids). These studies resulted in death most likely due to canids' inefficiency of excreting organic acids (WSDOT 2005). Under EPA classifications for acute toxicity, 2,4-D is slightly to moderately toxic to mammals.

At any application rate or scenario measured, an HQ greater than 1.0, exceeds the LOC. At the typical application rate of 1.5 pounds of a.e. per acre, central HQs exceed 1.0 for small mammals consuming contaminated insects (acute exposure, HQ=1.4); large mammals consuming grass (acute exposure, HQ=1.0); carnivorous mammals consuming small mammals (acute exposure, HQ=3.0); and the direct spray of a small mammal (acute exposure, HQ=1.5) (SERA 2006). Hazard quotients do not exceed 1.0 for any exposure scenarios assessed under longer-term (chronic) conditions.

Several central HQs for exposure scenarios using the highest anticipated application rate (4 pounds of a.e. per acre) exceed the LOC (HQ=1.0) for a number of scenarios. For acute exposures, these scenarios involve direct spray of small mammals (HQ=4.0), large mammals consuming contaminated grass (HQ=3.0), small mammals consuming contaminated grass (HQ=2.0), small mammals consuming contaminated insects (HQ=4.0), and carnivorous mammals consuming small mammals (HQ=8.0).

For non-canid mammals, the acute No Observed Adverse Effect Level (NOAEL) of 25 mg per kg per day is from the developmental study by Nemec et al. (1983) in which adverse effects (i.e., decreased body-weight gains in dams and skeletal abnormalities in offspring) were noted at 75 mg/kg/day. Based on these values, adverse effects could be anticipated at HQ values of 3 or more (e.g., 75 mg/kg/day divided by 25 mg/kg/day). The potential effects at intermediate HQ values (e.g., greater than 1 to less than 3) cannot be characterized. Using this approach, adverse effects could be expected at the typical application rate of 1.5 pounds a.e. per acre for carnivores consuming small mammals and three exposure scenarios at the highest application rate (SERA 2006).

This risk characterization for non-canid mammals is consistent with the risk assessments by the EPA Office of Pesticide Programs (OPP) (USDA Forest Service and National Park Service 2007) in which HQs for acute exposure exceed the LOC for mammals foraging on vegetation and insects, following broadcast spray application of 2,4-D. The EPA risk assessment does not give risk characterizations for canids, thus no comparison is possible.

However, reported HQs likely over-estimate risk because not all acres treated would be treated at the highest application rate, and for individuals to be exposed to potentially harmful doses, 100 percent of their diet would have to be contaminated. It is unlikely that large numbers of small mammal prey species would be directly sprayed because 2,4-D is not proposed for aerial application.

Birds

Dietary studies indicate that 2,4-D ranges from moderately toxic to practically non-toxic in birds. Under EPA classifications for acute toxicity, 2,4-D is practically non-toxic to moderately toxic to birds.

Based on reproductive studies, birds appear to be more tolerant to 2,4-D than mammals. Longer-term exposure to 2,4-D is not likely to cause adverse effects in birds. All longer-term (chronic) HQ values for birds are below the LOC (HQ 1.0) even at the highest application rate. While adverse effects due to the acute toxicity of 2,4-D remains a matter of concern, the plausibility of adverse effects in birds is much less compelling than in the risk characterization for mammals (SERA 2006). Thus, there is no basis for asserting that toxic effects from longer-term exposures to 2,4-D are plausible.

Amphibians

Under EPA classifications for acute toxicity, 2,4-D acid/salts formulations are practically non-toxic to amphibians. Several acute exposure studies showed that toads exposed to 2,4-D acid were the most sensitive, while leopard frogs exposed to 2,4-D were the most tolerant.

Over the range of 2,4-D acid/salt application rates, adverse effects on amphibians are likely only in the event of an accidental spill; however, with 2,4-D esters, adverse effects on amphibians are plausible in association with runoff and would be expected in direct application for weed control and in cases of relatively large accidental spills (2006). For 2,4-D acid and salts, the HQ values associated with non-accidental exposures (i.e., typical application rates) are below the trigger values (HQ less than 1.0), where at the maximum application rate of 4 pounds a.e. per acre, HQ values are recorded as 2.0 (SERA 2006).

Central HQ values associated with non-accidental (i.e., acute and long-term scenarios) exposures are well below the trigger values (HQ less than 1.0) for the typical and maximum application rates (SERA 2006). All upper HQ values associated with acute and long-term exposure scenarios are also below 1.0. Over the range of 2,4-D application rates, adverse effects on amphibians are only likely in the event of an accidental spill.

The results of the 2,4-D risk assessment for all taxa suggest that consideration should be given to alternate herbicides, and that use of 2,4-D should be limited to situations where other herbicides are ineffective or to situations in which the risks posed by 2,4-D can be mitigated (SERA 2006).

3.2.3.3.1.2 Aminopyralid

Mammals

For Aminopyralid, there is no basis for asserting that adverse effects are plausible in large or small mammals (HQs for all exposure scenarios less than 1.0) (SERA 2007b). The risk characterization for mammals is consistent with the risk characterization presented by the EPA, which found no basis for asserting that adverse effects in mammals are plausible (USDA Forest Service and National Park Service 2004).

Birds

For Aminopyralid, the risk characterization for birds is similar to that of mammals in that no HQs exceed the LOC (all exposure scenarios resulted in HQs less than 1.0). Unlike the case with mammals, the upper bound of the acute HQs approach a LOC at the highest application rate (e.g., a HQ of 0.6 for a large bird consuming contaminated grasses, and a HQ of 0.9 for a small bird consuming contaminated insects). Hazard quotients for the longer-term exposure scenarios for birds are also very low: a maximum HQ of 0.01 for a large bird consuming contaminated vegetation and 0.00001 for a fish-eating bird consuming contaminated fish (SERA 2007b).

Amphibians

Based on an acute toxicity study on northern leopard frog larvae, the EPA has classified aminopyralid as practically non-toxic to aquatic-phase amphibians (USDA Forest Service and National Park Service2004). The NOAEL value used in this study is very similar to the 100 mg a.e./L for tolerant species of fish; hence the HQs for amphibians are similar to those in fish and do not exceed or approach a LOC. The risk characterization for amphibians is particularly weak based on the severe limitation of available data. The most that can be said is that the very limited acute toxicity data on amphibians indicate that leopard frog larvae are no more sensitive to

aminopyralid than fish (SERA 2007b). Since the risk assessment is based on only one study, caution should be use when spraying aminopyralid formulations around amphibians, especially knowing the high permeability of amphibian skin.

3.2.3.3.1.3 Chlorsulfuron

Mammals

No basis exists for asserting that adverse effects are plausible in large or small mammals for chlorsulfuron (HQs for all exposure scenarios less than 1.0; SERA 2004b). Based on acute oral, dermal, and inhalation studies, chlorsulfuron is considered to be practically non-toxic to mammals (Dupont 2011; Denny 1991; USDA Forest Service 1994). The most consistent toxic effects observed in mammals after exposure to chlorsulfuron are bodyweight loss and decreased bodyweight gain. In standard experimental toxicity studies, chlorsulfuron has low acute oral toxicity (US EPA 1999).

Birds

Studies indicate that chlorsulfuron is practically non-toxic to birds (WSDOT 2006a). Quantitative risk characterization is that no adverse effects in mammals or birds appear to be plausible using exposure assumptions at the typical application rate of 0.015 pound of a.e. per acre, or the yearly maximum application rate of 0.25 pound of a.e. per acre. Feeding studies by Hinkle (1979) and Fink et al. (1981) did not result in any mortality or signs of toxicity. In a feeding study by Beavers et al. (1992), no treatment-related mortalities, signs of toxicity (including weight loss), or effects on reproductive parameters were observed in ducks that were fed chlorsulfuron in the diet (SERA 2004a).

Amphibians

Neither the published literature nor the EPA files include data regarding the toxicity of chlorsulfuron to amphibian species. Since there is no specific data available for amphibians, it is assumed that during amphibians' aquatic life stages this herbicide is considered as low in toxicity as it is for aquatic species; and during amphibians' terrestrial life stages, it is considered as low in toxicity as it is for terrestrial organisms. Since the risk assessment is based on limited or no data, caution should be use when spraying chlorsulfuron formulations around amphibians, especially knowing the high permeability of amphibian skin.

3.2.3.3.1.4 Clopyralid

Mammals

No basis exists for asserting that adverse effects are plausible in large or small mammals for clopyralid (HQs for all exposure scenarios less than 1.0) (USDA Forest Service 2005). Based on acute oral, dermal, and inhalation studies, clopyralid is considered to be practically non-toxic to mammals (Dow AgroSciences 1999). Numerous toxicity studies demonstrate that the acute toxicity of clopyralid is relatively low for mammals. Consequently, no adverse effects are anticipated in terrestrial wildlife from the use of clopyralid at the typical application rate of 0.3 pound of a.e. per acre or the yearly maximum application rate of 0.5 pound of a.e per acre. Concerning the characterization of risk, clopyralid has been tested only in a limited number of species and under conditions that may not well-represent populations of free-ranging, non-target wildlife. Therefore, the available data is sufficient to assert that adverse effects in terrestrial wildlife from the use of clopyralid do not appear to be likely (SERA 2004b).

Birds

Studies indicate that clopyralid is practically non-toxic to birds (WSDOT 2006b). A limited number of acute toxicity and dietary studies have been conducted on birds. None of the exposures tested resulted in significant data to estimate mortality. In a standard acute-toxicity study, Dabbert et al. (1997) found that direct spraying of bobwhite quail eggs at up to 0.56 kg of a.e. per hectare caused no gross effects (e.g., viability, hatchability, bodyweight) and no effects on immune function in chicks. Based on very limited data, birds may be somewhat more sensitive to clopyralid than mammals (SERA 2004b).

Amphibians

Neither the published literature nor the EPA files include data regarding the toxicity of clopyralid on amphibian species (SERA 2004b). Since there is no specific data available for amphibians, it is assumed that during amphibians' aquatic life stages, this herbicide is considered as low in toxicity as it is for aquatic species; during amphibians' terrestrial life stages, this herbicide is considered as low in toxicity as it is for terrestrial mammals. Since the risk assessment is based on limited or no data, caution should be use when spraying chlorsulfuron formulations around amphibians, especially knowing the high permeability of amphibian skin.

3.2.3.3.1.5 Dicamba

Mammals

Based on acute oral and dermal studies (USDA 1994), dicamba is considered to have a relatively non-toxic to slight-to-moderate toxicity for mammals, with LC50 values ranging from approximately 500 mg/kg to greater than 4,600 mg/kg (SERA 2004c). Acute dermal studies have shown a slight toxicity, and acute inhalation tests have shown a moderate toxicity to dicamba (WSDOT 2006c).

Diet/consumption chronic studies have shown mixed toxicity levels. Daily doses of dicamba produced no observable effects for survival, bodyweight, food consumption, organ weight, blood chemistry, or tissue structure (WSDOT 2006c; EXTOXNET 1996a). Consumption of the chemical at high levels for long time periods has been shown to cause changes in the liver and a decrease in bodyweight. Varying doses of dicamba during pregnancy in rabbits has resulted in slightly reduced fetal weights, toxic effects on the mothers, and increased loss of fetuses (EXTONET 1996a). At the typical application rate of 1.25 pounds of a.e. per acre, HQs did not reach a LOC.

At the highest application rate of 2 pounds of a.e. per acre, HQs meet and slightly exceed a LOC in acute exposure scenarios involving small mammals consuming contaminated insects (HQ=1.0) and small mammals being directly sprayed (HQ=1.1). None of the longer-term scenarios resulted in HQs that exceed the LOC at the highest application rate (SERA 2004c).

Birds

Based on acute oral/diet studies, dicamba is practically non-toxic to slightly toxic in acute exposures to birds (WSDOT 2006c). Two chronic reproductive studies were conducted on mallard ducks and bobwhite quail. The diet included a NOAEL of 800 parts-per million (ppm) (92 mg/kg/day) and a LOAEL of 1,600 ppm (184 mg/kg/day). Mallards appeared to be more sensitive, with the dietary NOAEL and LOAEL. The LOAEL was based on reduced hatchability

and survival of offspring. No signs of neurotoxicity were reported. In bobwhite quail, no effects were seen on any reproductive parameters at 1,600 ppm (SERA 2004c).

At the typical application rate of 1.25 pounds per acre, adverse effects on birds are plausible for acute exposures involving large birds consuming contaminated vegetation (HQ=2.0) and small birds consuming contaminated insects (HQ=3.0). At the highest application rate of 2 pounds per acre, adverse reproductive effects are plausible in acute exposure scenarios involving birds consuming contaminated vegetation or contaminated insects. The HQs associated with the long-term consumption of contaminated vegetation are significantly below the LOC. For acute consumption of contaminated vegetation, an HQ of 1.7 is associated with a dose of 152 mg/kg/day. This dose approaches the dietary reproductive LOAEL of 184 mg/kg/day that was associated with reduced hatchability and survival of offspring. Therefore, adverse effects on offspring appear to be plausible at the upper ranges of exposure, which are associated with the typical and yearly maximum application rates (SERA 2004c). However, dicamba is not proposed for aerial application.

Reported HQs likely over-estimate risk because not all acres treated would be treated at the highest application rate, nor would all acres be treated by broadcast-spray applications on greater than 0.5 acre per application. For animals to be exposed to potentially harmful doses, herbicides would have to be broadcast sprayed over a large enough area that the animal could forage exclusively within the treatment area to result in 100 percent of their diet being contaminated.

Amphibians

Based on limited studies, dicamba is slightly toxic to terrestrial-phase amphibians, with a reported LC50 concentration of greater than 10 ppm, (USDA Forest Service 2004a). Other acute toxicity studies with 24- to 96-hour LC50 values in the range of 106 to 220 mg/L indicate that dicamba is relatively non-toxic to terrestrial-phase amphibians.

Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (Berrill et al. 1997). Therefore, fish were used as surrogates to predict risk to amphibian species for aquatic scenarios.

A large number of toxicity studies are available on dicamba in several aquatic species, but the reported values are highly variable, with LC50 values in some studies being less than reported NOAEC5 values in the same species from another study. Consequently, for the characterization of risk, NOAEC values are not used directly and risks are characterized using LC50 values. This is an atypical expression of risk and is presented solely as means of comparing exposures to the available toxicity data. Within these very serious limitations, there is little basis for asserting that adverse effects in aquatic animals are plausible. For acute exposures, the HQs are in the range of 0.000003 to 0.0001. For longer term exposures, the HQs are in the range of 0.000000009 to 0.000002. While these values cannot be overly interpreted, both acute and longer term NOAEL values are generally below LC50 values by factors of far less than 10,000 (SERA 2004c).

3.2.3.3.1.6 Glyphosate—Terrestrial Formulations

Mammals

For the typical application rate of 1.75 pounds of a.e. per acre, the highest HQ for mammals is the upper-bound HQ of 0.7, which is associated with the acute exposure of a small mammal consuming contaminated insects. For the yearly maximum application rate of 4 pounds of a.e.

per acre, the highest HQ for mammals is the upper-bound HQ of 1.6, which is associated with the acute exposure of a small mammal consuming contaminated insects exclusively.

At application rates above 2.5 pounds of a.e. per acre, risks to mammals cannot be ruled out based on upper-bound estimates of exposure, but no risks are apparent based on central estimates of exposure. Field studies in mammalian wildlife have failed to note adverse effects on reproduction. Sullivan (1990) stated that, based on a number of parameters in populations of small mammals, no adverse effects in small mammals could be associated with Roundup spray.

At application rates of 2.5 pounds of a.e. per acre or less, "worst-case" exposure assessments indicate that mammals are not at risk. Based on central and more-likely estimates of exposure, no risks to mammals are apparent. The SERA risk assessment is also supported by well-documented field studies that failed to identify adverse effects in populations of small mammals following applications of Roundup (Sullivan 1990) as well as another, unidentified formulation of glyphosate (Ritchie et al. 1987).

Tu et al. (2001) cited a study measuring residue levels in litter and ground cover, which were detectable for 55 days at declining levels. The study concluded that carnivores were at lower risk to herbicide exposure than herbivores due to their lower relative visceral weights and a proportionally lower level of food intake.

Birds

Based on studies in acute oral, dietary, and terrestrial applications, glyphosate is considered practically non-toxic to birds. The risk characterization for birds is based on a somewhat-higher acute NOAEL (540 mg/kg of bodyweight vs. 175 mg/kg of bodyweight for mammals), but a somewhat-lower, longer-term NOAEL (43 mg/kg body wight vs. 175 mg/kg of bodyweight for mammals). These differences are reflected in lower acute (but higher chronic) HQs for birds, relative to mammals (SERA 2011a).

As with mammals, none of the HQs for birds exceed the LOC at the typical application rate of 1.75 pound of a.e. per acre. For the typical application rate, the highest HQ for birds is the upper-bound HQ of 0.5 associated with the longer-term consumption of contaminated grass by a large bird. The upper-bound HQ for consumption of contaminated grass by a large bird would reach a LOC (HQ=1.0) at an application rate of about 3.3 pounds of a.e. per acre. At the yearly maximum application rate of 4 pounds of a.e. per acre, the highest upper-bound HQ (1.2) is associated with the longer-term consumption of contaminated grass by a large bird. The highest central estimate (i.e., most likely) HQ for the yearly maximum application rate is associated with short-term consumption of contaminated insects by a small bird (HQ=0.3).

In the study by Kubena et al. (1981), on which the NOAEC level of 43 mg/kg of bodyweight/day is based, a 10-fold higher dietary exposure is associated only with mild signs of toxicity, including decreased bodyweight and changes in bone composition. Thus, no basis exists for asserting that severe adverse effects are likely to be observed in birds exposed to application rates greater than 3.3 pounds of a.e. per acre or at the yearly maximum rate of about 4 pounds of a.e. per acre (SERA 2011a). According to the 2011 SERA risk assessment, application rates greater than about 3.3 pounds of a.e. per acre will result in modest excursions above an HQ of 1.0 at the upper bounds for some exposures (SERA 2011a); however no direct evidence exists that these exposures would likely be associated with overt adverse effects.

Amphibians

For the typical application rate of 1.75 pounds a.e. per acre, the non-accidental, short-term exposure scenario for sensitive amphibians resulted in a central HQ of 0.5 and an upper bound, "worse case" HQ of 4.0. For the maximum application rate of 4 pounds a.e. per acre, the SERA risk assessment reports a central HQ of 1.1 and a "worse case," upper bound HQ of 8.0. Long-term exposure HQs did not exceed 1.0 for the typical or maximum application rates.

3.2.3.3.1.7 Glyphosate—Aquatic Formulations

Mammals

Aquatic formulations of glyphosate are considered practically non-toxic to mammals (WSDOT 2005). Hazard quotients for the typical application rate were all well below zero. At the yearly maximum application rate of 4 pounds of a.e. per acre, the highest upper-bound HQ (0.02) is associated with a spill scenario resulting in the consumption of contaminated water by a small mammal. The highest central estimate (i.e., most likely) HQ for the yearly maximum application rate is associated with a spill scenario resulting in the consumption of contaminated water by a small mammal (HQ=0.005). Therefore, aquatic formulations of glyphosate pose no apparent risks to mammals.

Birds

Based on studies in acute oral, dietary, and terrestrial applications, aquatic glyphosate is considered practically non-toxic to birds. The risk characterization associated with the aquatic formulations of glyphosate is extremely simple for birds, as is the case for mammals. As with mammals, none of the HQs for birds exceed the LOC at the typical or yearly maximum application rates. At the yearly maximum application rate of 4 pounds of a.e. per acre, the highest upper-bound HQ is 0.01, associated with the consumption of contaminated water by a small bird. Thus, there is no basis for asserting aquatic formulations of glyphosate pose risks to birds. (SERA 2011a).

Amphibians

The accidental spills associated with the aquatic formulation of glyphosate lead to exceedances in the upper bound of the HQ for most, but not, all sensitive aquatic species (i.e., 36 for fish, 0.05 for amphibians, 7 for invertebrates, 14 for macrophytes, and 79 for algae). The relatively low HQ (0.05) for sensitive amphibian species is associated with several studies that clearly indicate that the acute toxicity of aquatic glyphosate to amphibians is very low (SERA 2011a).

3.2.3.3.1.8 Imazamox

Mammals

There is no basis for asserting that adverse effects are plausible in mammals. For terrestrial applications, the highest HQ is 0.1, the upper bound of the HQ for a small mammal consuming contaminated insects. This HQ is below the LOC (HQ=1.0) by a factor of 10. For aquatic applications, the highest HQ is 0.01, the upper bound of the HQ for small mammal consuming contaminated water following an accidental spill. This HQ is below the LOC by a factor of 100 (SERA 2010).

The only elaboration associated with these HQs is that they probably overestimate risk. The NOAEL for mammals is taken as 300 mg/kg of bodyweight/day, the NOAEL used to derive the

RfD for imazamox in the human health risk assessment. Other NOAELs from chronic toxicity studies suggest that no adverse effects are likely to occur in mammals at doses of up to 1300 mg/kg of bodyweight/day. While the use of the lower NOAEL of 300 mg/kg of bodyweight/day may be viewed as conservative, this has no impact on the risk characterization (SERA 2010).

Birds

As with mammals, no basis exists for asserting that the use of imazamox will lead to toxic effects in birds. For terrestrial exposures, the maximum HQ is 0.06, below the LOC by a factor of about 17. This HQ is associated with the longer-term consumption of contaminated vegetation by a large bird that feeds exclusively on vegetation treated with imazamox. For aquatic applications, the highest HQ is 0.003, below the LOC by a factor of over 300; this HQ is associated with the consumption of contaminated water following an accidental spill (SERA 2010).

As with the HQs for mammals, the only reservation with the HQs for birds is that they probably overestimate risk. As detailed in the dose-response assessment for birds, toxic exposure levels of imazamox have not been defined for birds.

Amphibians

Risks to reptiles and terrestrial-phase amphibians cannot be characterized directly because of the lack of data on the toxicity of imazamox to this group of organisms. Based on the risk characterization for birds, as well as all other groups of terrestrial animals for which data is available, there is no basis for assuming that reptiles or terrestrial-phase amphibians are likely to be at risk from exposures to imazamox.

For aquatic scenarios, fish were used as surrogates to predict risk to amphibian species. Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (Berrill et al. 1997).

While limited, the available toxicity data on fish suggests that imazamox concentrations in surface water are unlikely to have an adverse effect on fish. For terrestrial applications of imazamox, the upper bound HQ for an accidental spill is 0.08, below the LOC by a factor of about 12. Based on peak expected concentrations of imazamox in surface water, the upper bound of the HQ is 0.0008, below the LOC by a factor of 1,250. For aquatic applications, the HQs are higher but still below the LOC. The upper bound HQ for an accidental spill is 0.2 and the upper bound HQ based on the maximum target concentration of 0.5 mg a.e./L is 0.004, below the LOC by a factor of 250. The lack of an adequately documented chronic toxicity value for fish precludes the development of a chronic HQ for fish. Nonetheless, given the very low HQs associated with expected peak concentrations of imazamox in surface water, as well as the general lack of any dose-duration relationship for imazamox in terrestrial animals, there is no basis for substantial concern about longer-term adverse effects in fish, and in this comparison, aquatic-phase amphibians.

3.2.3.3.1.9 Imazapic

Mammals

Based on dietary concentration studies, larger mammals, such as canids and lagomorphs, may be more sensitive to imazapic than smaller mammals such as rodents. No toxic effects have been observed in rodents tested at very high dietary concentrations of imazapic over prolonged periods of time (SERA 2004d). Based on dose-response assessments (i.e., acute NOAEL of

350 mg/kg/day and chronic NOAEL of 45 mg/kg/day), none of the exposure scenarios, acute or chronic, result in exposure estimates exceeding the applicable NOAEL (i.e., HQ <1.0). Based on the yearly maximum application rate of 0.1875 pound/acre, the HQ quotient for acute and chronic exposure is 0.02, which is below the LOC by a factor of 25. Therefore, the weight of evidence suggests that no adverse effects in mammals are plausible using the worst-case exposure assumptions at the yearly maximum application rate of 0.1875 pound/acre (SERA 2004d).

Birds

Based on dietary concentration studies, chronic toxicity of imazapic to birds is comparable to that in canids and has a low order of acute and chronic toxicity in birds (i.e., very low HQs for acute and chronic exposure) (SERA 2004d). For dose-response assessments, birds appear to be somewhat-less sensitive to imazapic than mammals. For studies on subchronic toxicity and reproductive effects in ducks and quail (dietary concentrations of 1658 ppm to 1907 ppm), no signs of systemic toxicity or reproductive effects (egg production, hatchability, survival of hatchlings) were observed (Mortensen et al. 1998; Miller et al. 1998). Pharmacokinetic studies have been conducted in birds (hens) (Afzal 1994; Gatterdam 1993). These studies indicate that imazapic is rapidly excreted unchanged and does not accumulate in body tissue, and no detectable concentrations of imazapic were found in eggs. Based on the yearly maximum application rate of 0.1875 pound/acre, the highest HQ for acute and chronic exposure is 0.02, which is below the LOC by a factor of 25. Therefore, the weight of evidence suggests that no adverse effects in birds are plausible using the worst-case exposure assumptions at the yearly maximum application rate of 0.1875 pound/acre (SERA 2004d).

Amphibians

No toxicity data is available for terrestrial-phase amphibians. Therefore, no quantitative risk characterization for terrestrial-phase amphibians can be made (SERA 2004d).

For aquatic scenarios, fish were used as surrogates to predict risk to amphibian species. Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (Berrill et al. 1997). All HQs for aquatic animals are extremely low, ranging from 0.00000001 (the lower range for long-term exposures in fish and invertebrates), to 0.00001 (the upper range for acute exposures for fish and invertebrates). Thus, there is no basis for asserting that effects on non-target aquatic species, including aquatic-phase amphibians, are plausible.

3.2.3.3.1.10 Imazapyr

Mammals

Imazapyr is practically non-toxic to mammals based on an acute oral LD50 of >5,000 mg/kg in rats. (The term “LD50” is an amount that, when administered to test animals, will result in mortality of 50 percent of the test population.) Acute dermal toxicity of >2,000 mg/kg was reported in rabbits. For aquatic applications, none of the HQs approaches a LOC. The highest HQ of 0.009 is associated with the upper bound of the HQ for a canid consuming contaminated fish following an accidental spill. This HQ is below the LOC (HQ=1) by a factor of over 100.

As with aquatic applications, none of the HQs for terrestrial applications exceed the LOC. The highest HQs are associated with consumption of contaminated grass by a small mammal—i.e.,

HQs of 0.2 (0.02 to 0.9). This scenario assumes the small mammal will consume nothing but contaminated grass following a direct spray. While this activity may occur in some instances, most small mammals have a more diverse diet, particularly in a forest environment, and residues on contaminated short grass will often be diminished by foliar interception. Thus, this scenario should be viewed as an extreme worst case (SERA 2011b).

Birds

Imazapyr is practically non-toxic to birds. Oral LD50 values of >2,150 mg/kg were reported for both quail and duck. As with mammals, no basis exists for asserting that signs of toxicity would be observed in birds after exposure to imazapyr. For terrestrial exposures, the upper bound of the longer-term HQ for the consumption of contaminated grass is 1.4, which modestly exceeds the LOC (HQ=1). The exposure scenarios for the exclusive consumption of contaminated grass by either a small bird or a small mammal should be viewed as extreme worst-case scenarios. Typically, neither small birds nor small mammals will consume only contaminated grass. All other HQs for birds following terrestrial applications of imazapyr are below, and in most cases substantially below, the LOC.

For aquatic applications, the highest HQ is 0.002, which is below the LOC by a factor of 500; this HQ is associated with the upper-bound exposure for a small bird that consumes water contaminated by an accidental spill of imazapyr.

As with the HQs for mammals, the only reservation with the HQs for birds is that they probably overestimate risk. As discussed in the dose-response assessment for birds, toxic exposure levels of imazapyr are not defined for birds (SERA 2011b).

Amphibians

Risks to terrestrial-phase amphibians cannot be characterized directly because of the lack of data regarding toxicity of imazapyr to this group of organisms. Based on the risk characterization for birds, as well as all other groups of terrestrial animals for which data is available, there is no basis for assuming that reptiles or terrestrial-phase amphibians are likely to be at risk from exposures to imazapyr. This approach has been adopted for amphibians in the recent US EPA/OPP (2007) risk assessment of imazapyr.

For aquatic scenarios, fish were used as surrogates to predict risk to amphibian species. Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (Berrill et al. 1997). And given the very low acute and chronic HQs in fish, and the conservative assumptions used to derive these HQs, there is no basis for asserting that acute or longer-term exposure to imazapyr will cause toxic effects in aquatic-phase amphibians (SERA 2011b).

3.2.3.3.1.11 Metsulfuron methyl

Mammals

Several studies (i.e., acute oral, acute inhalation, chronic dietary exposure, reproduction) show metsulfuron methyl to have a range of practically non-toxic to slightly toxic to mammals (WSDOT 2006d). In acute exposure scenarios, the highest exposures for small terrestrial mammals will occur after a direct spraying and could reach up to 0.7 mg/kg under typical exposure conditions. The highest HQ for any acute exposure is 0.08, the upper range of the HQ for the consumption of contaminated insects by a small mammal. Thus, no basis exists for

asserting that adverse effects are likely from applying metsulfuron methyl at any application rate, even the yearly maximum application rate of 0.15 pound of a.e. per acre.

Assessing both the central and upper estimated ranges of exposure, the determination is that only a low toxicity potential to mammals exists. The available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals when using the typical or worst-case exposure assumptions at the typical application rate of 0.015 pound of a.e. per acre or the yearly maximum application rate of 0.15 pound of a.e. per acre (SERA 2004e).

Birds

Acute oral and dietary studies have determined that metsulfuron methyl is practically non-toxic to birds (WSDOT 2006d). Based on several acute toxicity studies and two reproductive studies, birds appear to be no more sensitive than mammals to the toxic effects of metsulfuron methyl, with the major effects being decreased bodyweight gain. Assessing the central and upper estimated ranges of exposure, the determination is that only low toxicity potential to birds exists. The available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals (including birds) when using the typical or worst-case exposure assumptions at the typical application rate of 0.015 pound of a.e. per acre or the yearly maximum application rate of 0.15 pound of a.e. per acre (SERA 2004e).

Amphibians

Risks to terrestrial phase amphibians cannot be characterized directly because of the lack of data on the toxicity of metsulfuron methyl to this group of organisms.

For aquatic scenarios, fish were used as surrogates to predict risk to amphibian species. Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (Berrill et al. 1997). At the maximum application rate of 0.15 pounds/acre, the highest HQ is 0.00015, below the LOC by a factor of over 6,000. Given the very low acute and chronic HQs in fish and the conservative assumptions used to derive these HQs, there is no basis for asserting that acute or longer-term exposure to metsulfuron methyl will cause toxic effects in aquatic-phase amphibians (SERA 2004e).

3.2.3.3.1.12 Picloram

Mammals

All central estimates of the HQs for mammals are below the LOC. Because the central estimates of the HQs are based on average or mean estimates of the exposure parameters for the different scenarios, the central estimates of the HQs may be viewed as the expected or most likely measures of risk. For the typical application rate, the highest HQ for mammals is the upper-bound HQ of 1.3 associated with the short-term consumption of contaminated insects by a small mammal. For the yearly maximum application rate, the highest HQ for mammals is the upper-bound HQ of 2.0, which is associated with the short-term consumption of contaminated insects by a small mammal (SERA 2011c).

Due to picloram's persistence in the environment, chronic exposure could be a concern to these species. Pearson and Callaway (2008) indicated that observed decreases in the populations of small mammals were apparently due to food supply decreases rather than any direct toxic effect of picloram to mammals. Based on the proposed action and design criteria listed in this document, picloram is expected to pose a low risk to mammalian species.

Birds

Based on data from several studies (acute gavage toxicity, acute dietary toxicity, reproductive effects), picloram is considered practically non-toxic to birds. For the typical application rate, the highest HQ for birds is the upper-bound HQ of 0.9 associated with the longer-term consumption of contaminated vegetation by a large bird. For the yearly maximum application rate, the highest HQ for birds is the upper-bound HQ of 1.4, which is associated with the longer-term consumption of contaminated vegetation by a large bird (SERA 2011c).

Amphibians

Several literature reviews have not identified toxic information for amphibians. It is reasonable to assume that amphibians are potentially the most sensitive to herbicides because of their complex life cycles and more permeable skin. Risks to terrestrial phase amphibians cannot be characterized directly because of the lack of data regarding toxicity of picloram to this group of organisms.

No dose-response assessment for aquatic-phase amphibians is developed. Consequently, no quantitative risk characterization can be derived. Based on a marginal data set involving bioassays of one species of fish and two species of amphibians using a herbicide formulation containing picloram, and perhaps 2,4-D as well, no remarkable differences in sensitivity between fish and amphibians are apparent. While this information is marginal, it is generally supportive of the approach taken in US EPA/OPP (2004), in which data on freshwater fish are used as surrogates for aquatic-phase amphibians. Exceedances in the LOC for fish are limited to accidental spill exposures in sensitive fish species (SERA 2011c).

When estimating the effects of pesticides on amphibians, it is appropriate to be very conservative. Carey and Bryant (1995) discussed a number of pathways through which amphibians could be impacted by environmental contaminants. They stated "while a variety of results have been obtained (concerning amphibian tolerance levels of various environmental toxicants) because of the number of species, life stages, and techniques used, the literature suggests that adult and larval amphibians are not necessarily more sensitive to chemicals than other land or aquatic vertebrates." However, they caution that toxicants need not be directly lethal to impact amphibians. Sub-lethal concentrations of some contaminants may increase susceptibility of larvae to disease; increase predation of larvae by impacting swimming ability, or by retarding growth rates. They point out that "endocrine-disrupting toxicants can have effects at tissue levels well below detectable levels," and that "toxicants designated as safe should not be considered to be free of endocrine-disrupting effects until proven otherwise."

3.2.3.3.1.13 Rimsulfuron

Mammals

Rimsulfuron inhibits acetolactate synthase, an enzyme used for biosynthesis of amino acids in plants. This enzyme does not occur in mammals, thus rimsulfuron has little toxic impact on mammals. Rimsulfuron is also not acutely toxic via dermal or oral routes of exposure to mammals (USDI BLM 2014). An LD50 of greater than 5,000 mg of a.i./kg of bodyweight was selected as the oral toxicity reference value (TRV) for small mammals. An LD50 of 11.8 mg of a.i./kg of bodyweight per day was selected as the chronic TRV for small mammals. An LD50 of greater than 2,000 mg of a.i./kg of bodyweight was selected as the dermal TRV for small mammals (USDI BLM 2014).

Birds

Rimsulfuron has low toxicity to birds. Rimsulfuron inhibits acetolactate synthase, an enzyme used for biosynthesis of amino acids in plants. This enzyme does not occur in mammals, thus Rimsulfuron has little toxic impact on birds. An LD50 of greater than 16,969 mg of a.i./kg of bodyweight was selected as the oral TRV for small birds. An LD50 of 3,394 mg of a.i./kg of bodyweight per day was selected as the chronic TRV for small birds. An LD50 of greater than 2,000 mg a.i./kg of bodyweight was selected as the oral TRV for large birds. An LD50 of 1,000 mg of a.i./kg of bodyweight per day was selected as the chronic TRV for small birds (USDI BLM 2014).

Amphibians

Risks to terrestrial phase amphibians cannot be characterized directly because of the lack of data on the toxicity of rimsulfuron to this group of organisms (USDI BLM 2014).

For aquatic scenarios, fish were used as surrogates to predict risk to amphibian species. Available toxicity information for some herbicides indicates that amphibians and fish have a similar sensitivity to herbicides (USDI BLM 2014). For terrestrial amphibians, small birds and mammals were used as surrogates. For all surrogate scenarios (fish, mammals, birds), the risk was far lower than the LOCs by several orders of magnitude (USDI BLM 2014).

3.2.3.3.1.14 Sulfometuron Methyl

Mammals

Sulfometuron methyl is generally considered practically non-toxic with a very low acute oral toxicity. This consideration is based on an acute LD50 of greater than 5,000 mg/kg for the male rat (WSDOT 2006e). Acute dermal LD50 values range from over 2,000 mg/kg for a female rabbit to over 8,000 mg/kg for a male rabbit, which also indicates a rating of practically non-toxic. The USDA reported an inhalation toxicity value of 5 mg/L (ppm) after a 4-hour acute exposure to Oust.

Several studies indicate rats have exhibited multiple toxic effects from chronic dietary exposures to sulfometuron methyl. For example, rats experienced reduced red blood cell counts and increased liver weight when fed the compound at relatively low doses (LD_{50} of 50 mg/kg) for a period of 1 year (Jordan and Cudney 1987). In a study conducted over a 90-day period, rats exhibited an increased production of white blood cells at 250 mg/kg (the highest dose tested). However, in a 2-year feeding study, no effects were found below 50 mg/kg (Retnakaran and Wright 1987, as cited in summarized in EXTOXNET [1996b]). The formulation Oust produced mild erythema and slight edema for 72 hours in rabbits.

Using the yearly maximum application rate of 0.38 pound of a.e. per acre, the highest HQ for any acute exposure was 0.3, the upper range of the HQ for the consumption of contaminated insects by a small mammal. The only exceedance for chronic exposures occurred in the upper-bound HQ for large mammals consuming contaminated vegetation (HQ=1.5). Thus, no basis exists for asserting that adverse effects are likely from the typical application rate proposed for sulfometuron methyl. For chronic exposures, all central HQs were also well below 1.0 (SERA 2004f).

Birds

Sulfometuron methyl is considered practically non-toxic to birds. A dietary acute LC50 of greater than 5,000 mg/kg is reported for mallards and dietary LC50 values of greater than 5,620 mg/kg is reported for the northern bobwhite quail (EXTOXNET 1996b).

Results of all acute exposure studies in birds show that sulfometuron methyl has very low toxicity, with LD50 values exceeding 5,000 mg/kg by gavage (Dudeck and Bristol 1981) and exceeding 5620 ppm in the diet (equivalent to 1,068 mg/kg/day) (Fink et al. 1981). Only one study reported signs of toxicity following acute sulfometuron methyl exposure—a gavage study in mallard ducks using single doses of technical-grade sulfometuron methyl ranging from 312 to 5,000 mg/kg (Dudeck and Bristol 1981).

Using the yearly maximum application rate of 0.38 pound of a.e. per acre, the highest HQ for any acute exposure is 0.1, the upper range of the HQ for the consumption of contaminated insects by a small bird. For chronic exposures, all central HQs are well below 1.0. The only exceedance for chronic exposures occurs in the upper-bound HQ for large birds consuming contaminated vegetation (HQ=2.0). Thus, no basis exists for asserting that adverse effects are likely from the typical application rate proposed for sulfometuron methyl (SERA 2004f).

Amphibians

Central HQ values associated with non-accidental (i.e., acute and long-term scenarios) exposures are well below the trigger values (HQ less than 1.0) for the typical and maximum application rates (SERA 2004f). All upper HQ values associated with acute and long-term exposure scenarios are also below 1.0.

The risk characterization for aquatic animals is relatively simple and unambiguous. Sulfometuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the HQs for aquatic animals are extremely low, with a range of 0.000000002 (lower range for acute exposures in tolerant aquatic invertebrates) to 0.004 (longer-term exposures to amphibians). It should be noted that confidence in this risk characterization is reduced by the lack of chronic toxicity studies and lack of data in amphibians (data only available in a single species). Even with these uncertainties, there is no basis for asserting that adverse effects on aquatic animals are likely (SERA 2004f).

3.2.3.3.1.15 Triclopyr: Trimethylamine Salt (TEA)

Mammals

The risk characterization for mammals is dominated by exposure scenarios associated with consuming contaminated vegetation or insects. The HQs for mammals increase as bodyweight increases. While small mammals may consume more than larger animals, the greater sensitivity of larger mammals to triclopyr suggest they are at greater risk. At the typical application rate of 1.5 pound of a.e. per acre, the acute HQ for a large (70 kg) mammal consuming contaminated short grass is 4.0. The corresponding chronic HQ is 7.0. For the small (20 g) mammal, the corresponding HQs are much lower (i.e., 0.5 for acute exposures and 1.0 for longer-term exposures).

As discussed in the SERA risk assessment, HQs of about 4.0 might be associated with subclinical adverse effects, although overt signs of toxicity might not be evident (SERA 2011d). It should be noted that the scenarios used to develop the HQs are based on the assumption that

the consumption of contaminated vegetation comprises 100 percent of the mammal's diet (SERA 2011d). Reported HQs likely over-estimate risk because not all acres treated would be treated at the highest application rate, nor would more than 0.5 acres be treated per application. For animals to be exposed to potentially harmful doses, these herbicides would have to be broadcast sprayed over a large enough area that the animal could forage exclusively within the treatment area for 1 day and have 100 percent of their diet contaminated. Other exposure scenarios involving direct spraying and the consumption of contaminated water and fish lead to HQs below the LOC.

In the EPA assessment for mammals, acute and chronic-based and chronic dietary-based risk quotients exceed the EPA's acute and chronic endangered species LOC for all foliar application uses of triclopyr. Triclopyr is not proposed for aerial application; therefore, actual risk to grazing mammals is less than the reported HQ values indicate.

Birds

Based on the findings of available field studies, triclopyr is not likely to cause adverse effects in birds. Under the yearly maximum application rate, exposures associated with consuming contaminated water and contaminated fish are negligible. In the accidental spill scenarios, the highest HQ for birds is 0.08, which is the upper bound of the HQ for a small bird consuming contaminated water. The exposure scenario for a small bird consuming contaminated insects approaches a LOC at 0.7, but does not exceed (SERA 2011d).

Amphibians

Aquatic application of triclopyr does not pose substantial risks to aquatic animals across the range of labeled application rates. The typical application rate for triclopyr is 1.5 pounds a.e. per acre, and the maximum rate proposed is 2 pounds a.e. per acre. Application rates in excess of about 3 pounds a.e. per acre, which are peak concentrations of triclopyr in surface water, could pose acute risks to aquatic-phase amphibians (SERA 2011d). The EPA conducted risk assessments on amphibians by using toxicity studies on birds. Acute risks to amphibians following applications of triclopyr would reach a LOC at an application rate of 3 pounds a.e. per acre, based on potential peak exposures to triclopyr (SERA 2011d). The CTNF and CNG will not be applying this chemical at or above 3 pounds a.e. per acre because that exceeds the maximum application rate. Studies of silvicultural application scenarios state that the ecological risk to native amphibian population under the current use practices would be considered negligible (Wojtaszek et al. 2005). The risk characterization for amphibians associated with aquatic applications of triclopyr does not lead to HQs that exceed the LOC for either emergent applications or submergent applications (SERA 2011d).

3.2.3.3.2 Effects Common to All Herbicides

3.2.3.3.2.1 Mammals

The application of herbicides is likely to alter terrestrial vegetation. This alteration is likely to lead to some secondary changes that could impact mammals (e.g., changes in food availability and habitat quality). These secondary effects are likely to vary over time and vary among different mammal species.

3.2.3.3.2.2 Birds

Secondary effects on some species of birds may occur through changes in vegetation that may impact food availability and habitat. These effects may be beneficial to some species and detrimental to others, and the magnitude of any effects are likely to vary over time. In some instances, habitat changes could result in changes at the localized population levels of some bird species.

3.2.3.3.2.3 Amphibians

Treatment of upland sites with herbicides could result in a substantial, though temporary, reduction in vegetative cover, particularly if a site was broadcast sprayed with a broad-spectrum formulation. Such a loss of vegetation could indirectly impact amphibians by removing cover. However, other important components for cover, such as duff and woody debris, would be maintained, and could even increase in quantity. It is possible that prey items, such as invertebrates, could also be reduced temporarily as a result of crushing, toxicity from spraying, or loss of habitat. However, long-term negative effects to habitat should not occur. Furthermore, treatments to reduce weedy species could benefit herpetofauna habitat by returning it to a more native state.

3.2.3.3.2.4 Vegetation Structure

Direct and indirect impacts on vegetation structure depend on the specific treatment used, including the particular herbicide used, rate of application, and season of application. Direct impacts of herbicide application would be a change in composition of invasive plant communities, along with other forbs, grasses, and shrubs in treatment areas. Non-target plants could be damaged by unintentional application, drift, or residual soil activity of herbicides. These short-term impacts to plant composition and community diversity would likely be offset within as little as 3 years, as native forbs recover. No long-term loss of native vegetation species diversity from the proposed treatments would occur, and species composition under most treatments would be expected to resemble native plant assemblages within 3 years (Rice et al. 1997a).

Conifers are largely tolerant of the proposed herbicides at typical application rates. Common injuries to conifers include chlorosis, needle shed, needle curl, and branch die-back (Appendix G). Dicamba and picloram can result in root uptake if applied within the dripline. Seedlings are susceptible to injury from the application of 2,4-D.

Deciduous trees and shrubs, which are an important habitat component for many migratory bird species, are largely tolerant of the herbicides proposed for use in riparian areas at application rates used for forbs. Injury, such as leaf cupping or curling, chlorosis, and/or potential defoliation, as well as injury or mortality to seedlings could occur. Deciduous woody species are more susceptible to injury or death from sulfometuron methyl. No broadcast application is proposed for Aquatic Influence Zone (AIZ), and no applications would occur if sustained wind speeds exceed label directions in order to prevent drift and damage to non-target riparian plant species.

Evergreen shrub seedling injury or mortality can result from applying 2,4-D, chlorsulfuron, dicamba, metsulfuron methyl, and picloram; mature shrubs are largely tolerant, although minor foliar injury such as leaf curl/cupping, chlorosis, epinasty, or defoliation could occur. Shrubs are very tolerant to applications of clopyralid and imazapic. Applications of sulfometuron methyl

could result in injury or mortality of all age classes of shrubs at application rates of above 1.0 ounce/acre.

Perennial grasses, once they are past the seedling stage, are largely tolerant of the herbicides being proposed. Some herbicides, such as imazapic, metsulfuron methyl, and sulfometuron methyl, are used to control annual grasses.

Because most of the target species are forbs, it is reasonable to expect non-target forbs are susceptible to herbicide application. The herbicides proposed for aerial use are selective and are used to target specific families of plants. Most native forbs are moderately tolerant to tolerant of aminopyralid, and most forbs are tolerant to metsulfuron methyl, because it is used to target annual grasses. Clopyralid targets the aster/composite, legume/pea, knotweed, and nightshade families; chlorsulfuron, sulfometuron methyl, and triclopyr target the borage, mustard/crucifer, and legume/pea families; and impazapic targets the borage, mustard/crucifer, and amaranth/goosefoot families. Many plant families are susceptible to picloram, but the aster/composite and legume/pea are especially susceptible. Most forb families are susceptible to dicamba, but the legume/pea is especially susceptible. Many plant families are susceptible to 2,4-D and glyphosate, but actively growing plants will tolerate some injury at low application rates, and no injury would occur to dormant plants.

3.2.3.3.3 Effects from Inert Ingredients and Adjuvants

Adjuvants are specially designed chemicals added to an herbicide solution to modify the performance of the total spray mixture. Adjuvants are not regulated by the EPA in the same way that pesticides are. The EPA does not register or approve the labeling of spray adjuvants. Field testing is generally completed by the adjuvant manufacturer (Bakke 2007). Labels accompanying adjuvants describe their properties and prescribe use rates. Information on types of adjuvants to use can also be found on herbicide labels and in publications by university extension services (Prather 2011, Zollinger 2012).

Adjuvants perform various functions, including enhanced plant uptake of the herbicide; better mixing of otherwise incompatible herbicides; increased adhesion of the spray to plant surfaces; and reduced spray drift. In many herbicide products, adjuvants are included as part of the pre-mixed formulation as purchased. Applicators can also add adjuvants to spray mixtures prior to application.

For many pesticide products containing adjuvants as part of the formulation, the compounds are not explicitly identified on the label or the Material Safety Data Sheet. Unless they are on one of EPA's lists of more toxic chemicals, they do not have to be identified. The identity of these ingredients in a pesticide or adjuvant product is legally protected from full disclosure as "Confidential Business Information."

At least one adjuvant is known to pose hazards to aquatic wildlife—the surfactant used in the original formulation of RoundUp, also known as polyoxyethyleneamine (POEA). This surfactant is more toxic to aquatic life than the active ingredient glyphosate. The POEA adjuvant (RoundUp Pro) will be used only in uplands, where no potential for movement into aquatic systems can occur. Within or near aquatic systems, only products labelled for aquatic application would be used. Adjuvants used on the CTNF and CNG are identified in Table 3-8.

Table 3-8. Recommended adjuvant type by herbicide.

Herbicide	Recommended Adjuvant Types
2,4-D amine	Non-ionic surfactants (NIS), fertilizer, crop oil concentrate
Aminopyralid	NIS
Chlorsulfuron	NIS, seed oil, organosilicone
Clopyralid	NIS, crop oil concentrate
Dicamba	Any as allowed by label
Glyphosate	NIS
Imazamox	NIS, fertilizer, seed oil, petroleum/crop oil concentrate, organosilicone
Imazapic	NIS, seed oil, organosilicone
Imazapyr	NIS, seed oil
Metsulfuron methyl	NIS, seed oil, organosilicone
Picloram	None needed but can add as per surfactant manufacturer's label
Rimsulfuron	NIS
Sulfometuron methyl	Any allowed by label
Triclopyr triethylamine salt (TEA)	NIS

Source: Prather 2011 and product labels.

Adjuvants with low toxicity to wildlife include modified seed oils, alkyl ethoxylates, and silicones. The most-commonly used adjuvant is marker dye and it is analyzed in *Use and Assessment of Marker Dyes Used with Herbicides* (Pepling et al. 1997).

"Activator" adjuvants enhance activity of an herbicide's active ingredient, while "special purpose or utility modifier" adjuvants offset common problems occurring during application, including poor water quality or foam produced during agitation of the spray mixture (Bakke 2007). Many adjuvants have properties that place them on a continuum between these two definitions and enable them to function as both activators and utility modifiers. Special-purpose or utility adjuvants are used to offset or correct certain conditions associated with mixing and application, such as impurities in the spray solution, extreme pH levels, and drift. These adjuvants include acidifiers, buffering agents, water conditioners, anti-foaming agents, compatibility agents, and drift-control agents. Acidifiers enhance absorption of weak acid-type herbicides. Drift-reduction agents generally increase the average droplet size. Defoamers reduce foaming that occurs during agitation of the spray mixture. Colorants or dyes help applicators determine what area has been treated, which helps to prevent skips and overlaps and treatment of non-target areas. Colorants or dyes reduce the chance of human exposure to recently treated vegetation (Bakke 2007).

Surfactants (surface active agents) are a broad category of activator adjuvants designed to improve or facilitate the dispersing/emulsifying, absorbing, spreading, sticking, and/or pest-penetrating properties of the spray mixture. Pure water will stand as a droplet, with a small area of contact with the waxy leaf surface. Water droplets containing a surfactant will spread in a thin layer over a waxy leaf surface (Bakke 2007).

Post-emergence herbicide effectiveness depends on spray-droplet retention and herbicide absorption by invasive-plant foliage. Adjuvants and spray water quality influence post-emergent herbicide efficacy (USDA Forest Service 2006a). Because post-emergence herbicide effectiveness is greatly influenced by plant factors such as age, size, and the growing conditions encountered before application, herbicide performance can vary. Variations in post-emergence herbicide performance can be avoided by using an adjuvant or surfactant in the spray solution.

Surfactants generally improve the effectiveness of post-emergence herbicides. Typically, surfactants are not added to herbicides that are soil applied (pre-emergence) (Zollinger 2012). Surfactants used on both the CTNF and CNG include non-ionic surfactants, methylated or ethylated vegetable oils, nitrogen sources, and organosilicone/silicone surfactants.

Non-ionic surfactants (NIS) are all-purpose surfactants consisting of linear or nonyl-phenol alcohols and/or fatty acids. This class of surfactant reduces water surface tension and improves spreading and sticking and herbicide uptake (USDA Forest Service 2006a). Often, non-ionic surfactants will have additional additive properties, as described on their labels.

Methylated or ethylated vegetable (seed) oils (MSO) are produced by reacting fatty acids from seed oils (corn, soybean, sunflower, and canola) with an alcohol to form esters. The methyl or ethyl esters produced by this reaction are combined with surfactants/emulsifiers to form esterified seed oil. These surfactants reduce water surface tension and improve herbicide uptake by improving herbicide distribution on the leaf surface (USDA Forest Service 2006a. Adverse environmental conditions, such as low humidity, hot weather, lack of rain, drought-stressed invasive plants, or invasive plants not actively growing due to some environmental stress, favor the use of MSO. These oils are more effective than non-ionic surfactants as an adjuvant for post-emergence herbicides (Zollinger 2012).

Nitrogen sources typically consist of premixed combinations of various forms of nitrogen and surfactants. They are generally used with broadleaf herbicides and herbicides that recommend adding ammonium sulfate or 28 percent nitrogen. These surfactants reduce water surface tension and improve leaf surface spreading (Miller and Westra 1998). Fertilizers containing ammonium nitrogen have increased the effectiveness of herbicides like glyphosate and 2, 4-D amine. Fertilizer applied with other herbicides may reduce invasive-plant control or cause crop injury. Some fertilizers enhance non-target plant growth to stimulate competition and keep invasive plant species from re-establishing. Fertilizers should be used with herbicides only as indicated on the label or where experience has proven acceptability (USDA Forest Service 2006b).

Organosilicones and silicone surfactants are two types of nonionic surfactants. Organosilicone surfactants drastically reduce water surface tension to the point where the herbicide droplets thin and coalesce to form a thin layer on the leaf surface (known as "superspreading"). In addition, this class of surfactant provides improved effectiveness through maximum rainfastness (Tu et al. 2001). Table 3-9 lists the recommended adjuvant types for each herbicide.

3.2.3.3.4 Toxicity of Adjuvants

Of the adjuvants discussed in this paper, only two carry the Danger signal word 5 (Entry II and LI-700), which is due to the potential effects to the eyes (severely irritating or corrosive). The bulk of the remainder carry the Caution signal word, while several carry the Warning signal word (again because of potential irritant effects to the skin or eyes). None of these adjuvants carry the poison symbol. All of the adjuvants discussed here are no more than slightly toxic when ingested, inhaled, or absorbed through the skin (Acute Toxicity Categories III or IV). "Normal" environmental exposure levels of surfactants and emulsifiers to humans would appear to be negligible based on the extremely high dosages that are typically necessary to cause toxic responses in mammals (Tu et al. 2001).

Table 3-9. Adjuvant type, class, product, and product manufacturer [a].

ADJUVANT TYPE	CATEGORY	PRODUCT NAME	PRODUCT MFG.	PRINCIPAL FUNCTIONING AGENTS	USE RANGE	SIGNAL WORD	COMMENTS
Activator	Non-ionic surfactant (NIS)	Activator 90	Loveland	Alkylphenol ethoxylate, alcohol ethoxylate and tall oil fatty acid	0.125–0.5%	Caution	Low foam, biodegradable, non-flammable
		R-11	Wilbur-Ellis	Alkylphenol ethoxylate, butyl alcohol, dimethylpolysiloxane	0.063–1%	Warning	Spreader, activator
		Spreader 90	Loveland	Alkylpolyethoxy ethers and ethoxylated derivatives	8–64 oz/100 gal	Warning	Spreader
		Super Spread 90	Wilbur-Ellis	Alkyl aryl polyoxyethylene glycols and free fatty acids	0.25–0.5%	Caution	Spreader
Activator	Basic blend *and* methylated or ethylated vegetable oil *and* nonionic surfactant *and* nitrogen source	Renegade	Wilbur-Ellis	Modified vegetable oil, ammonium solution, nonionic surfactant	1–2.5%	Warning	Unique blend, high load of Nitrogen
Activator	Methylated or Ethylated Vegetable Oil	MSO with Leci-Tech	Loveland	Methylated seed oils plus emulsifying surfactants	1–2 pt/A	Caution	MSO and non-ionic
Activator	Methylated or ethylated vegetable oil *and* organo-silicone surfactant	Syl-tac	Wilbur-Ellis	Organosilicone/ modified vegetable seed oil	0.125–0.375%	Caution	
		Phase	Loveland	Methylated seed oil plus organosilicone surfactant	0.125–0.5%	Caution	
Activator *and* Utility Modifier	Nonionic surfactant *and* buffering agent or acidifier	Super Spread 7000, LI 700	Wilbur-Ellis	Alkyl aryl polyoxyethylene, ethoxylated alcohols, aliphatic polycarboxylate	0.25–4 pt/100 gal	Caution	
Utility Modifier	Colorant	Hi-Light	Becker-Underwood	Proprietary blue colorant	6–32 oz/100 gal	Caution	
		Bullseye	Milliken Chemical	Proprietary blue colorant	0.5 oz/gal	None	

ADJUVANT TYPE	CATEGORY	PRODUCT NAME	PRODUCT MFG.	PRINCIPAL FUNCTIONING AGENTS	USE RANGE	SIGNAL WORD	COMMENTS
Utility Modifier	Water conditioning agent *and* buffering agent or acidifier	Bronc Max	Wilbur-Ellis	AMS/ammonium alkyl aryl sulfonates, polycarboxylic acid	0.125–1%	Caution	Ammonium sulfate (AMS) replacement
Utility Modifier	Water conditioning agent	Choice Weather Master	Loveland	Blend of salts of polyacrylic, hydroxy carboxylic, propionic acids, phosphate ester, ammonium sulfate	0.25–0.5%	Caution	AMS, water conditioner

[a] Products currently used on both Forests. For information on the process for adding adjuvants to the list, see section on IWM.

Testing of LD_{50} (lethal dose, 50 percent kill) on a range of wildlife shows that while some adjuvants are toxic to wildlife at small concentrations, others are considered "practically nontoxic."

Below is the definition of LC_{50} (lethal concentration, 50 percent kill) and the classification levels.

- <1 mg/l: HT (Highly Toxic)
- 1-10 mg/l : MT (Moderately Toxic)
- 10-100 mg/l: ST (Slightly Toxic)
- 100, 1,000 mg/l: PN (Practically Nontoxic)
- >1,000 mg/l: IH (Insignificant Hazard)

3.2.3.3.5 Summary of Risk by Species Status

3.2.3.3.5.1 Threatened, Proposed, and Regional Forester's Sensitive Species

Direct impacts to threatened, proposed, or sensitive species could occur from the potential exposure to various herbicides and associated chemicals through several routes. Wildlife can come in direct contact with herbicides externally from direct spray, grooming activities, or contact with contaminated vegetation, or internally through foraging on plants or prey species, or in a diluted form from contaminated drinking water. Wildlife can also be exposed to herbicides topically by inhalation through breathing direct spray or evaporated herbicide.

Wildlife can also be affected by herbicides from changes in vegetation structure which depends on specific treatment used, the particular herbicide, the rate of application, and the season of application. Direct impacts from herbicide application would result in changes in composition of invasive plant communities, along with other forbs, grasses, and shrubs in treatment areas. Short-term impacts to plant composition and community diversity would likely last for as little as 3 years as native forbs recovered on the site. Proposed treatments are not expected to have any long-term loss of species diversity of native vegetation. Vegetative species composition can be expected to resemble native-plant communities within 3 years.

In general, the introduction of contaminants into an ecosystem can cause direct harm to organisms and may indirectly affect their ability to survive and reproduce. The most important

factors regulating chemical toxicity in animals are the exposure dose, duration of exposure, and potency of the chemical. The nutritional, physiological, and genotypic state of an ecological receptor at the time of exposure can significantly modify the toxicity of the chemical or chemical mixture. Herbicide properties (e.g., toxicity, metabolism, environmental fate, and transport) will also influence the impact herbicides will have on wildlife (WSDOT 2005). Information regarding the environmental fate of each herbicide being proposed is listed in Appendix C of the Terrestrial Wildlife Resources Specialist Report (USDA Forest Service 2020a). Applications of herbicides are likely to alter terrestrial vegetation and may impact terrestrial animals by altering food availability and habitat quality. Secondary effects, such as changes in reproductive capability or survivability, food availability, and habitat quality, are common to all herbicides (SERA 2011a-d).

3.2.3.3.5.2 Riparian Breeding Birds and Migratory Birds

Riparian breeding birds and migratory birds are widely adapted to many habitat types and require many different habitat components seasonally, so presumably they could utilize every cover type—sagebrush/salt desert scrub, grassland, high-elevation mixed conifer, low-elevation mixed conifer, juniper/pinyon/mountain mahogany, and riparian. Within the approximately 3 million-acre action area, approximately 82,503 acres of invasive plant infestations have been identified.

Of the 14 herbicides proposed for use, two had exposure scenarios for birds with HQs exceeding the LOCs: dicamba and triclopyr TEA. Dicamba had acute-exposure scenarios with an HQ exceeding the LOC for large birds eating contaminated vegetation and small birds eating contaminated insects. Triclopyr TEA had acute- and chronic-exposure scenarios with HQs exceeding the LOCs for birds eating contaminated vegetation. Neither dicamba nor triclopyr TEA are proposed for aerial application.

While two herbicides resulted in HQs above the LOC, direct effects to riparian breeding birds or migratory birds as result of herbicide toxicity would not likely occur. The risk estimates for the herbicides discussed above overestimate potential field exposures, and adverse effects would not likely occur. Design criteria for herbicide application would also ensure herbicides would be applied safely and appropriately.

None of the herbicides analyzed had an exposure scenario of a predatory bird consuming a contaminated small mammal or fish with an HQ exceeding the LOC.

For birds, indirect effects may occur through vegetation changes that may impact food availability and habitat (USDA Forest Service 2006a). Indirect effects from treatment methods would not be expected to have a long-term negative effect on riparian breeding birds or migratory birds. Studies looking at the aerial application of glyphosate to control brush found the treatments resulted in vegetation that was structurally less complex and reduced the abundance of invertebrates. Birds using shrub habitat for foraging and nesting declined in abundance post-treatment, more so than species that tended to be habitat generalists. Once the vegetation recovered from the herbicide treatment, bird abundance increased. Using selective herbicide in shrub habitats did not affect nesting success or population density (Marshall and Vandruff 2002).

Habitat alteration resulting from temporary decreases in forage species as a result of invasive plant treatment activities would not be expected to have a noticeable effect on nesting or roosting

habitat or forage abundance. Rather, treatment activities would be expected to have a long-term beneficial effect on overall habitat quality and quantity.

The patchy nature of the invasive plant infestations and the multi-state breeding range for riparian breeding birds and migratory birds indicate that, while adverse effects to some individual birds cannot be ruled out, a population-level effect to the species would not be likely from proposed invasive plant treatments. Indirect effects to birds associated with impacts to non-target vegetation (e.g., shrubs, small trees) may occur; these effects could locally impact bird habitat for 1–3 years before vegetation re-establishes.

Riparian breeding birds and migratory birds are primarily impacted by habitat loss and fragmentation. Invasive plant treatments do not alter native habitat. Some individuals can be harmed by herbicide applications, but herbicides proposed under this alternative have relatively low toxicities and are not expected to add to or accumulate with other herbicide exposures because they are not retained or stored in the body. None of the birds or their habitats would be significantly affected by invasive plant treatments. Even effects to individuals would have a very low probability of occurring. In many cases, no effect at all would occur to the birds or their native habitats.

3.2.3.3.5.3 Big-Game Species of Interest

Big-game species are present on all ranger districts of the CTNF and CNG. They are widely adapted to many habitat types and require many different habitat components seasonally, so presumably they could utilize every cover type.

Within the approximately 3-million-acre action area, approximately 82,503 acres of noxious invasive plant infestations have been identified. Of the 14 herbicides being analyzed for use, two resulted in HQs exceeding the LOC for the scenario of large mammals consuming contaminated vegetation. 2,4-D and triclopyr TEA, which are not proposed for aerial delivery, had acute scenarios with HQs exceeding the LOC. Only triclopyr TEA had a chronic scenario with an HQ exceeding the LOC. However, these values likely over-estimate risk because they assume 100 percent of the individual's diet would consist of contaminated vegetation.

For triclopyr TEA, the HQs for mammals increase as bodyweight increases. Both acute and chronic exposure scenarios for large mammals eating contaminated vegetation had HQs exceeding the LOC at the typical application rate. Based upon HQs that exceed the LOC, the greatest risk would be to large mammals eating contaminated vegetation over a long time period. Data suggest that HQs of about 4.0 could be related to adverse effects such as changes in blood chemistry or birth defects. Overt signs of toxicity would not likely be observed. The HQs developed using risk assessments suggest that adverse effects could occur to mammalian wildlife at application rates used by the USDA Forest Service. The exposure scenario is designed to be extreme; the assumption is that 100 percent of the diet would be contaminated, which would not realistically occur.

Spot spraying and roadside spraying of invasive plants would not likely expose big-game species to harmful levels of herbicide because these species are unlikely to forage exclusively on treated invasive plants. Also, the patchy nature of the applications would make it unlikely that deer, elk, or moose would forage exclusively on the scattered treated patches.

Treating invasive plants in big-game habitat would beneficially affect big game by preserving native forage species, maintaining or improving the nutritional value of available forage, and

maintaining the long-term suitability of the habitat. Invasive plants can reduce the ability of an area to support big-game species (Rice et al. 1997b). Maintaining and improving native herbaceous plants and shrubs would increase the nutritional value in these areas and contribute to increased animal health and ability of critical areas, such as winter range and key elk habitat, to support deer and elk.

Habitat alteration resulting from temporary decreases in forage species as a result of invasive plant-treatment activities (herbicide, manual and mechanical, biological, and restoration) would not be expected to have a noticeable effect on forage abundance for big-game species. Rather, treatment activities would be expected to have a long-term beneficial effect on overall forage quality and quantity.

3.2.3.4 Direct and Indirect Effects of Invasive Plant Treatment Activities Related to Disturbance

3.2.3.4.1 Alternative 1—No Action/Current Management

Under the No Action/Current Management Alternative, no change would occur from current invasive-plant management efforts. This alternative would continue the same invasive plant management programs and treatments and levels of effort for controlling invasive plants within the CTNF and CNG that are currently used. In general, this alternative includes treating invasive terrestrial plants using biological, mechanical, and/or herbicide treatments. Herbicide application under this alternative would be limited to the treatment of terrestrial invasive plants with 14 herbicides and using ground-based application techniques only. Potential disturbance from invasive plant species treatments proposed under Alternative 1 would be the same as Alternative 2 discussed below.

3.2.3.4.2 Alternative 2—Proposed Action

Under the Proposed Action, invasive plants would be aggressively eradicated, controlled, or contained using a variety of methods and, following treatment, the sites would be restored (where appropriate) to native vegetation. Loss of native habitat to invasive-plant infestations would decrease over time as invasive plant populations are reduced and eliminated. Many wildlife species would benefit in the short term and long term as native plant communities are restored following invasive-plant treatment. Restored plant communities would provide improved forage, hiding cover, and reproductive cover for wildlife as native plant density, canopy cover, and species diversity increase and multi-layered grass/shrub canopies develop on formerly invasive plant-infested sites compared to the No Action/Current Management Alternative and existing conditions. Wildlife species relying on grassland shrubs, forb communities, riparian areas, and low-elevation pine and Douglas-fir forests would benefit the most, as these plant communities are the most likely to be negatively impacted by invasive plant infestations.

The short-term and long-term indirect effects of more-effective invasive plant control under the Proposed Action would benefit more wildlife species in the long term than the No Action/Current Management Alternative. Long-term benefits to wildlife under the Proposed Action would be considerably greater than those under the No Action/Current Management Alternative because of more-effective invasive plant control. Species would benefit from reducing the rate of native plant community productivity loss resulting from invasive plant expansion.

Consideration of impacts by treatment option suggests that mechanical treatment would have a somewhat longer-term displacement effect on wildlife than chemical treatments, and biological-control agents that feed only on target plants would have almost no direct effect on wildlife. Human disturbance would increase in treatment localities, generally for short durations. Use of aircraft would increase disturbance from noise due to over-flights along access corridors to and from treatment areas and in the treatment areas themselves.

Short-term and long-term indirect effects would be expected to be largely beneficial and would occur incrementally over a long period of time, as invasive plant-infested areas recover to more natural conditions. Restoring disturbed areas (where appropriate) would not be expected to adversely affect wildlife resources. A short period of time would exist when habitat values on areas being restored would be low, because of low vegetation density. As restored areas recover, effects would be beneficial as wildlife habitat values would improve existing conditions.

3.2.3.4.2.1 Biological Control

For mammals and birds, bio-control treatments are expected to decrease the negative impacts from noxious weed and invasive plant infestations on terrestrial wildlife species by utilizing insects and targeted grazing to decrease invasive plant species. Insects proposed for biological use within the CTNF and CNG are highly specialized to target invasive-plant species and are not expected to negatively impact terrestrial wildlife populations or native forage. Minimal or no direct or indirect effects on terrestrial wildlife species would be expected from introducing insects and targeted grazing as part of a bio-control method of treatment.

In addition, studies have found that native rodents may take advantage of the food source provided by biocontrol agents (Pearson et al. 2000). Insectivorous riparian breeding birds and migratory birds may also feed on insects introduced during biological control treatments. Biological control that reduces invasive plant populations, increases native plant populations and provides a supplemental food source would be indirectly beneficial to wildlife.

Targeted livestock grazing would decrease the negative consequences of invasive plant infestations on terrestrial wildlife. However, livestock introduced to control invasive plant populations would likely also graze on native plants. Livestock grazing may displace some big-game species during treatment periods and could reduce forage in the treatment area for the remainder of the treatment year. Grazing of livestock may cause brief disturbance to big-game species and may cause a local reduction in non-target vegetation due to nonselective grazing; however, long-term improvements to big game habitat would occur.

Other effects of grazing in aquatic habitats can include nutrient loading; reduction of shade and cover, which would increase water temperature; more intermittent flows; changes in stream channel morphology; and sedimentation caused by bank degradation and off-site soil erosion. Removing streambank vegetation, in addition to causing greater fluctuations in temperature, can also decrease water storage capacity and increase erosion potential. The removal of vegetation in upland areas can also increase erosion, as well as reduce water infiltration and accelerate runoff. Grazing can reduce erosion by stimulating the growth of stabilizing vegetation and improve aquatic habitats by increasing the number and size of woody shrubs along streams. Over the long term, a reduction of sediment loading into streams for most flow regimes and a reduction of summer stream temperatures as woody vegetation along streambanks begins to provide increasing levels of shade would be possible.

Biological-control treatments would have little-to-no effect on most riparian breeding birds and migratory bird species. The grazing of livestock may briefly disturb migratory bird species and may locally reduce non-target vegetation due to nonselective grazing; however, long-term improvements to habitat used by these species would occur as additional habitat with the necessary structure and diversity would be created.

For amphibians, use of domestic animals to contain weeds in upland or aquatic habitats occupied by amphibians can cause death or injury to animals through trampling. Domestic animals may also disturb egg masses and larvae, potentially reducing the number of individuals that reach reproductive age.

Use of domestic animals could negatively affect aquatic and riparian habitats utilized by amphibians if not managed to maintain riparian ecologic functions and processes. One study indicated that exclusion of cattle grazing resulted in re-establishment of native trees and native wetland plants, re-establishment of creek pools, and an expansion of frog populations into streams and ungrazed stock ponds. When cattle drink from small ponds and streams, they can draw down water levels, leaving egg masses above the water surface, thereby subjecting them to desiccation and/or disease.

Other effects of grazing on aquatic habitats include nutrient loading, reduction of shade and cover, which result in increases in water temperature, more intermittent flows, changes in stream channel morphology, and sedimentation caused by bank degradation and off-site soil erosion . Presence of domestic animals in riparian vegetation can cause mass erosion from trampling, hoof slide, and streambank collapse, all of which cause soils from the bank to enter the stream, reducing the quality of habitat. Trampling can also compact the soils and reduce infiltration, which in turn may decrease the recharge of the saturated zone and increase peak flow discharge. Removal of streambank vegetation, in addition to causing greater fluctuations in temperature, can also result in decreased water storage capacity and increased erosion potential. The removal of vegetation in upland areas can also increase erosion, as well as reducing water infiltration and accelerating runoff.

There would likely be long-term positive effects from using domestic animals to contain weeds, provided guidelines to increase protection of riparian vegetation and streambanks were followed. Grazing can result in reduced erosion through the growth of stabilizing vegetation, and aquatic habitat improvement by increasing the number and size of woody shrubs along streams. Over the long-term, there might also be a reduction of sediment loading into streams for most flow regimes, and a reduction of summer stream temperatures as woody vegetation along streambanks began to provide increasing levels of shade.

3.2.3.4.2.2 Chemical Control

For mammals, birds, and amphibians, human disturbance, in the form of human activity and noise of short duration, would be expected to occur in most treatment areas. Disturbance from aircraft, vehicles, and workers on horseback or on foot would increase during herbicide treatment activities, causing some wildlife to be locally displaced in or near the treatment areas during treatments. Due to the brief duration of these activities, wildlife would be expected to resume normal behaviors after treatments are complete. Also, if wildlife displacement occurs, it could reduce the risk of direct herbicide exposure to those displaced individuals.

Effects of noise on wildlife can be classified as those affecting auditory physiology and sensory perception, those affecting behavior, and those affecting populations. Noise levels are expected to marginally increase with aircraft activity around the subject treatment areas for very short periods of time. Along access corridors to multiple spatially similar treatment areas, the coming and going of invasive-plant treatment vehicles, personnel, equipment, and aircraft may displace wildlife for longer periods (on the order of weeks rather than days); however, the duration of disturbance would be less for areas aerially treated when compared to ground-based methods. Typically, the duration of traffic along these corridors would be limited to a few days, and once complete, wildlife would return to these areas.

Temporary displacement of individual riparian breeding birds or migratory birds may occur during chemical treatment activities Herbicide treatments could result in trampling or harm to eggs/young of ground or low-nesting species during the breeding season. The short term, low magnitude, and limited extent (typically 1 acre or less scattered over larger areas) of disturbance that would occur from chemical treatments would not negatively impact populations of riparian breeding birds or migratory birds.

Invasive plant treatments on summer range can disturb big-game species, but disturbance would be short term, of low intensity, and limited in extent. The level of disturbance would not create negative effects for these very mobile and wide-ranging species. Invasive plant treatments would have minimal effect on big-game species. Disturbance near winter range would not likely affect big-game species because invasive plant treatments would not occur during the winter.

Noise and other disturbances from aerial application methods may disturb big game populations for a short time (1–3 days), but these impacts would not persist. The greatest impacts to elk, moose, and mule deer could occur to females if they are disturbed during or shortly after calving. However, most invasive plant treatment activities would not occur in calving and fawning habitat.

3.2.3.4.2.3 Manual and Mechanical Control

For mammals and birds, it is expected that mechanical treatments will result in minimal impacts to terrestrial wildlife populations. Increased human activity in noxious weed and invasive nonnative weed infestation areas would occur and result in short-duration local avoidance of these areas by some wildlife species. Mechanical treatments would be considered a low risk activity for most wildlife species based on habitat distribution and use, and their proximity to treatment areas.

Disturbance from manual and mechanical treatments is likely to pose greater risks to terrestrial wildlife species than herbicide application methods. Small species that lack rapid mobility (e.g., amphibians and very young individuals) are vulnerable to crushing or injury from people or equipment. Manual treatments can take longer to implement than other methods, increasing the length of time of disturbance. Manual treatments are often used at small sites, where the potential to impact wildlife would be concentrated at that site, but may also be used in large areas with scattered invasive plants. In these situations, crews may be in an area for more than a day. Mechanical methods can generate more noise disturbance than other methods. Use of vehicle-mounted equipment, such as mowers, is less selective and more likely to directly impact small animals than use of hand-operated equipment, such as string trimmers. Mechanical treatment methods would typically occur along roadsides or in dispersed use sites, and areas that are unlikely to provide wildlife habitat.

Loud and sudden noises above background or ambient levels can cause disturbance that might flush a bird off the nest or abort a feeding attempt. Based on field measurements, vehicles used to spray roadside vegetation with herbicides do not generate noise above ambient levels; therefore, no "injury" or "harassment" from noise will occur. Other mechanical devices proposed for use on invasive plants have potential to create noise above background levels that may disturb some species if used during biologically sensitive periods (i.e., nesting and denning).

Rehabilitation seeding treatments require native seed mixes. The planting or seeding of desirable species following other invasive plant treatments can be effective at shading or out-competing invasive plants. This treatment can also cause short-term disturbance, but has potential to restore wildlife habitat faster than passive re-vegetation.

Temporary direct displacement effects on wildlife resulting from disturbance during weed treatments would be localized and minor relative to the total CTNF and CNG acreage. This displacement would likely last only a few days or weeks while the actual treatment is occurring but could occur during any time of the year that treatments are implemented.

Threatened and proposed species may be directly affected by temporary disturbances associated with implementation of mechanical treatments. Canada lynx, grizzly bears, and yellow-billed cuckoos might be temporarily displaced by human activity; however, the likelihood of such interactions would be low and limited to individuals and no population-level effects would be expected.

Sensitive species would be directly disturbed, temporarily, during mechanical weed treatment procedures. Potential disturbance and displacement of sensitive species would likely last only a few days or weeks while the actual treatment is occurring but could occur during any year that treatments are implemented. Sustained human disturbance in the immediate vicinity of a nest or den site during sensitive periods could result in reproductive failure during that year or could result in re-nesting or den relocation. However, the likelihood of such an occurrence is very low because project design criteria would minimize disturbance to sensitive species.

Indirect effects from manual or mechanical treatments are expected to be largely beneficial and would occur incrementally over a long period of time, as weed-infested areas recover to more natural conditions. Restoration of disturbed areas (where appropriate) would not be expected to adversely affect wildlife resources. A short period of time would exist when habitat values on areas being restored would be low, because of low vegetation density. As restored areas mature, habitat quality would improve as ecological functions and processes are restored. This would beneficially affect wildlife.

For amphibians, equipment used during mechanical treatments can directly affect herpetofauna in upland habitats by killing or injuring individuals, including those seeking cover in shallow burrows. During removal of downed woody material, placing the material into piles could also crush animals.

Mechanical treatments can expose soil by crushing or removing vegetation and would be expected to increase potential for erosion over the short-term, resulting in some sediment inflow into aquatic habitats. Like ash and sediment resulting from fire, this sediment could cause mortality by smothering eggs and larvae and could inhibit respiration in invertebrates on which the herpetofauna feed. Use of equipment may also crush other invertebrates and vertebrates upon which certain species feed.

3.2.3.5 Cumulative Effects

Cumulative effects under NEPA are the impacts on the environment which result from the incremental impacts of the action when added to the other past, present, and reasonably foreseeable future actions regardless of which agency undertakes them (e.g., state, private, federal).

The action area for all terrestrial wildlife species analyzed in this document consists of the lands within the boundaries of the CTNF and CNG.

Appendix H discusses what is known about herbicide use on other land ownerships adjacent to the project area, including adjacent federal, tribal, state, and private lands. Precise information about herbicide use off of NFS lands is not available. Private landowners and counties are not required to report herbicide use or other invasive plant treatment information, thus an accurate accounting of the total acreage of invasive plant treatment for all land ownerships is unavailable.

For terrestrial wildlife species addressed in this document, activities that likely had the most impact on these species include past and current livestock grazing, past and current mining activities, road maintenance, motorized use of roads, firewood gathering, past and current timber harvest, and developed and dispersed recreation.

Invasive plant treatments involve relatively small, well-defined spatial areas. Most treatments would be confined to linear areas along travelways and small acreage patches infested with invasive plants, leaving other native vegetation intact. Native wildlife habitat would not be removed, modified, or degraded, nor would any hydrologic regimes be affected by the Proposed Action. Treatments would occur once, and possibly up to three times, each year, generally from late-spring to mid-fall. Treatments would be of low intensity and of small magnitude and generally of short duration (1 day or less). Given the spatial and temporal scale of invasive plant treatments and the design criteria that reduce disturbance, potential for cumulative effects is low.

For terrestrial wildlife species, the actions assessed in this report for invasive plant treatment-related activities on NFS lands would increase the extent and amount of human disturbance contributing to displacement of individual animals from source habitats. Areas of disturbance can create barriers to movement and reduce foraging opportunities and may affect reproductive success. Design criteria for invasive plant treatment-related activities on NFS lands would minimize the extent of negative effects to terrestrial wildlife species and their habitats. Cumulative exposure to herbicides would occur only for animals that move between NFS lands and other ownerships. Because the herbicides proposed for use in this project are rapidly excreted, do not bioaccumulate or biomagnify, and pose a relatively low risk to wildlife, they would be unlikely to result in any cumulative toxic effect, even if exposures occurred from multiple ownerships.

Every mile of road has an associated area of vulnerability to nonnative plant species invasion due to use and maintenances and associated herbicide treatments that occur in known invasive plant infestations. This risk of nonnative species invasion has created positive and negative impacts on species that prefer disturbed habitats. The potential negative impacts depend on the nonnative plant species and the type of herbicide applied.

Definitive cumulative effects from nonnative plant species competition and the related treatments are unknown. Past, ongoing, and foreseeable USDA Forest Service management

activities mentioned above and public use of NFS lands have and would continue to contribute to the introduction and spread of nonnative plant species.

For terrestrial wildlife species, the Proposed Action would increase the extent and amount of human disturbance contributing to displacement of individual animals from source habitats. Areas of disturbance can create barriers to movement and reduce foraging opportunities and may affect reproductive success. Design criteria for invasive plant treatment-related activities on NFS lands can minimize the extent of negative effects to these species and source habitats from invasive plants.

Negative cumulative effects to any wildlife species considered in this document from the No Action/Current Management Alternative or the Proposed Alternative would not be likely when added to past, present, or reasonably foreseeable actions because invasive plant treatments create only discountable effects or no effects from disturbance or herbicide exposure and do not remove or degrade wildlife habitat.

3.3 Issue 2: Fisheries

The fisheries resource specialist report was developed for this analysis and is included by reference (USDA Forest Service 2020b).

3.3.1 Methodology for Analysis

Chemical treatment is an important and effective method when the management objective is weed eradication or control. It involves applying herbicides (chemical compounds) at certain stages of plant growth to kill weed species. However, herbicide use requires caution, as it is a chemical compound that can negatively affect aquatic species. If not used properly, herbicides can contaminate water, harm fish through exposure to chemicals, and negatively affect aquatic plants and insects. Other potential effects of herbicide use to fisheries resources include erosion from physical disturbance resulting from mechanical treatments and water quality impacts resulting from chemical treatments. However, failure to treat invasive plants can also adversely affect aquatic resources. Loss of native vegetative cover can result in soil loss and impacts to water quality, riparian vegetation, and stream channel morphology. Treating invasive plants can help maintain native vegetative ground cover and prevent many of these impacts.

The Interdisciplinary Team (IDT) Fisheries Biologist analyzed the potential effects of chemical contaminants on fishes and macroinvertebrates using the SERA risk assessments, toxicity indices, and HQs.

Toxicity indices (thresholds) were established using either measured chronic No Observed Adverse Effect Level (NOAEL) or 1/20th of the acute LC50 (a lethal concentration that results in mortality for 50% of subjects), whichever was lower. The NOAEL measurement is defined as no biologically or statistically significant adverse effects attributable to treatment. Use of these thresholds, including a chronic NOAEL for acute exposures, was intended to account for uncertainty regarding sublethal effects to fish (USDA Forest Service 2005). Extreme-case scenarios were developed to estimate herbicide concentrations in water and, therefore, the dose received by fish and aquatic organisms.

The estimated dose (from the scenarios) was divided by the “toxicity index,” and the result is known as the HQ. When the HQ is less than 1.0, the dose is less than the toxicity index. Adverse

effects from doses calculated to be below the toxicity indices were considered discountable. When a calculated dose was greater than the toxicity index, it was assumed a potential existed for adverse effects. This very conservative approach constitutes an "extreme-case" analysis for potential effects of herbicides.

The techniques and methodologies used in this analysis considered pertinent available science, and the conclusions are based on a scientific analysis that shows a thorough review of relevant scientific information. Determinations were reached based upon previous monitoring of similar types of activities on NFS lands and a review of pertinent literature. The potential effect of weed treatment activities, including herbicide use, on Forest lands is well documented, and no significant scientific uncertainties or risks associated with this proposal exist.

3.3.1.1 Analysis Area

The action area (area of analysis) includes the CTNF and CNG for all alternatives. There are 23 subbasins (4th-order HUC) in the action area, encompassing all areas potentially affected directly or indirectly by the Proposed Action. Aquatic Resource Baseline Conditions for each subbasin with sensitive species are discussed in the Fisheries BE, which is available in the project record. Because of the potential for downstream and cumulative effects within watersheds, the action area encompasses entire subwatersheds where invasive plant treatments, and sensitive species may occur.

3.3.1.2 Measurement Indicators

Indicators are measures used to track the potential effects of the Proposed Action and the other alternatives on the significant issues. Measurement indicators for water quality and fisheries are:

- Adequacy of design criteria/BMP's (see section 2.2.2.2) that apply to water quality and aquatic organisms.
- Effects of herbicide to be used within riparian areas on aquatic organisms.

3.3.2 Affected Environment

3.3.2.1 Aquatic Habitat Conditions and Threats

The CTNF and CNG harbor approximately 13 native and 10 nonnative fish species. A significant amount of aquatic habitat is managed within the CTNF, which is utilized by Yellowstone cutthroat trout, Bonneville cutthroat trout, and northern leatherside chub. Yellowstone cutthroat trout are found within all drainages other than the Bear River, where Bonneville cutthroat trout are found. Northern leatherside chub are relegated to the tributaries of the Salt River and were reported within the Blackfoot River drainage in the last 40 years but appear now to be extirpated. Northern leatherside chub were likely found in the Middle and Lower Bear River but are now known to only occur in the Upper Bear River in Wyoming and Utah. The CNG may have historically supported native trout but none occur presently. The CTNF and CNG has more than 9,270 miles of perennial streams with approximately one third being fish bearing and nearly 24,256 acres of perennial and intermittent lakes and reservoirs.

Invasive terrestrial and aquatic plants are displacing native plants and have the potential to destabilize streams and reduce watershed function, thereby reducing the quality of fish and

wildlife habitat in the CTNF and CNG. Invasive plants found growing adjacent to or within aquatic environments can invade, occupy, and dominate riparian and aquatic habitats that have the potential to degrade fish habitat. Invasive plants can change stand structure and alter future inputs of organic litter input (woody and leafy debris) that provide the basic foundation of the aquatic ecosystem food webs. Native vegetation growth may change as a result of invasive plant infestation, and the type and quality of litter fall and organic matter may decline, which can alter or degrade habitat for aquatic organisms. The amount and type of aquatic vegetation has the potential to alter water chemistry through nutrient uptake, respiration, and decomposition. Therefore, aquatic invasive plant infestation has the potential to greatly alter habitat quality for aquatic organisms.

Invasive plant infestations have been shown to influence soil erosion and sedimentation (Lacey et al. 1989), which can adversely affect aquatic resources of the CTNF and CNG. Forest and land management practices also may affect fish and their habitat. Excessive sedimentation can alter streambeds, affect spawning and rearing areas and success, and raise water temperatures, resulting in adverse effects to aquatic habitat quantity and quality and the wellbeing of fish and benthic invertebrate communities. Invasive plant control at or near the headwaters of rivers and tributaries within the CTNF and CNG can have a direct beneficial downstream effect on riparian habitat and the health of aquatic resources by reducing seed dispersal and the threat of invasive plant establishment.

River and stream corridors are vulnerable to invasive plant establishment, and yet they provide important natural habitat conditions for fish and benthic organisms. They support migration, spawning, rearing, and overwintering for aquatic species in different life stages. Portions of the river corridors are subject to intense use by humans and wildlife. Human activities include diversion of water for livestock, agriculture, and community water use. Recreational activities like camping, fishing, and rafting are popular on nearly every stretch of these waters. Mining, timber, and livestock grazing activities can also affect the quality of the habitat.

Generally, instream flows within the CTNF and CNG adequately support healthy riparian communities and aquatic habitat. Instream flows can be affected by human use (primarily irrigation) at lower elevations. Sedimentation and drought can also affect instream flows.

Roads confine many of the rivers and major streams within the CTNF and CNG. These roads can contribute to the sedimentation of drainages and provide avenues for the proliferation of invasive plants. Road construction has reduced riparian habitat, thus reducing the recruitment of woody and leafy debris into the stream channels that contribute to the formation of pools and provide cover for aquatic species. Conversion of some riparian areas to other uses further degrades habitat by removing native vegetation and replacing it with nonnative grasses and other landscaping, thereby increasing an area's vulnerability to invasive plants. Streamside roads can also constrict channels, causing degradation to fish habitat through loss of riparian and floodplain function.

3.3.2.2 Region 4 Sensitive Species

The FSM directs the regional forester to identify sensitive species for each National Forest where species viability may be a concern. The Intermountain Region (R4) Sensitive Species List was updated in June 2016. The fish species in Table 3-10 may reside within the project area and appear on the Region 4 sensitive species list. A more detaild description of the habitat

requirements, threats, and status on the forest for each species carried into analysis can be found in the fisheries resource specialist report (USDA Forest Service 2020b).

Table 3-10. Habitat, spawning habitat, and threats on Region 4 sensitive species that may reside within the project area.

SPECIES	HABITAT	SPAWNING HABITAT	THREATS
Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*)	Freshwater rivers and tributaries in Idaho, Wyoming, Utah and Nevada.	Cool, well-oxygenated water with well-sorted gravels and minimal fine sediments.	Habitat destruction, range reduction, competition from non-native trout, and hybridization with other trout species.
Northern Leatherside Chub (*Lepidomeda copei*)	Cooler creeks and rivers with slow-moving water in Idaho, Utah, and Wyoming	Cobble and gravel substrate in moving water.	Habitat destruction and collection for bait.
Bonneville Cutthroat Trout (*Oncorhynchus clarkia utah*)	Tributaries to the Great Salt Lake, Utah in Utah, Wyoming, Nevada, and Idaho.	Cool, well-oxygenated water with well-sorted gravels and minimal fine sediments.	Habitat destruction, range reduction, competition from non-native trout, and hybridization with other trout species.

3.3.2.3 Watersheds, Infestations, and Fish Presence

Invasive plants have been identified across 82,453 acres of the CTNF and CNG's 4th field watersheds, of which all but three contain R4-sensitive fish species (Table 3-11). About 15,306 acres of infestations are mapped within the AIZ and, of these, 15,147 acres containing sensitive species.

Table 3-11. All infested watersheds located within the Caribou-Targhee National Forest (CTNF) and Curlew National Grassland (CNG) shown in alphabetical order.

WATERSHED NAME	4TH LEVEL HUC_8 NUMBER	TOTAL ACRES IN HUC ON NATIONAL FOREST	TOTAL INFESTED ACRES IN HUC	PERCENT INFESTED IN HUC	INFESTED ACRES IN AIZS	THREATENED, ENDANGERED OR SENSITIVE SPECIES PRESENT IN HUC [a]
American Falls	17040206	7,863.20	100.25	1.27	32.50	NA
Bear Lake	16010201	220,154.57	9,573.99	4.35	1,609.10	BCT
Beaver-Camas	17040214	154,681.80	1,294.67	0.84	308.68	YCT
Birch	17040216	146,498.28	133.89	0.09	42.34	YCT
Blackfoot	17040207	124,860.91	5,352.95	4.29	1,330.67	YCT
Central Bear	16010102	22,733.18	964.36	4.24	119.81	BCT
Curlew Valley	16020309	43,895.91	2,458.89	5.60	0.00	NA
Greys-Hobock	17040103	1,606.27	67.25	4.19	6.39	YCT
Idaho Falls	17040201	1,274.60	81.70	6.41	5.20	YCT
Little Bear-Logan	16010203	19,983.75	855.97	4.28	276.39	BCT
Lower Bear-Malad	16010204	69,920.71	758.94	1.09	127.18	NA
Lower Henrys	17040203	108,375.60	2,364.77	2.18	347.09	YCT
Medicine Lodge	17040215	156,166.35	191.34	0.12	92.52	YCT

WATERSHED NAME	4TH LEVEL HUC_8 NUMBER	TOTAL ACRES IN HUC ON NATIONAL FOREST	TOTAL INFESTED ACRES IN HUC	PERCENT INFESTED IN HUC	INFESTED ACRES IN AIZS	THREATENED, ENDANGERED OR SENSITIVE SPECIES PRESENT IN HUC [a]
Middle Bear	16010202	137,238.66	12,411.22	9.04	2021.38	BCT
Palisades	17040104	482,184.76	5,696.21	1.18	1,960.10	YCT
Portneuf	17040208	157,311.61	2,603.87	1.66	896.88	YCT
Salt	17040105	220,799.06	6,854.19	3.10	2,144.79	YCT, NLC
Teton	17040204	282,531.51	2,148.27	0.76	573.78	YCT
Upper Henrys	17040202	498,467.93	27,440.20	5.50	3006.54	YCT
Willow	17040205	35,613.35	1,100.38	3.09	405.00	YCT
TOTAL		2,896,353.92	82,453.30	2.85	15,306.35	

[a] R4-sensitive species: YCT=Yellowstone cutthroat trout, NLC=northern leatherside chub, BCT=Bonneville cutthroat trout, NA=no threatened, endangered, or sensitive species.

3.3.3 Environmental Consequences

3.3.3.1 Effects for Alternative 1—No Action/Current Management

3.3.3.1.1 Direct and Indirect Effects

In watersheds where nonnative species have displaced native species, invasive plants can alter processes that affect the quality and quantity of fish habit. Invasive plant infestations can alter ground cover and raindrop interception, which can increase wildfire frequency, surface runoff, and sediment transport. Once established, invasive plant infestations can sometimes alter fuel characteristics of the landscape and establish a lasting wildfire cycle that promotes the dominance of the invasive species (Brooks et al. 2004). Many invasive species are annual plants with allopathic mechanisms that kill other plants and reduce the vegetation density. Vegetative cover can be changed to the point where the hydrology of an area is disrupted. Studies by Lacey et al. (1989) reported a 50 percent increase in runoff at knapweed-infested sites compared to non-infested sites.

With the expected and continued spread of invasive plants under Alternative 1, there would be an increased potential for both short- and long-term soil erosion and stream sedimentation at sites infested by invasive plants. Increased soil erosion and stream sedimentation can directly and indirectly adversely affect aquatic habitat and associated fish and aquatic invertebrate populations.

Invasive plants found growing adjacent to or near waterbodies can invade, occupy, and dominate riparian areas and indirectly impact aquatic ecosystems and fish habitat. Native vegetation growth may change as a result of invasive plant infestation, and the type and quality of litter fall and quality of organic matter may decline, which can alter or degrade habitat for aquatic organisms. The USDA Forest Service (USDA Forest Service 1999 and 2001b) noted that the establishment of invasive plant species such as knapweed and sulphur cinquefoil within or adjacent to riparian habitats could increase overland runoff and sediment yield from such habitats. A study within the Lolo National Forest, in western Montana, showed that a site with 80 percent knapweed cover yielded 5 times the amount of sediment as sites covered with bunchgrass (Hickenbottom 2000). The same study estimated that the effects of a 20-minute

thunderstorm (100-year event intensity) occurring on 1,648 acres of big-game winter range infested with spotted knapweed could produce an additional 160 tons of sediment compared to a site free of invasive species.

Increased sediment delivery to drainages can directly and indirectly affect aquatic resources through the sedimentation of stream substrates and increased levels of turbidity and suspended sediment in the water column. Increased sedimentation can have the following effects: (1) degradation in stream-bottom habitat used by aquatic insects such as caddisflies, mayflies, and stoneflies, which are important prey items for fish; (2) subsequent reduction in aquatic insect abundance and diversity; (3) reduction in the permeability between interstitial spaces within spawning gravels that inhibits the flow of oxygenated water and the removal of metabolic wastes; (4) subsequent reduction in spawning success, hatching success, and fish production; and (5) reduction in the interchange of surface and subsurface waters in the hyporheic zone beneath the stream channel (Nelson et al. 1991). Substantially increased sedimentation can eliminate or reduce the depths of pools that provide important, year-round cover for juvenile, sub-adult, and adult fish. If severe enough, increased sediment loads can cause the erosion and migration of stream channels and the subsequent degradation of aquatic and riparian habitat (Meehan 1991).

Aquatic plants are a valuable component of aquatic ecosystems. They provide cover, habitat, and food for many species of aquatic biota, fish, and wildlife. However, invasive aquatic species can degrade water quality and impair fish habitat. Other impacts on waters include block intakes that supply water for domestic or agricultural purposes and interfere with navigation, recreation, and aesthetics.

Aquatic resources potentially impacted by the direct and indirect effects of increasing invasive-plant infestations within the CTNF and CNG include all of the special-status fish species described in the “Affected Environment” section of this report. Potentially at-risk resources include aquatic invertebrate species. The greatest potential for impacts from increased sediment delivery and possible riparian degradation may be to the native salmonids. These species have relatively narrow range of habitat requirements, including the need for clean, cold, well-oxygenated, and interconnected water running over gravel substrates for spawning, egg incubation, rearing, migration, and adult success (Bjornn and Reiser 1991). Site-specific impacts from erosion and sediment delivery would depend on the slope, soil characteristics, precipitation amount and pattern, distance to water, riparian buffer health and extent, and the species and life stages present.

The impacts by invasive plants on the environment can last decades, while the impacts of treatment tend to be short term (1 year or less). Passive and active restoration would accelerate native vegetative recovery in treated sites. There would be no additional, potential negative effects or risks to fisheries resources or aquatic habitats from herbicide application, or short-term increases in erosion and sediment delivery to drainages caused by mechanical treatments (soil disturbance) under the Alternative 1.

3.3.3.1.2 Effects to Forest Service Region 4 Sensitive Fish Species

The effects to R4-sensitive Yellowstone cutthroat trout, northern leatherside chub, and Bonneville cutthroat trout (and the aquatic habitats of these fishes) by implementing Alternative 1 may include localized increases in site erosion and stream sedimentation in association with expanding infestations of invasive plants. Indirect effects of increased stream sediment would be reduced habitat suitability of substrate habitats for sediment-intolerant fish prey organisms. Soil

erosion would likely increase in infested riparian areas as a result of increased bank erosion and channel instability. Impacts would be localized and limited to existing and significant near-stream invasive-plant infestations and new infestations. No negative effects or risks to R4-sensitive fish species would occur from herbicide application or short-term increases in erosion and sediment delivery to drainages caused by mechanical treatments, rehabilitation activities, or restoration activities (soil disturbance) under Alternative 1. Implementing Alternative 1 may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or loss of viability to the population or species of Yellowstone cutthroat trout, Bonneville cutthroat and northern leatherside chub. Locally elevated sedimentation related to reduced soil stability in invasive plant-infested areas, is not likely to result in a downward population trend for the species.

3.3.3.1.3 Irreversible/Irretrievable Effects

Invasive plants can alter native plant communities and make restoration more difficult. However, with no treatment, invasive plants can irreversibly alter habitat elements important for some species. Invasive plant treatments can prevent this damage from occurring or slow the rate of damage from invasive plants.

3.3.3.1.4 Cumulative Effects

Cumulative effects are defined as "the incremental impacts of the Proposed Action and alternatives when added to effects of other actions both on NFS lands and other adjacent federal, state, or private lands" (40 CFR 1508.7). This analysis considers the effects of other ongoing and foreseeable future activities. This analysis does not consider past activities, as CEQ regulations do not require agencies to comprehensively list and analyze all individual past actions. Impacts of past activities are typically captured in the current state of the project area as described under the "Affected Environment" section and do not generally provide useful information for predicting cumulative effects of the Proposed Action and alternatives.

Under Alternative 1, the current management strategy would continue with the following array of standard invasive plant management practices currently used within the CTNF and CNG:

- Biological control through the use of predators, parasites, and pathogens, target grazing.
- Herbicide control using ground-based spot and broadcast application methods.
- Mechanical and manual methods such as hand-pulling, mowing, cutting, or torching.

Counties may continue to undertake invasive-plant control on their road right-of-way within NFS lands. Active invasive-plant treatments, including ground-based herbicide application, mechanical control, and biological control releases, would continue to occur on private, county, state, and adjacent land managed by the BLM through those land managers and through actions conducted by CWMA participants.

This alternative would be expected to result in some localized eradication, control, and containment of noxious weeds within NFS and non-NFS lands. However, weed infestations on NFS lands would be expected to continue to increase, which would impede the efficacy of ongoing CWMA efforts to eradicate, control, or contain new weeds that have spread to adjacent lands from infestations within the CTNF and CNG. The resultant continued spread of noxious weeds could potentially adversely affect aquatic and riparian habitats both on and off NFS lands through increased erosion and sediment delivery to drainages. The potential for adverse

cumulative effects on aquatic resources would be greatest on adjacent non-NFS lands which may not be treated.

Cooperative Weed Management Area herbicide applications to private, state, county, or BLM-administered lands adjacent to CTNF and CNG non-wilderness areas would continue to occur under Alternative 1, as would chemical applications on private lands by landowners within the project area. Potential cumulative effects to NFS lands would be limited primarily to areas downstream from private inholdings where the potential for adverse effects to aquatic and riparian resources would exist if a spill- or wind-drift-related impact occurred close to NFS boundaries.

3.3.3.2 Alternative 2—Proposed Action

3.3.3.2.1 Overall Direct and Indirect Effects of Alternative 2

Under Alternative 2, invasive-plant infestations within the project area are likely to decline, and the percent of annual expansion of invasive species would be less than under Alternative 1. However, the current management strategy is not likely to be able to effectively treat large, remote infestations using the currently approved methods. Because treatments under Alternative 2 would limit the spread of some new infestations and potentially decrease the severity of some existing infestations, the effects described above would be less severe and would occur over a longer timeframe than those described under Alternative 1.

Design criteria related to ground-based herbicide application under this alternative are expected to effectively protect CTNF and CNG fisheries resources, including R4-sensitive species from impacts due to herbicide delivery to aquatic habitats. Design criteria identified for herbicide applications under Alternative 2 would minimize the potential for both direct delivery of herbicides to aquatic habitats and impacts to those habitats from surface runoff, wind drift, leaching, or accidental spills. However, short-term disturbances may occur and may have slight negative effects on aquatic resources in specific areas. These impacts could include localized, short-term increases in erosion and sediment delivery to drainages caused by the creation of barren ground (from invasive-plant removal). Invasive-plant infestations would progressively decline over time in response to treatment actions, reducing the potential for erosion, sediment delivery, and improved aquatic habitat to drainages to benefiting aquatic resources. Long-term benefits to aquatic habitats, from slowing potential rates of spread, would be expected in the project area.

3.3.3.2.2 Biological Control

3.3.3.2.2.1 Direct and Indirect Effects

Releasing biocontrol agents to control invasive plants should have no adverse effects on aquatic resources. The biological controls proposed (insects and plant pathogens) target specific invasive plant species as hosts and would not compete for food with aquatic organisms, but they may provide an incidental food source for fish where invasive-plant infestations occur near stream channels. Because insects and plant pathogens target specific invasive-plant, native riparian vegetation necessary for cover and bank stability would not be affected. Design criteria requires that only APHIS-approved agents will be used and the appropriate USDA Forest Service protocols for documenting releases and monitoring will be followed. The Proposed Action's

future use of new biocontrol agents is not anticipated to lead to unintended ecological concerns, specifically, no adverse effects to sensitive fish.

Biological treatments involving grazing could have an effect on habitat indicators (e.g., riparian condition, sediment, substrate embeddedness, and other habitat indicators). Grazing operation plans will be presented for review prior to approval in R4-sensitive waters. The effects of targeted grazing will be evaluated and disclosed in a Biological Evaluation when proposed in waters that have R4 sensitive species habitat.

3.3.3.2.2.2 Effects to Forest Service Region 4 Sensitive Fish Species

Implementing biological control (insects, pathogens and site-specific grazing) may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or loss of viability to the population or species to R4-sensitive Bonneville cutthroat trout, Yellowstone cutthroat trout, and northern leatherside chub and their aquatic habitats.

Biological releases (insects) may provide a slight beneficial effect in contributing an additional incidental fish food source to aquatic environments in and around release sites and a reduction in targeted invasive plant populations. Biological controls (insects and plant pathogens) target specific invasive plant species as hosts and would not affect native riparian vegetation necessary for cover and bank stability. Design criteria include the use of only those biocontrol agents approved by APHIS, State of Idaho, or State of Utah, used with appropriate USDA Forest Service protocols for documenting releases and monitoring of biocontrol agents. With these design criteria in place for all current and future use of new biocontrol agents, it is not anticipated to lead to unintended ecological concerns.

Use of grazing treatment of invasive plants may detrimentally impact aquatic habitats especially in riparian areas. Improperly managed grazing could result in a loss of riparian vegetation, reduction in bank stability, decreased shading, increase water temperatures, and detrimental changes in stream channel morphology. The action excludes use of targeted grazing within riparian areas because targeted grazing design criteria would avoid potential impacts to riparian and stream habitat.

Watershed Conditions (AIZs)—Releasing biocontrol agents would target specific invasive species and is not anticipated to have a vegetative effect on native riparian species. The primary indirect effect of biological treatments on sensitive species would be a reduced need for herbicide use. Therefore, the effects of biological control treatments are considered insignificant since they have little-to-no potential to adversely affect fish. The reduction of invasive plants encroaching on and invading riparian areas, wetlands, and streams would benefit native plant species and improve riparian condition.

3.3.3.2.2.3 Irreversible/Irretrievable Effects

Biological control treatments implemented under Alternative 2 would not result in any irreversible or irretrievable commitments of aquatic resources. Irreversible loss of fisheries resources would only occur where an action was implemented that caused permanent loss of some level of fisheries production. Biological control releases would not impact fisheries resources or aquatic habitat integrity in any watershed containing R4-sensitive species to an extent that measureable loss of production would occur.

3.3.3.2.2.4 Cumulative Effects

In addition to the use of biocontrol agents and site-specific grazing on NFS lands, other federal, state, county, and private entities also implement active biological control in their IWM programs. Cumulatively, multiple releases by different entities have the effect of distributing biocontrol agents over a broader area. Some beneficial effects could occur for fish in the form of an incidental food source where releases occur near stream channels. No adverse cumulative effects are anticipated to occur.

3.3.3.2.3 Manual and Mechanical Treatment Methods

3.3.3.2.3.1 Direct and Indirect Effects

Manual and mechanical treatments can increase bank erosion, stream sedimentation, and disturbance to aquatic organisms if carried out over a large, contiguous area near or within occupied lotic or lentic habitats. In this scenario, sedimentation can cover eggs or spawning gravels, reduce prey availability, and irritate fish gills. Sediment generated at the localized scale would be unmeasurable to nonexistent because of the small acreage treated (less than 25 acres) with manual and mechanical methods and due to project design criteria. (For example, mechanized treatment within the AIZ needs to be reviewed and approved by a hydrologist or fisheries biologist. Manual treatments within the AIZ may be used as a removal method. As manual methods are more spot treatments and minimize potential erosion and sedimentation).

Both short- and long-term localized impacts to individual drainages may occur in association with mechanical treatment methods. Short-term effects of mechanical invasive-plant treatment may include a temporary increase in the amount of bare ground. Commonly, dead plant material from plants that were mechanically removed breaks down and covers the soil surface, providing a protective litter layer. However, where this does not occur, increased areas of bare ground could result in a temporary increase in soil erosion and associated sediment delivery to stream channels, especially during a high-intensity rain event. This increase is usually confined to very small areas since mechanical control is practiced only at a small scale (e.g., typically less than 25 acres but not more than 100 acres). Torching would be conducted as a spot application and would not cause large areas of bare ground.

Over the long-term, however, mechanical reductions of invasive plant infestations would benefit aquatic habitat by re-establishing desirable vegetation which in turn should reduce erosion and subsequent sediment delivery to nearby waters. Reducing invasive-plant infestations and establishing desirable vegetation would benefit watershed health and reduce the potential for future encroachment by invasive plants into riparian or aquatic environments.

3.3.3.2.3.2 Effects to Region 4 Sensitive Fish Species

Implementing mechanical treatments may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or loss of viability to the population or species of R4-sensitive Bonneville cutthroat trout, Yellowstone cutthroat trout, and northern leatherside chub and their aquatic habitats, because control of weeds is expected to improve watershed conditions.

Short-term localized increases in soil erosion and sediment delivery could occur in association with increased bare ground at mechanical treatment sites. Manual treatments may result in short term minor soil disturbance around each treated plant or in small areas where hand pulling occurs. Mechanical treatments would result in minor soil disturbance or erosion. Many of these sites would retain some native vegetation to maintain ground cover to minimize erosion. Design

criteria should minimize erosion from reaching waterbodies (these criteria include limiting mechanical treatment within the AIZ to areas that have been reviewed approved by a hydrologist or fisheries biologist).

Manual removal would not be limited. Surface roughness and the small number of acres treated each year should also help to minimize erosion from treated sites. In situations where many acres or numerous sensitive sites (i.e., riparian areas) require treatment, revegetation with appropriate, certified noxious weed-free native seed mixes or root stocks may occur, which should help increase ground cover and further minimize erosion. Overall, the chance of sediment impacting water quality should be discountable. Subsequent re-establishment of desirable vegetation, however, would result in a long-term reduction of erosion and sediment delivery at these sites relative to pre-treatment conditions (Havlin and Moebius-Clune 2013).

Manual and mechanical treatments can cause short-term localized disturbance in cover and food resources. These treatments would occur on relatively few acres in scattered locations throughout the project area because more cost-effective methods are often available (e.g., herbicide applications), especially for larger infestations. Although minimal, localized, short-term effects could occur, the desired result of these activities would be to re-establish native species, which would reduce long-term erosion.

Hand removal of targeted invasive aquatic plants is effective for small infestations. Environmental impacts, including turbidity and streambed disruption, would be short-term (Gettys et al. 2014). Because hand removal will be conducted only on small areas, no adverse effects are anticipated.

Design criteria and BMPs would help to minimize disturbance. Short-term ground disturbance would occur where manual control methods occur, but because this method is effective usually only for small infestations, the resulting impacts would be highly localized. Soil and bare ground exposed by these isolated impacts would likely not result in measurable increases in stream-channel sediment loads, and the long-term effects of re-establishing native plants would be beneficial to water quality.

Watershed Conditions (AIZs)—Mechanical treatments may result in disturbance to native vegetation as invasive plant species are treated. Since some sites have large areas of infestation, riparian vegetation could be disturbed on several acres each year. However, this method is very target-specific and should result in only localized impacts to riparian vegetation.

In situations where many acres of riparian vegetation require treatment, revegetation with an appropriate, noxious-weed-free-certified, native-seed mix or root stock may occur. The project design criteria (e.g., mechanized treatment within the AIZ must be reviewed and approved by a hydrologist or fisheries biologist) should minimize impacts to native riparian vegetation. Beneficial effects would be expected from the reduction of invasive plants encroaching on and invading riparian areas, wetlands, and streams. A reduction of noxious weeds in riparian areas and along streambanks would benefit native plant species and improve streambank stability and riparian condition. Overall, impacts to riparian vegetation should be minimized and effects would be insignificant.

3.3.3.2.3.3 Irreversible/Irretrievable Effects

Mechanical treatment of invasive plants under Alternative 2 would not result in any irreversible or irretrievable commitments of aquatic resources. Irreversible loss of fisheries resources would

only occur in a case where an action was implemented that caused permanent loss of some level of fisheries production. Mechanical treatment activities would not impact fisheries resources or aquatic habitat integrity in any watershed containing R4-sensitive species to an extent that measureable loss of production would occur.

3.3.3.2.3.4 Cumulative Effects of Mechanical Control

Other federal, state, county, and private entities implement the same mechanical control methods as the USDA Forest Service. Since mechanical control methods are practiced on small and isolated acreages, there is little likelihood of adverse cumulative effects. Cumulative effects would be expected only if other federal, state, county, or private entities began to practice mechanical control methods (e.g., chaining) not currently used.

3.3.3.3 Herbicide Applications

3.3.3.3.1 Direct and Indirect Effects

3.3.3.3.1.1 Effects on Riparian and Upland Processes

In watersheds where nonnative species have largely displaced native species, weeds can alter processes that affect the quality and quantity of fish habit. Weed infestations can increase surface runoff and sediment transport by increasing fire frequency and by altering ground cover and raindrop interception. Once established, weed infestations can sometimes alter fuel characteristics of the landscape and establish a lasting fire cycle that promotes the dominance of the invasive species (Brooks et al. 2004). Many invasive species are annual plants that have allopathic mechanisms that kill other plants and reduce the density of vegetation. Vegetative cover can be changed to the point where the hydrology of an area is disrupted. Studies by Lacey et al. (1989) reported a 50 percent increase in runoff at knapweed-infested sites compared to non-infested sites.

Nonnative aquatic weeds can adversely impact aquatic ecosystems by filling the water column and forming dense canopies that shade out native aquatic vegetation. Stands of nonnative aquatic weeds can provide poor habitat for waterfowl, fish, and other wildlife. Significant plant sloughing, leaf turnover, and decomposition of large amounts of plant material at the end of the growing season increase phosphorus and nitrogen in the water column. Dense nonnative aquatic vegetation mats alter water quality by raising the pH, decreasing oxygen under the mats, and increasing temperature (IISC and ISDA 2007). Invasive species can also dominate systems leading to decreased biodiversity and habitat heterogeneity, which are desirable in an aquatic system (as summarized in Hershner and Havens 2008).

The proposed weed treatments are intended primarily to prevent the establishment of new invaders and contain the spread of existing weed infestations. With this type of treatment objective, the treatment areas tend to consist of widely scattered patches of weeds, with many sites concentrated near roads, trails, and open areas. However, in some locations well-established expanses of weeds could be treated.

To the extent that invasive plant control efforts are successful, the Proposed Action would benefit native, and sensitive fish species by conserving native riparian vegetation and ecological process in areas that would otherwise become dominated by invasive plants. The action could cause detrimental effects when non-target plants are killed by herbicide spraying in riparian areas. Herbicide spraying in riparian areas can kill non-target plants that provide streambank

stability and shade and cover for fish, and spraying can also increase surface runoff by creating areas of bare soil devoid of any vegetation. The risk of creating areas of bare soil is particularly true for non-selective herbicides, such as glyphosate, that kill all plants. Non-target species killed by herbicides tend to be forbs, grasses, and legumes, which are capable of re-establishing themselves within a few growing seasons. Shrubs and trees are also susceptible to herbicide effects, but spot spraying is not likely to kill mature shrubs or trees since it takes a larger amount of herbicide to kill these larger plants than the amount applied through focused spot spraying.

Overall, alterations in riparian and upland vegetation caused by the Proposed Action are unlikely to have a significant effect on native fish, or sensitive species through mortality of non-target plants when applied as spot treatments. Hand-spraying with the use of a marker dye allows precise herbicide application to target plants without causing widespread mortality to non-target plants. The majority of weed treatment locations are also in upland areas where they have no direct effect on streams. In general, where herbicides kill non-target riparian plants, the plant mortality is likely to be localized and short term; lasting no more than the time it takes for native plants to become re-established. In contrast, successful eradication or control of invasive plants is likely to provide long-term benefits by protecting native vegetation from invasive species and by maintaining natural riparian functions and surface erosion processes.

3.3.3.3.1.2 Effects Analysis Framework

The effects of herbicides on native fish, R4-sensitive fish and their habitat depend on numerous factors that interact in complex ways that cannot be described precisely for each and every circumstance. Given the information that is available, some of the effects analysis relies on extrapolation or inference from published studies on similar chemicals or surrogate fish species that may not respond to herbicides identically to resident fish.

3.3.3.3.1.3 Herbicide Toxicity

The herbicides proposed for use are characterized by relatively low aquatic toxicity. Three methods are referenced in comparing toxicity to fish and other aquatic organisms. The first is evaluating the lethal concentration (LC50) of each herbicide. The 96-hour LC50 refers to the concentration that is lethal to 50 percent of the fish exposed at that level for 96 hours. The lower the LC50, the more toxic the compound. The 96-hour LC50 for the herbicides proposed for use are provided in Table 3-12.

Although the LC50 is frequently used as a toxicity standard, 50 percent fish mortality is not acceptable. The No Observed Effect Level (NOEL) or No Observed Effect Concentration (NOEC) was used in place of the LC50 when it was available from studies.

These levels represent a conservative approach to evaluating the active ingredients of the proposed herbicides to fish. NOEL/NOEC is the highest concentration of toxicant to which organisms are exposed in a full life-cycle or partial life-cycle test that causes no observable effect on survival, growth, or reproduction of the test population. Thus, no significant difference would exist between the test solution and the control, as determined by hypothesis testing.

Table 3-12. Aquatic Level of Concern Assessment for Herbicides Proposed for Use by the Caribou-Targhee National Forest (CTNF) and the Curlew National Grassland (CNG).

ACTIVE INGREDIENT AND PRODUCT NAME	TYPICAL APPLICATION RATE (lb a.e./ac)	MAX LABEL APP. RATE (lb a.e./ac)	BIO-ACCUM-ULATES	PEAK EEC[a] (mg/L)	LOWEST 96-HOUR LC_{50}[a] (mg/L a.e. or a.i.)	LOWEST SUBLETHAL EFFECT THRESHOLD (mg/L)	HAZARD QUOTIENT [c]
2,4-D amine[d] *Weedar 64*	1–2.0	4.0	No	0.08	162 Non-toxic	96-h LC_{50} = 95.6	0.0008
Aminopyralid[e] *Milestone*	0.078–0.11	0.11	No	0.011	100 Non-toxic	Partial loss of equilibrium at NOEC=50 mg/L	0.0002
Chlorsulfuron[f] *Telar XP*	0.01–0.02	0.12	No	0.025	40 Slightly	NOEC = 30	0.0008
Clopyralid[g] *Transline*	0.1–0.5	0.5	No	0.01	103.5 Non-toxic	LC_{50} = 103.5	0.0001
Dicamba[h] *Banvel*	0.5–2.0	2.0	No	0.006	50 Slightly	LC_{50} = 28	0.0002
Glyphosate[i] (more toxic with surfactant) *Roundup Original*	0.5–3.0	4.0	No	0.044	1 Highly Toxic	NOAEC = 0.5	0.9
Glyphosate[i] (less toxic no surfactant) *Roundup Custom*	0.5–3.0	4.0	No	0.044	10 Moderately	NOEC = 0.5	0.09
Glyphosate Aquatic[i] (less toxic no surfactant) *Rodeo*	0.5–3.0	4.0	No	0.147	10 Moderately	NOEC = 0.5	0.3
Imazamox[j]	0.25–0.50	0.5	No	0.001	Nd[r]	NOAEC=122	0.007
Imazapic[k] *Plateau*	0.09–0.16	0.188	No	0.00009	>100 Non-toxic	NOEC = 100	0.0000009
Imazapyr[l]	0.5–1.0	1.5	No	0.55	>100 Non-toxic	NOAEC=10.4	0.06
Metsulfuron methyl[m] *Escort*	0.01–0.02	0.15	No	0.0003	150	NOEC = 10 Behavioral changes	0.00003
Picloram[n] *Tordon 22K*	0.25–1.0	1.0	No	0.011	4.8 Moderately	NOEC = 0.19	0.06
Rimsulfuron[o]	0.0469	0.0625	No	Nd[p]	>390 Non-toxic	NOAEL=160	0.0000674
Sulfometuron[q] methyl *Oust*	0.09–0.38	0.38	No	0.0004	7.3 Moderately	NOEC=7.3	0.00005
Triclopyr TEA[r] aquatic *Renovate*	1–1.5	2.0	No	0.0735	117 Non-toxic	NOAEC = 20	0.004
Triclopyr TEA[r] *Garlon 3A*	1–1.5	2.0	No	0.006	117 Non-toxic	NOAEC = 20	0.0003

[a] Peak estimated environmental concentration (EEC) is extrapolated from SERA assessments using the max application rate. Values are based modeling herbicide drift using a backpack sprayer using Worksheet Maker 6.0. The EEC is an extreme level and should be viewed as an extreme-case situation.
[b] Toxicity Classifications to Address Acute Risk (LC_{50} mg/L) to Aquatic Organisms from Chemical Use — <0.1 (very highly toxic); 0.1-1 (highly toxic); >1-10 (moderately toxic); >10-100 (slightly toxic); and >100 (practically non-toxic).
[c] HQ values from Worksheet Maker 6.0 based on maximum application rates using central concentration levels for sensitive species. When sensitive species studies are unavailable, HQ values for tolerant species are used and noted.
[d] USDA Forest Service 2006b, [e] SERA 2007b, [f] SERA 2004a, [g] SERA 2004b, [h] SERA 2004c, [i] SERA 2011a, [j] SERA 2010, [k] SERA 2004d, [l] SERA 2011b, [m] SERA 2004e. [n] SERA 2011c, [o] BLM 2014, [p] Nd=Not determined, [q] SERA 2004f, [r] SERA 2011d.

Analysis of the potential effects of chemical contaminants on fishes and macroinvertebrates used the SERA risk assessments, toxicity indices, and HQs through the use of risk assessment worksheets (http://www.sera-inc.com/fsworksheetmaker.html). Values are based modeling herbicide drift using a backpack sprayer using Worksheet Maker 6.0. The Estimated Environmental Concentration (EEC) is an extreme level and should be viewed as an extreme-case situation. To evaluate potential risks to non-target organisms (algae, invertebrates, and fish), HQs were calculated by dividing the peak EEC available for each active ingredient by the most sensitive Toxicity Reference Values (TRV) (LC50, LOEC [lowest concentration of an effluent or toxicant that results in adverse effects], EC50 [the median effective concentration of the toxicant] in the environment that produces a designated effect in 50 percent of the test organisms exposed, or NOEL). HQs are based upon ecological effects data, pesticide use data, fate and transport data, and estimates of exposure to the pesticide. The TRV may be a surface water or surface soil effects concentration or a species-specific toxicity value derived from the literature.

Toxicity indices (thresholds) were established using either measured chronic NOAELs or 1/20th of the acute LC50, whichever was lower. Use of these thresholds, including a chronic NOAEL for acute exposures, was intended to account for uncertainty regarding sublethal effects to fish. Extreme case scenarios were developed to estimate the herbicide concentration in water and, therefore, the dose received by fish and aquatic organisms.

The estimated dose (from the scenarios) was divided by the "toxicity index" and the result is known as the HQ. When the HQ is less than 1.0, the dose is less than the toxicity index. Potential effects from doses calculated to be below the toxicity indices are discountable. When a calculated dose was greater than the toxicity index, it was assumed a potential for adverse effects existed. This very protective approach constitutes an "extreme-case" analysis for potential effects of herbicides.

Actual proposed treatments contain untreated buffers, or distances within which only focused spot spray or hand selective application is allowed. The herbicide use buffers proposed under Alternative 2 would substantially limit the amount of herbicide potentially coming in contact with water. The potential amount of herbicide coming in contact with water after using herbicide use buffers would be minimized to almost non-detectable levels.

3.3.3.3.1.4 Exposure of Aquatic Organisms to Contaminants

This section characterizes the concentrations of herbicides likely to occur in water, and the way in which aquatic organisms are likely to be exposed to these contaminants. Aside from using the herbicide according to the label guidelines, Alternative 2 includes numerous criteria that minimize the likelihood of appreciable water contamination, such as relatively small and scattered treatment areas, low application rates, ground-based application, and application methods that reduce the likelihood of water contamination by wind drift or runoff. Water quality monitoring associated with similar weed treatment projects suggest that safeguards, like those in the Proposed Action, limit the occurrence of water contamination and reduce the concentrations of chemicals if chemicals do reach live water.

3.3.3.3.1.5 Chronic and Acute Exposures

A fundamental difficulty in characterizing environmental exposures arises due to constantly changing contaminant concentrations in flowing water and an ever-increasing spatial scale as herbicides disperse downstream. Once a contaminant reaches moving water, contaminants begin

to disperse and become more diluted with increasing time or distance from the contaminant source. Consequently, the highest contaminant concentrations are likely to occur for brief periods of time in the immediate area surrounding the point of application and, initially, the concentrations may be similar to the peak spray concentrations as shown in Table 3-12. As contaminants become dispersed over large areas, such as a stream reach or an entire drainage, they become diluted by mixing with less-contaminated water. As contaminants move downstream, they affect an ever-increasing area with ever-increasing durations, but the concentrations become substantially reduced from the initial concentrations where they first entered the stream.

Two types of exposure scenarios emerge from the effects of dispersal and dilution: acute exposures that affect small areas for short durations with relatively high concentrations, and chronic exposures that affect large areas for long durations with relatively low concentrations. In addition, acute exposures may often involve only those chemicals sprayed at a single location, which tend to occur only when chemicals are applied close to a stream. Chronic exposures are more likely to contain a mixture of chemicals sprayed at a variety of locations throughout the watershed. Because acute exposures affect small areas and chronic exposures affect large areas, the majority of organisms exposed to herbicides will experience chronic exposures.

3.3.3.3.1.6 Exposure of Aquatic Life to Contaminants in Water

In spite of efforts to minimize water contamination from Alternative 2, herbicides cannot be kept out of the water entirely. There are several potential pathways by which herbicides may be introduced into water (i.e., direct application, drift, mobilization in ephemeral channels, overland flow, leaching, and spills) through various application methods (i.e., ground, aerial, and aquatic treatments). Exposure risks would be minimized through the use of design criteria (use in accordance with label directions (section 2.2.2.2)). Overland flow is the most likely mechanism for herbicides to reach surface water under the Proposed Action for both ground and aerial application methods. Concerns are (1) if a large spill occurs where chemicals are not completely cleaned up and residual chemicals reach water, and (2) water contamination after an herbicide is applied from surface or subsurface runoff during and shortly after precipitation events. For these scenarios, peak concentrations that could reach water were determined. Peak water concentrations of each herbicide have been estimated in the USDA Forest Service and SERA risk assessments with the primary mechanism being surface runoff. The central limit of the peak concentrations estimated in the SERA assessments are used to evaluate the maximum severity of water contamination that might occur from the Proposed Action. These concentrations are unrealistically high because; (1) the use of data from agricultural models generally provides an extreme upper estimate of water contamination in a forest setting, except where herbicides are applied to ditches that drain directly into streams; (2) pesticide concentrations estimated at the point where runoff first enters a stream may reach concentrations that approach the peak concentrations, but as spatial scale increases beyond the point of entry, mixing and dilution causes pesticide concentrations in the water column to converge on an average concentration reflective of the total amount of pesticides applied in the watershed and the size of the drainage area; and (3) the peak concentration levels do not take design criteria into account.

For ground application, herbicides will typically be applied to scattered patches or individual plants that are growing in an environment that includes organic debris and other vegetation that inhibit off-site movement of the chemicals. This pattern of application creates small areas with relatively high herbicide concentrations, which are dispersed over much larger areas the majority

of which are not exposed to herbicides. In this circumstance, two types of exposure can occur: acute exposures in a small area or chronic (long-term) exposures over large areas.

For aquatic application, only aquatic-labeled products would be used to treat ponds or lakes where aquatic invasive are present. These areas are anticipated to be very limited in scope and size. No treatments will take place in ESA waters or those waters that may affect ESA species until a site-specific consultation were complete. Design criteria to limit herbicide exposures to aquatic life, include using only aquatic-approved adjuvants, limiting treatment areas to prevent oxygen depletion and following steps outlined in the Aquatic Invasive Plan Control Framework Strategy (Appendix D).

For aerial application, herbicides could be applied in larger, upland application units resulting in both acute and long-term exposures. Delivery of herbicides from aerial application to surface water via overland flow is dependent on a number of chemical and environmental factors. Prior to any aerial application of herbicide, design criteria require that the Aerial Herbicide Application Coordination and Safety Implementation Plan (Appendix I) are followed. This coordination would include site-specific analysis in order to determine appropriate treatments that would minimize adverse effects. Peak concentrations represent the worst-case scenario for the action alternatives from acute exposures that are likely to exist from minutes to hours, and occur only in the immediate area where herbicides are sprayed. The intensity of herbicide use also characterizes relative differences in chronic exposures that are likely to occur from the Proposed Action. The duration of chronic exposures is likely to span days to months, and these exposures may occur over broad portions of the action area. Design criteria (see section 2.2.2.2) would be followed to limit chronic exposures over the action area.

Chronic exposures caused by the Proposed Action are likely to mimic the patterns of the intensity of pesticide use in the watershed. Typical exposure scenarios, which have concentrations below the peak, are also described for situations that will be more commonly encountered under the Proposed Action.

3.3.3.3.1.7 Herbicide Toxicity: Lethal, Sublethal and Environmental Exposures

Toxic chemicals can potentially harm fish through three potential pathways: killing them outright, sublethal changes in behavior or physiology, and altering the environment (Stehr et al. 2009). Environmental alterations are indirect consequences of the action that may affect critical habitat through changes in cover, shade, runoff, and availability of prey.

The HQ of 1.0 is not exceeded for any of the proposed herbicides at maximum application rates for acute central exposure limits. Given proposed design criteria and herbicide use buffers, exceedances with respect to fish are not likely to actually occur for this project. Picloram is the chemical associated with greatest risk, because of its persistence, mobility, and toxicity. In contrast, aminopyralid, which is effective on some of the same target plants as picloram, poses relatively low risk to aquatic resources and may be used closer to surface waters. Glyphosate is a concern for fish and invertebrates at the upper limits but not at central limits. It does not persist in the environment because it readily binds to organic matter in soil and is easily broken down by microorganisms. Glyphosate (no surfactants) would not be used closer than 15 feet for spot or hand-selective applications.

For this project, it is possible that herbicide concentrations may exceed the LOC for algae and macrophytes (aquatic plants). Nearly all herbicides may affect aquatic plants should they be

exposed. Analyses show that chlorsulfuron and aquatic imazamox pose the highest risk to aquatic plants and algae. The use of chlorsulfuron near streams is restricted by the design criteria because of the susceptibility of aquatic plants to this herbicide. Adverse effects to aquatic macrophytes could reduce food supply to aquatic invertebrates, which could negatively affect fish species indirectly by reducing their primary food prey base. Most of the herbicides have some potential to harm aquatic plants, thus, the Proposed Alternative could negatively affect the aquatic food chain.

3.3.3.3.1.8 Effects on Aquatic Macrophytes, Microphytes and Invertebrates

Because herbicides would not be applied to water except in isolated incidents of aquatic invasive plant treatment, adverse effects from the Proposed Alternative are possible only when incidental water contamination occurs from runoff or other transport mechanisms discussed previously. Apart from direct effects of herbicides on fish, herbicides present an indirect risk to salmonids through the potential alteration of primary productivity (aquatic plant life) and invertebrate communities. The risks of the action alternatives from potential changes in the integrity of the foodweb and other aspects of the biological community are only partially understood. Scant toxicity data exist for many of the algal and invertebrate species found in the action area. Most of the toxic effects reviewed are inferred from commonly tested invertebrate taxa such as Daphnia, and algal taxa such as Navicula and Anabaena, which may not be representative of the taxa found in the action area. These taxa are relatively sensitive species that provide a general characterization of risk, but different species can have vastly different sensitivities to a particular chemical. For example, among the various marine and aquatic species investigated by Nyström et al. (1999), toxicity endpoints varied as much as six orders of magnitude between species. Due to a deficiency of direct information on environmental effect of herbicides, uncertainties are associated with the following factors: (1) the fate of herbicides in streams; (2) the resiliency and recovery of aquatic communities; (3) the site-specific foraging habits of salmonids and the vulnerability of key prey taxa; (4) the effects of pesticide mixtures that include adjuvants or other ingredients that may affect species differently than the active ingredient; and (5) the mitigating or exacerbating effects of local environmental conditions.

If herbicide contamination were to reduce the abundance of macroinvertebrates in streams, a corresponding reduction in salmonid biomass through reduced body size or reduced numbers would likely occur. Less food may induce density-dependent effects, such as increased competition between foragers (Ricker 1976), and changes in salmonid growth rates that are largely determined by the availability of prey in freshwater systems (Chapman 1966; Mundie 1974). In spite of data limitations, a reasonable amount of certainty exists that significant changes in the food web would not occur under the action alternatives, based on several corroborating field studies that generally failed to detect changes in community attributes when herbicides such as those proposed are applied in similar settings (Michael et al. 2006). The weight of evidence suggests a relatively low risk of altering the food web and biological community on which salmonids depend.

Aquatic herbicides have similar potentials to ground-based herbicides for indirect risk to fish through the potential alteration of primary productivity and invertebrate communities. The active ingredients found in many aquatic herbicides are the same as those commonly used in terrestrial herbicides. However, the exact formulations (i.e., the active ingredient and any adjuvants) usually differ. For example, a terrestrial-use form of glyphosate, known as Roundup, contains

nonylphenol ethoxylate (NPE) surfactants that are toxic to aquatic organisms, whereas an aquatic-use form, AquaMaster or Rodeo, does not include surfactants.

The assessments used to characterize toxic effects are constant exposures that are 24 hours or longer, which is not an exposure scenario likely to be encountered under the action alternatives. Based on studies of herbicide transport discussed in the hydrology technical report (USDA Forest Service 2020c), the duration of exposures that are likely to occur in the field are likely to be pulses of contamination less than 1.0 hour in duration. In one particular study, Michael et al. (2006) concluded that the magnitude and duration of herbicide pulses (from herbicide use similar to those proposed under the action alternatives) may be too brief to cause significant changes in invertebrate communities, and if changes were to occur, communities tend to rapidly re-establish their original composition through recolonization. Another factor that further reduces potential effects on invertebrate production and prey availability is the relatively low intensity and dispersed nature of proposed herbicide use that precludes the possibility of herbicides reaching concentrations that would affect prey availability to a meaningful extent beyond the point where herbicides first reach a stream. Aquatic herbicide treatments could result in short term reductions in benthic aquatic species. However, all herbicides proposed for aquatic treatments are classified as slightly toxic to non-toxic.

The acute toxicity HQs for most of the herbicides proposed are below the LOC of 1.0 for algae but above an LOC of 1.0 aquatic macrophytes. Aquatic herbicides are designed to kill aquatic macrophytes. Impacts from runoff and other exposure pathways for these herbicides may pose a risk to certain algal and macrophytic species. Risk would be greatest where contaminated runoff directly enters the stream. However, effects are expected to be localized since the contaminated runoff would further dilute as it mixes with a larger waterbody. While localized effects to food that fish depend on may occur, herbicide exposure should not result in significant changes in the food web over a large portion of stream. Furthermore, if these extreme case scenarios occurred, they would be infrequent pulse events and algal species would be expected to quickly recolonize any impacted areas.

3.3.3.3.1.9 Effects of Herbicides on Individual Fish

Potentially harmful effects from herbicides to native fish and R4-sensitive fish by altering the food web, damaging riparian vegetation, or altering hydrology were discussed previously and found to be relatively minor risks of the action alternatives. All of these pathways could adversely affect fish through lethal or sublethal exposure, if herbicides were applied shortly before an unexpected precipitation event contaminated runoff could reach a stream. Under the action alternatives, none of the herbicides, carriers, or surfactants proposed for use are likely to cause outright mortality of sensitive salmonids.

The amount of exposure provides a general indicator of risk where sublethal effects are unknown. Sublethal effects may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering.

Common sublethal endpoints are reported for many chemicals, but none of the herbicides have been thoroughly screened for all potential sublethal effects that might have biological relevance. Herbicide concentrations likely to occur under the action alternatives appear capable of causing minor behavioral changes, but the duration of exposure to the peak concentrations is likely to be much shorter than the duration of exposures in the toxicity assays that are used to characterize

toxic effects. All acute toxicity assays cited in the SERA reports are based on exposures lasting 24 hours or more, while peak concentrations of ground-based herbicide applications in forest settings tend to occur in brief pulses lasting for much shorter periods. With the particular herbicides proposed under the action alternatives the typical pattern of herbicide contamination from runoff is a rapid spike in herbicide concentrations at the beginning of the first runoff event following herbicide application, followed immediately by a sharp exponential decline in concentrations as the runoff continues, and in subsequent runoff events (Bergamaschi et al. 1999; Muller et al. 2004). In one particular study, Michael et al. (2006) observed that Oust (sulformeturon methyl) transportation to streams in surface runoff occurred in pulses with maximum concentrations persisting for less than 15 minutes before dropping exponentially to lower levels.

Based on the pulsed nature of herbicide contamination, the duration of peak herbicide concentrations where adverse effects are most likely to occur is unlikely to persist beyond a few hours and occurs only during the first one or two runoff events that follow herbicide application. The limited duration of exposure is not likely to cause more than minor risks to fish survival or growth if sublethal effects do not continue to occur at relatively low concentrations after pulses of contamination have passed. With the herbicides proposed under the action alternatives, the peak EEC and HQ values are generally below thresholds. Consequently, there is no known risk of chronic sublethal effects, only acute sublethal effects from the Proposed Action. It is important to recognize that many biologically relevant indicators of sublethal effects have not been tested with the chemicals proposed under the action alternatives, and many potential sublethal toxicological effects may harm fish in ways not readily apparent in laboratory assays. Where small changes in the health or performance of individual fish are observed in toxicity assays (e.g., a small percentage change in the activity of a certain enzyme, an increase in oxygen consumption, the formation of pre-neoplastic hepatic lesions), predicting how these changes would affect essential behavior patterns of fish in the wild may not be possible. Additionally, animals tested under laboratory conditions are not subjected to predators, competitors, pathogens, and numerous other hazards found in the natural environment that affect the survival and reproductive potential of individual fish.

Although sublethal toxicity profiles are not entirely known for the herbicides proposed under the action alternatives, the potential severity of sublethal effects can be inferred in part by the patterns of exposure. Sublethal effects could compromise the viability and genetic integrity of wild populations in a situation where exposures result in significant losses of fish throughout a large geographic area except for treatment of large fires or a small area occupied by a population with unique genetic traits. The likelihood of population changes from sublethal effects of the chemicals proposed is largely undocumented, but appreciable population effects can be ruled out if the exposure to harmful effects is limited to small numbers of fish and a spatial pattern that is not likely to cause the loss of a unique genetic stock. Under the action alternatives, spraying would not occur over large contiguous areas except for treatment of large fires, and most of the action area would not be subjected to spraying in any given year, which would eliminate the possibility of significant fish losses throughout a large geographic area. Appreciable amounts of water contamination are also unlikely to occur in upland sites that are several hundred feet from streams. Only riparian spray sites and aquatic application sites, which are few in number and widely scattered across the action area, are likely to become contaminated.

Given the project design criteria and proposed herbicide use buffers, sublethal effects are possible but not likely to actually occur under the action alternatives.

3.3.3.3.1.10 Effects of Herbicide Treatments on Fish Populations

Based on the toxic effects of the herbicides described above, the action alternatives have a range of possible consequences to fish populations that might be caused by sublethal effects due to uncertainties regarding the toxicity of the proposed products. At one end of the range, herbicide exposures may be too brief and too low to cause any appreciable effects to individual fish or fish populations. At the other end of the range, sublethal effects could possibly harm sensitive fish in all locations if they are exposed to a large herbicide concentration. The herbicide formulations proposed include classes of chemicals with the potential to cause sublethal effects due to possible effects on the food chain.

If the worst-case scenario is assumed, the magnitude of risk depends almost entirely on the number, size, and geographic pattern of the areas where herbicides reach streams in an appreciable amount. The circumstances where herbicides may be capable of causing appreciable amounts of contamination are limited to unlikely situations where several factors must occur in combination. Those situations are likely to be encountered when (1) herbicides are sprayed near live water, in ditches hydrologically connected to streams, or locations where chemicals are capable of moving rapidly through soils into the alluvial aquifer; (2) when precipitation occurs before the herbicides break down, bind to soil particles, or get taken up by plants; (3) spray intensity is high enough to provide an appreciable source of contaminants; and (4) R4-sensitive fish or redds are near the spray site or point of herbicide entry. Design criteria (section 2.2.2.2) would minimize the likelihood of encountering situations that would cause an appreciable amount of contamination.

Specific locations where potential harm is of greater concern under the action alternatives cannot be identified at this time, since most of the above factors would not be known until spray sites are selected in the field. Under the worst-case scenario, the circumstances when R4-sensitive fish are likely to be exposed to herbicides capable of causing harm are too limited and isolated from one another to have an appreciable effect on overall fish populations in a specific drainage or in the action area. We can again only anticipate that individual or small groups of fish could be exposed to sublethal effects.

3.3.3.3.1.11 Effects on Habitat

The action alternatives are unlikely to cause appreciable changes in the physical attributes of habitat that are important for salmonids, such as substrate composition, water temperature, dissolved oxygen, streamflow, cover, or channel morphology. The low intensity of spraying in AIZs and patchy nature of the spray locations leaves the vast majority of the action area unaffected by herbicides. Where watershed processes are presently altered by weeds, if native species become established after the invasive plants are killed by the herbicides, the native plants are likely to provide ecological functions and rates of erosion that are more normative than the baseline conditions within designated critical habitat boundaries. Overall, appreciable changes in watershed processes are unlikely to occur under the action alternatives due to the small amount of area that would be treated and the scattered nature of the treatment areas.

3.3.3.3.1.12 Effects of Inert Ingredients and Adjuvants

Adverse effects from exposure to surfactants may include acute toxicity (illness, death) or chronic toxicity (such as teratogenic or carcinogenic effects). Inert ingredients can contribute to the toxicity of herbicide formulations or herbicide-surfactant mixtures to selected aquatic organisms (Buhl and Faerber 1989; Paveglio et al. 1996). In some cases, the toxicity of the inert ingredient may be greater than the toxicity of the active ingredient (Solomon and Thompson 2003).

The USDA Forest Service (Region 5) looked extensively at the risk of surfactants used in herbicide applications (Bakke 2003). Bakke (2003) concluded it appears that surfactants used in forestry can affect aquatic organisms at lower doses than for terrestrial organisms. However, the USDA Forest Service found no evidence that typical exposures of surfactants would lead to dose levels of concern for aquatic wildlife (Bakke 2003). Bakke (2003) concluded that although the potential exists for surfactants to affect the environmental fate of herbicides in soil, any potential effects would be unlikely under normal operations because of the relatively low concentration of surfactants in the soil-water matrix and surfactant degradation or dilution from the applied site before reaching a waterbody. Short exposure time, dilution, binding to sediments, and the breakdown of metabolites and contaminants all act to reduce exposure. For fish, calculated levels of exposure in USDA Forest Service applications were at least 30 times lower than the 1,000-ppm protective level described in the literature (Bakke 2003).

Localized effects could be seen if a surfactant spill occurred and lead to concentrations approaching or exceeding 1,000 ppm (Bakke 2003). Risk assessments have been performed by University of Washington and Washington State University (WSDA 2004) using acute bioassay values (LC50) for rainbow trout (Oncorhynchus mykiss) and aquatic invertebrates (Daphnia magna). Toxicity values for some surfactants were in the “moderately toxic” range according to EPA classifications. However, for these values to be reached, herbicide mixtures were applied directly to water at higher concentrations than what would be used by the CTNF and CNG.

Listed inert ingredients for the herbicide formulations being considered for use within the CTNF and CNG include water, ethanol, isopropanol, isopropanolamine, polyglycol 26-2, and polyoxyethylamine. None of these chemicals are listed as Level 1 (Inert Ingredients of Toxicological Concern) or Level 2 (Potentially Toxic Inert Ingredients) compounds. While there is some concern regarding the toxicity of polyoxyethylamine (POEA), a surfactant included in a formulation of glyphosate, POEA would only be used in uplands where little potential exists for movement into aquatic systems. Within or near aquatic systems (see Proposed Action document), only products labelled for aquatic application would be used.

Bullseye and Hi-Light blue dyes will be used within 100 feet of water sources and in other areas as needed. These dyes are typically photo-oxidized and disappear within a 2-3 days. Hi-Light® Blue is a water-soluble dye that contains no listed hazardous substances. It is considered to be virtually non-toxic to humans. Its effect on non-target terrestrial and aquatic species is unknown; however, its use has not resulted in any known problems. The dye used in Hi-Light® Blue is commonly used in toilet bowl cleaners and as a colorant for lakes and ponds (SERA 1997).

3.3.3.3.1.13 Effects on Individual Fish through Synergy

Synergism is a special type of interaction in which the combined impact of two or more herbicides (or the addition of certain surfactants to herbicides) is greater than the impact

predicted by their individual effects. There are concerns about potential synergistic interactions of herbicides with other herbicides in the environment or when they are mixed during application (tank mixing). In some cases, a mix of herbicide ingredients is the most effective treatment for invasive plants. For instance, imazapyr mixed with glyphosate is more effective on knotweed plant than either herbicide is alone. Combinations of chemicals in low doses have rarely demonstrated synergistic effects.

Surfactants, by their very nature, are intended to increase the effect of a pesticide by increasing the amount of pesticide that is in contact with the target (by reducing surface tension). This is not synergism, but more accurately is a reflection of increased dose of the herbicide active ingredient into the plant. Information on synergistic effects of using adjuvants, surfactants and dyes utilized in herbicide spraying programs is extremely limited. Although not much data exists in the technical literature, Abdelghani et al. (1997) and Oakes and Pollak (1999) indicate a lack of synergistic effects between surfactants and pesticides. Because of these uncertainties about potential effects, additional measures have been specified restricting use of spray adjuvants in proximity to live waters.

3.3.3.3.2 Effects to Forest Service Region 4 Sensitive Fish Species

Determinations herein are based upon FSM 2600-2009-1 direction as it applies to Region 4 designated sensitive species.

- No Impact
- May Impact Individuals Or Habitat, But Will Not Likely Contribute To A Trend Towards Federal Listing Or Loss Of Viability To The Population Or Species
- Will Impact Individuals Or Habitat With A Consequence That The Action May Contribute To A Trend Towards Federal Listing Or Cause A Loss of Viability To The Population Or Species
- Beneficial Impact

Direct effects to R4-sensitive fish species as a result of exposure to herbicides proposed under the action alternatives are not likely to occur. Design criteria minimize the potential for herbicide entry to waterways via surface runoff, wind drift, leaching, or direct spill pathways. With the exception of glyphosate (Roundup original), all herbicides proposed under the action alternatives display low-to-moderate toxicity and risk values to fish species.

Indirect effects to aquatic habitats are expected to be minimal and limited to potential short-term increases in sedimentation at sites where removal of noxious weed species temporarily leaves areas of barren ground until revegetation with native plants occurs. Broadcast herbicide applications would follow the label application guidelines, so impacts to native riparian vegetation integrity would be expected to be minimal.

Population level effects to R4-sensitive Bonneville cutthroat trout, Yellowstone cutthroat trout, and northern Leatherside chub would be negligible. Implementation of the action alternative MAY IMPACT individual Bonneville cutthroat trout, Yellowstone cutthroat trout, and northern leatherside chub, or habitat but will not likely contribute to a trend towards federal listing or loss of viability to the population or species.

3.3.3.3.2.1 Irreversible/Irretrievable Effects

Fisheries resources and aquatic habitat integrity would not be impacted in any watershed containing TES species to an extent that loss of production occurs for an implemented action. Irreversible loss of fisheries resources would only occur in a case where an action was implemented that caused permanent loss of some level of fisheries production. Irretrievable commitments of habitat components for fisheries resources would be limited to temporary and localized riparian vegetation reductions associated with invasive plant treatment activities that would be expected to result in overall beneficial effects over time.

3.3.3.3.2.2 Cumulative Effects

Cumulative effects are “the incremental impacts of the Proposed Action and alternatives when added to effects of other actions both on NFS lands and other adjacent federal, State, or private lands” (40 Code of Federal Regulations (CFR) 1508.7). Relative to special status species, cumulative effects are defined in 50 CFR 402.02 as "those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation." Other activities within the CTNF and CNG have the potential to affect the native, resident, and special status species and critical habitat within the action area. Future federal actions, including vegetation and fuels projects, prescribed fire, livestock management, travel management, minerals, and other land management activities would be reviewed through separate NEPA and Section 7 consultation processes. Past federal actions have already been added to the environmental baseline in the action area.

Under the action alternative, the CTNF and CNG will implement an active program of noxious weed management, including ground-based herbicide application, mechanical treatment, aerial spraying, aquatic application, and biological releases. Active weed treatments, including each of these same treatment methods, would additionally continue to occur on private, county, state and BLM-managed lands through actions conducted by CWMA participants. There are nine CWMAs in and around the CTNF and CNG: Jackson-Snake, Continental Divide, Highlands, Lemhi, Lost River, Power, Upper Snake River, Utah and Idaho, and Henrys Fork. Analysis of cumulative effects will therefore address an analysis area encompassing all land ownerships within project area watersheds.

Current ongoing and foreseeable CTNF and CNG forest management activities within this cumulative effects analysis area are identified in Appendix H. Appendix H identifies the herbicides currently being used adjacent to the project area, ownership by county, and current and foreseeable future activities on NFS lands. The extent of herbicide applications for invasive plant management on lands adjacent to or near the CTNF and CNG cannot be quantified in all instances as only some of these activities are known to the USDA Forest Service and many entities are not required to report herbicide use to the state or other government agencies. Since other governmental invasive plant management entities do not collect usage data to the extent that the USDA Forest Service does or in the same manner, comparison can, in some instances, be difficult. Moreover, the State of Idaho does not require that private applicators collect application data to the same degree as professional applicators.

The total land mass for the entire 17 county area is 23,559,969 acres. Federal lands make up about 60 percent while private lands and state land makes up about 38 percent. The remaining acreage is tribal and other non-categorized lands. Because consistent and complete information

about herbicides use adjacent to the CTNF and CNG is not available, certain assumptions were made for this analysis:

1. Herbicide labels are being followed. Herbicides are being applied per the label.
2. Herbicides are being used on known nonnative plants adjacent to the project area.
3. Herbicide treatments including aerial and ground application of herbicides will continue on state-owned, privately owned, and public lands adjacent to and surrounding the CTNF and CNG.
4. The applications of herbicides outside the project area are spatially distinct from treatments within the project area.
5. Where croplands are adjacent to NFS lands, we assume that herbicides being applied for crop management may also include treatment of nonnative invasive plants.
6. Other applicators may be applying combinations or mixes of herbicides in addition to those listed below, but always within specified label restrictions.

Cooperative Weed Management Area partners are licensed pesticide applicators; therefore, herbicides were applied in compliance with label direction. Given the relatively small proportion of treatment across the landscape, the implementation of design criteria designed and utilized to protect sensitive species, and the use of label guidelines for proper application, cumulative adverse effects aquatic species are not expected from implementing any of the action alternatives. All the proposed treatments used in conjunction with treatment methods that neighboring land management agencies, landowners, and CWMA partners implement may serve to increase the efficacy of treatments, which could result in beneficial cumulative impacts to aquatic habitats.

Cumulative effects from treatments under the action alternative, combined with treatments under the CWMAs, would benefit aquatic habitat and resources compared to the No Action/Current Management Alternative through the more widespread eradication, control, and containment of noxious weeds. The CWMAs and the CTNF and CNG weed management program would cumulatively be expected to result in increased levels of weed treatment success.

These cumulative effects could potentially benefit aquatic and riparian habitat and a range of protected and other sensitive species through reduced erosion and sediment delivery to drainages. No adverse downstream cumulative effects on non-NFS land would be expected from worst-case situations involving herbicide runoff or leaching because of the extremely low concentrations (see also Water Resources section below). There is the potential for downstream adverse effects on aquatic and riparian resources if an herbicide spill or wind-drift-related impact occurred close to USDA Forest Service boundaries. Increased flows proceeding downstream would further dilute the herbicide. Weed management design criteria described previously are designed to prevent or reduce the risk of these types of impacts from occurring.

Additional cumulative effects on aquatic resources associated with foreseeable future activities within the CTNF and CNG that are described in Appendix H. These cumulative effects include the potential for erosion and sediment delivery from road and trail-related construction and maintenance activities, livestock grazing along drainages, and recreational activities adjacent to drainages. Also, cumulative effects on aquatic resources from weed treatment activities under the action alternatives potentially include short-term increases in erosion and sediment delivery to drainages caused by more extensive mechanical treatments (soil disturbance) and chemical

treatments (creation of barren ground from weed removal) than under the Alternative 1. These areas would be subject to erosion until native vegetation becomes re-established, after which time, erosion and sediment delivery should be less than when weeds were present and provide correspondingly greater benefits than under Alternative 1. This would represent an overall long-term cumulative benefit to aquatic habitat and resources.

Finally, herbicide application in adjacent areas (CWMAs, BLM, state and private land) could have cumulative effects on aquatic resources. However, the CWMA efforts are coordinated with the management agencies to avoid multiple treatments within a defined geographic location. In addition, all such applications would be in accordance with EPA label guidelines, which are designed to protect aquatic organisms. The USDA Forest Service (USDA Forest Service 2001b) discussed the potential for two additional types of cumulative effects on aquatic organisms from herbicide application. These are the potential for the bioconcentration of herbicides in aquatic organisms and the possibility of synergistic, combined effects on aquatic organisms when several herbicides are present. For bioconcentration to occur, a pollutant must be present in a high concentration for an extended period of time, the organism must be exposed to the pollutant, and the pollutant must have a high resistance to breakdown or excretion by the organism to allow a sufficient uptake period that would result in an elevated bioconcentration. The USDA Forest Service (USDA Forest Service 2009) concluded that the risk of bioconcentration would be low because of the relatively small amount and timing of herbicide application. The risk of herbicide bioconcentration in aquatic organisms within the CTNF and CNG also would be expected to be low because of the extremely low concentrations of herbicides that aquatic organisms would be briefly exposed to during even a worst-case situation.

The USDA Forest Service (USDA Forest Service 2001b) concluded that no synergistic effects from herbicide application would occur because (1) the EPA currently supports an additive model in predicting synergistic effects, (2) relatively small amounts of herbicides would be applied, and (3) where more than one herbicide is used the amount of each chemical applied would typically be reduced. This same rationale and conclusion regarding the potential for synergistic effects on aquatic resources also applies to the CTNF and CNG. In addition, because the chances of multiple different herbicide activities taking place in the same drainage on the same day are unlikely, the potential for cumulative synergistic effects on aquatic organisms within the CTNF and CNG would be minimal.

3.3.3.3.3 Rehabilitation and Restoration

3.3.3.3.3.1 Direct and Indirect Effects

Reestablishing desirable vegetation would benefit native species and habitat quality. Invasive plant control is a rehabilitative and restorative practice in itself, aimed at reducing or removing invasive plants and corresponding banks of viable seeds stored in the soil, in order to promote the establishment and maintenance of desirable plant species (USDA Forest Service 2011). Long-term benefits would occur from establishing desirable vegetation that would reduce adverse erosion and sediment. A reduction of noxious weeds and establishment of desirable vegetation would benefit watershed health and reduce the potential for noxious weed encroachment into riparian areas. An upward vegetative trend of desired plant species helps meet the desired conditions of plant communities. Healthy, functional plant communities containing desirable species are resilient to disturbances such as fire and are more resistant to invasive plant invasion (Masters and Sheley 2001). The beneficial direct effects of rehabilitation and restoration

practices include increased cover and density of desired plant species and soil stabilization, with a resultant reduction in erosion and sedimentation risks to aquatic habitats. Indirectly, rehabilitated and restored sites are more resilient to disturbance.

The USDA Forest Service prefers to rely on natural regeneration as part of rehabilitative measures to restore ecosystem structure, function, and productivity on sites degraded by invasive plants. Passive or natural regeneration is preferred during and after control treatments for sites that still contain sufficient cover and density of desirable plant species. Some degraded sites require additional intervention to achieve a desired plant community that is stable, self-sustaining, resilient to disturbances, and resistant to weed invasion (Masters and Sheley 2001).

Broadcast seeding will result in no short-term adverse effects to watershed condition indicators because it is conducted by hand, will use only native weed-free seed, and disturbs no soil. Localized temporary soil and vegetation disturbance may occur from mechanical activities in some cases where invasive plants are the only vegetation and it is removed. This could potentially result in increased sediment delivery in the short term in an area where the soils would already have decreased ground cover, soil impacts, and increased erosion as a result of invasive plant infestation. However, areas that will be restored with mechanical equipment generally occur on moderate slopes, and involve burned areas or areas of concentrated human disturbance. Design criteria (section 2.2.2.2) include (1) maintaining a 25-foot vegetative buffer next to live water; (2) limiting mechanical treatment to the use of power tools that do not disturb the ground within the 100-year floodplain, within 25 feet of stream banks, or flood-prone areas along lakes, ponds, springs, and seeps; (3) ensuring mechanical (soil disturbing) equipment is not used within 25 feet of water. Seeding using an ATV on gentle terrain would not be expected to result in a measurable amount of soil disturbance. Use of mechanical equipment would not be expected to result in disturbance to riparian vegetation due to the proposed buffers. Seeding by hand or aerial broadcasting would not be expected to result in a measurable amount of soil disturbance. Long-term benefits will occur from establishment of desirable vegetation that will reduce adverse erosion and sediment. Direct ground disturbance could occur during rehabilitation or restoration activities. However, design criteria limiting treated slopes to less than 45 percent, a maximum of 25 acres per project, and landtype erosion hazard ratings to low or moderate would prevent large-scale erosion from occurring during and after these treatments. Also, because soils in these areas would likely be already experiencing increased erosion as a result of invasive plant infestations, additional ground disturbance would likely have minimal additional effects on erosion or water quality, and the long-term effects would be beneficial.

3.3.3.3.3.2 Effects to Forest Service Region 4 Sensitive Fish Species

Implementing restoration and rehabilitation activities with the design criteria listed below would not result in effects of a scope or magnitude that would be considered likely to adversely affect R4-sensitive species occurring within the action area.

Mechanical treatment components of restoration and rehabilitation actions could result in some localized and temporary soil and vegetation disturbances at restoration sites. Short-term localized increases in soil erosion and sediment delivery could occur. However, the following design criteria would prevent significant soil erosion or sediment delivery:

- Mechanized treatment within the AIZ needs to be reviewed and approved by a hydrologist or fisheries biologist. Manual treatments within the AIZ may be used as a removal method.

- Minimize ground-disturbing activities to the extent possible during re-seeding efforts.
- Conduct rehabilitation and restoration activities only in areas with slope gradients less than 45 percent.
- Conduct rehabilitation and restoration activities only in areas with low or moderate landtype erosion hazard ratings.

Subsequent re-establishment of desirable vegetation would result in a long-term reduction of erosion and sediment delivery at these sites relative to pre-treatment conditions.

Implementing restoration and rehabilitation actions may impact individual Bonneville cutthroat trout, Yellowstone cutthroat trout, and northern leatherside chub in their aquatic habitat, but will not likely contribute to a trend towards federal listing or loss of viability to the population or species, because sediment delivery will be minimized and site appropriate buffers maintained.

3.3.3.3.3.3 Irreversible/Irretrievable Effects

Restoration and rehabilitation activities implemented under the Preferred Alternative would not result in any irreversible or irretrievable commitments of aquatic resources. Irreversible loss of fisheries resources would only occur in cases where an action was implemented that caused permanent loss of some level of fisheries production. No activities proposed for implementation in association with restoration or rehabilitation actions would impact fisheries resources or aquatic habitat integrity in any watershed containing sensitive species to an extent that measureable loss of production would occur.

3.3.3.3.4 Cumulative Effects

Other land managers (private landowners; state, local, and federal agencies; and CWMAs) also practice active restoration when necessary to re-vegetate sites. As with USDA Forest Service operations, active restoration is limited to small areas and high-priority sites. Because of the very small scale and wide spatial distribution of assisted restoration actions, the potential for adverse cumulative effects is minimal to non-existent.

3.4 Issue 3: Water Resources

The hydrologist specialist report was developed for this analysis and is included by reference (USDA Forest Service 2020c).

3.4.1 Methodology for Analysis

3.4.1.1 Overview of the Water Resource Concerns

The Proposed Action and Alternatives can potentially have direct and indirect effects on water resources. Potential direct effects include erosion from physical disturbance resulting from mechanical treatments, and water quality impacts resulting from chemical treatments. Public comments have identified concerns about the potential impacts of chemical invasive plant treatment on surface and groundwater quality. Potential indirect effects are related to the effects that invasive plants can have on the landscape, including adverse effects on soil and water resources. Loss of native vegetative cover can result in soil loss, water quality impacts, impacts to riparian vegetation, and impacts to stream channel morphology. Treatment of invasive plants can help maintain native vegetative ground cover and prevent many of these impacts.

3.4.1.2 Overview of the Water Resources Analysis

This report provides a description of the affected environment and an analysis of the environmental effects of the following alternatives on water resources within the project area, focusing on water resource conditions.

The objectives of this analysis are to:

- Ensure that the project complies with the applicable direction and standards and guidelines of the Land Management Plans and other pertinent policy, regulations, and law.
- Recommend project design criteria to advance project benefits and minimize impacts.
- Evaluate the project regarding the hydrologic and watershed resources.
- Analyze the effects of current condition of the resource, and proposed management to move the resource toward desired future conditions.

The analysis in this report is supported by literature reviews, modeling, and professional judgment.

3.4.1.3 Analysis Scale

The analysis area for water resources is the project area, which includes 2.9 million acres of lands administered by the CTNF and the CNG. The analysis area includes the CTNF and CNG for all alternatives. There are 20 subbasins (4th-order HUC) in the analysis area, encompassing all areas potentially affected directly or indirectly by the Proposed Action.

3.4.1.4 Methodology

This analysis utilizes several sources of existing background information, described in the following paragraphs.

Best available science: Abundant scientific literature is available describing research on herbicide persistence in soil and water, the effects of various treatments on water quality and soils, and the effects of invasive plant infestations on runoff and erosion.

Herbicide Risk Assessments: Because herbicides have the potential to adversely affect the environment, the EPA must register all herbicides prior to their sale, distribution, or use in the United States. In order to register herbicides for outdoor use, the EPA requires the manufacturers to conduct safety evaluations on wildlife, including toxicity testing on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. An ecological risk assessment uses the data collected to evaluate the likelihood that adverse ecological effects may occur as a result of herbicide use.

Risk Assessments for each of the herbicides proposed for use in this project were produced for the USDA Forest Service by SERA. These risk assessments, listed in Table 3-1, provide detailed information on herbicide behavior, persistence, and potential effects on soil and water, incorporating data from modeling of herbicides using the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model. The intent of the generic modeling in USDA Forest Service risk assessments is to develop extreme values for exposure assessments that are likely to encompass levels of exposure potentially realizable in USDA Forest Service programs (SERA 2007a).

Invasive plant control monitoring data: Monitoring data collected during implementation and monitoring of existing invasive plant control programs is a valuable source of information used to predict the effects of similar proposed treatments. More extensive studies have been conducted on aerial herbicide applications within the nearby Lolo National Forest and Bitterroot National Forest in Montana (USDA Forest Service 2010).

The State of Idaho has declared 67 nonnative, invasive aquatic and terrestrial plant species as noxious (Table 3-24 below in Vegetation section), and the State of Utah has declared 27 nonnative, invasive aquatic and terrestrial plant species as noxious (Table 3-25 below in Vegetation section). Only a total of 26 of these legally designated noxious weeds are known to infest lands within the project area. The remaining species, however, are present elsewhere in Idaho, Utah, and neighboring states and have the potential to become established in the project area. The two national forests also track a number of nonnative invasive plant species that may not be listed as noxious in Idaho, Utah, or other western states, but that are recognized as causing economic or environmental harm. This analysis incorporates management activities for controlling all 67 plant species legally designated as noxious weeds by the State of Idaho, all 27 species legally designated as noxious weeds by the State of Utah, and other nonnative invasive plants causing economic or environmental harm.

Collective knowledge: Some of the information and assumptions used in this analysis are based on the collective knowledge provided by the IDT, based on experience from decades of invasive plant treatment implementation.

Modeling: The effects of invasive plant treatments and herbicide applications on soil and water resources are estimated in this analysis through the following quantitative methods:

GLEAMS: The Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model is a field-scale, root zone model that describes the fate of chemicals in various soil types and climatic conditions (Leonard et al. 1987). The US Department of Agriculture (USDA) developed GLEAMS, and the USDA Agricultural Research Service (ARS) maintains GLEAMS. This model is used extensively in many of this analysis' herbicide risk assessments completed prior to 2007 (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006) to model estimates of herbicide concentrations in streams, ponds, and soil following herbicide application. Results of this modeling are summarized in the Effects of Herbicides on Surface and Ground Water Quality under each of the Alternative Effects Analysis.

Gleams-Driver: The Gleams-Driver model was developed by SERA for the USDA Forest Service as a pre-processor and post-processor for GLEAMS (SERA 2007a). Gleams-Driver prepares input files, runs the GLEAMS model, and reads and processes GLEAMS output. The Gleams-Driver model has been utilized in this analysis' risk assessments completed in 2007 and later (SERA 2007b, 2010, 2011a, 2011b, 2011c, 2011d). The format of the Gleams-Driver inputs and outputs varies from the GLEAMS modeling. Results of this modeling are in the Alternative Effects Analysis section below.

3.4.2 Affected Environment

3.4.2.1 Watersheds

Watersheds are a natural hydrologic boundary for surface water runoff. Since they are definable features on the landscape, they are broadly used as spatial boundaries for investigations of

surface-water resources (Maxwell et al 1995). Watersheds throughout the US have been defined by the US Geological Survey and are used by the US Water Resources Council and others for comprehensive planning and investigations. A hierarchical hydrologic unit code (HUC) consisting of two digits for each level in the hierarchical unit system, is used to identify any hydrologic areas of interest (USGS 1987).

The CTNF and CNG lies within two major watershed Regions (1st Code HUC). The northern portion of the Forest (from Soda Springs north to the Montana boarder) is within the Pacific Northwest Region, which contain the smaller Upper Snake River Subregion (2nd HUC). The southern portion of the Forest, from Soda Springs to the south (including the Grasslands) is within the Great Basin Region, which contains the Great Salt Lake and Bear River Subregions. The Subregions can be further broken down into smaller basins (3rd HUC), subbasins (4th order HUC), watersheds (5th order HUC) and subwatersheds (6th HUC). The project area (analysis area) within the CTNF and CNG, there are 20 subbasins (Table 3-13) and 73 watersheds. This analysis will be focused at the subbasin and watershed level in the action area encompassing all areas potentially affected directly or indirectly by the Proposed Action.

Table 3-13. Subbasins within the action area.

BASIN	SUBBASIN	4TH LEVEL HUC CODE	FOREST SERVICE ACRES	% OF SUBBASIN WITHIN PROJECT AREA	INFESTED FOREST SERVICE ACREAGE	% FOREST SERVICE INFESTED ACREAGE	% OF TOTAL FOREST SERVICE INFESTED ACREAGE
Bear River	Central Bear	16010102	22,455.43	0.78%	959.5	4.3%	**30.3%**
	Bear Lake	16010201	220,154.77	7.61%	9,087.7	4.1%	
	Middle Bear	16010202	137,238.78	4.75%	12,211.2	8.9%	
	Little Bear-Logan	16010203	19,983.76	0.69%	856.0	4.3%	
	Lower Bear-Malad	16010204	69,920.77	2.42%	711.7	1.0%	
Great Salt Lake	Curlew Valley	16020309	43,895.95	1.52%	2,441.1	5.6%	**3.1%**
Upper Snake	Greys-Hobock	17040103	1,606.27	0.06%	56.0	3.5%	**66.6%**
	Palisades	17040104	482,185.19	16.68%	5,455.3	1.1%	
	Salt	17040105	220,799.26	7.64%	6,788.5	3.1%	
	Idaho Falls	17040201	1,274.60	0.04%	81.7	6.4%	
	Upper Henrys	17040202	498,468.37	17.24%	25,339.5	5.1%	
	Lower Henrys	17040203	108,224.34	3.74%	2,364.4	2.2%	
	Teton	17040204	282,531.76	9.77%	2,117.6	0.7%	
	Willow	17040205	35,614.74	1.23%	1,086.9	3.1%	
	American Falls	17040206	7,863.21	0.27%	72.8	0.9%	
	Blackfoot	17040207	124,861.02	4.32%	5,323.2	4.3%	
	Portneuf	17040208	156,944.27	5.43%	2,220.3	1.4%	
	Beaver-Camas	17040214	154,685.55	5.35%	1,242.6	0.8%	
	Medicine Lodge	17040215	156,166.49	5.40%	173.2	0.1%	
	Birch	17040216	146,498.40	5.07%	126.2	0.1%	
Total			**2,891,372.93**	**100.0%**	**78,715.3**	**2.7%**	**100.0%**

Because of the potential for downstream and cumulative effects within watersheds, the action area encompasses entire subwatersheds where invasive plant treatments occur. Approximately 2.7 percent of the USDA Forest Service subbasin acreage is infested by invasive plant species. Of that infested acreage, 67 percent of the existing invasive plant infestations are located in 14 subbasins within the Upper Snake River Basin. The Upper Henrys subbasin includes over 33 percent of the infestation acreage alone (Table 3-13).

3.4.2.2 Surface Water

The CTNF and CNG has about 8,088 miles stream channel with 3,122 miles of perennial and 4,966 miles of intermittent as defined by NHD mapping. The mapping also shows 1,180 miles ephemeral channels/draws. There is also nearly 24,256 acres of perennial and intermittent lakes and reservoirs as defined by NHD mapping.

Stream flows within the project area are primarily controlled by snowmelt runoff, with peak runoff occurring in May and June. Low flows typically occur from late summer through the winter months. Many intermittent streams draining small headwater basins only carry flow during snowmelt runoff, and many streams disappear into course sediments of alluvial fans at the bases of these mountain ranges. High-intensity summer thunderstorms can produce intense rainfall capable of causing short-duration flash floods in many of the steep drainages in the project area, particularly where wildland fire has impacted soils and ground cover. Extreme flows often occur where high-intensity summer thunderstorms occur over severely burned areas.

Total annual water yields throughout CTNG and CNG are about 2 million acre-feet (USDA Forest Service 1997). Water within the CTNG and CNG is consumed in a number of ways including evaporation, infiltration to groundwater, use by plants and animals, diversions from springs and stream channels for private consumption, and land irrigation and the like. As such, the amount of water actually crossing the Forest boundary can be considerably less than that produced within its watersheds.

3.4.2.3 Aquatic Influence Zones (AIZs)

Aquatic influence zones (AIZs) are the zones surrounding lakes, reservoirs, ponds, perennial and intermittent streams, and wetlands, such as wet meadows, springs, seeps, bogs and other areas identified below. These areas control the hydrologic, geomorphic, and ecological processes that shape various features mentioned above and directly affect water quality and aquatic life. They also provide unique habitat characteristics important to those plant and animal species that rely on aquatic, wetland, or riparian ecosystems for all or a portion of their life cycle. Many such habitats are locally rare or are sensitive to disturbance. Overall, these areas serve as important reservoirs of biodiversity; critical linkages for the interchange of plant and animal genetic material; specialized areas of nutrient and energy cycling and freshwater filtration, storage, and transport.

These AIZs provide a high level of aquatic protection and maintain ecological functions (e.g., sediment transport, microclimate control, nutrient and energy regulation, and connectivity within the watershed) and processes (e.g., stream channel formation, plant community development, recruitment of organic material, including large wood, and hydrologic cycles) necessary for the restoration and maintenance of habitat for aquatic and riparian dependent organisms, and provide clean water that supports designated beneficial uses.

The CTNF and CNG are guided by three separate land management plans. In each of the plans, AIZ, or similar management prescriptions[1] have been established to provide special management directions to protect, maintain and restore AIZ values. Five basic water types are identified, and varying buffer width are assigned to identify, protect and manage these AIZs.

The five basic water types found within the NFS lands are:

1. Fish-bearing Stream Reaches,
2. Perennial Non-fish-bearing Stream Reaches,
3. Lakes,
4. Reservoirs, Ponds and Wetlands Greater Than 1 Acre, and
5. Intermittent Streams, and Wetlands Less Than 1 Acre.

The buffer widths range from 50 feet to 300 feet and depend on the water type, subsection location and the associated Land Management Plan. Typically, perennial fish bearing stream are buffered 300 feet on each side and intermittent are buffered 150 feet on each side. The project area includes a total of 406,910.4 acres within AIZs and represent 14 percent of the total national forest subbasin acres. Table 3-14 shows that there are 11,152.5 acres infestation occurring in AIZs which represents 3.8 percent of the total AIZ acres within the project area. Table 3-14 also shows the percent of that total subbasin inventoried infestation that occurs within the AIZ. The average is 14.2 percent and ranges from 0 to 53.4 percent.

Table 3-14. All infested watersheds located within the Caribou-Targhee National Forest (CTNF) and Curlew National Grassland (CNG) in alphabetical order and those acres located in Aquatic Influence Zones (AIZs).

BASIN	SUBBASIN	4TH LEVEL HUC CODE	FOREST SERVICE ACRES	% OF SUBBASIN WITHIN PROJECT AREA	INFESTED FOREST SERVICE ACREAGE	INFESTED FOREST SERVICE AIZ ACRES	% INFESTATION IN AIZ
Bear River	Central Bear	16010102	22,455.43	0.78%	959.5	119.81	12.5%
	Bear Lake	16010201	220,154.77	7.61%	9,087.7	1,609.10	17.7%
	Middle Bear	16010202	137,238.78	4.75%	12,211.2	2,021.38	16.6%
	Little Bear-Logan	16010203	19,983.76	0.69%	856.0	276.39	32.3%
	Lower Bear-Malad	16010204	69,920.77	2.42%	711.7	127.18	17.9%
Great Salt Lake	Curlew Valley	16020309	43,895.95	1.52%	2,441.1	0.00	0.0%
Upper Snake	Greys-Hobock	17040103	1,606.27	0.06%	56.0	6.39	11.4%
	Palisades	17040104	482,185.19	16.68%	5,455.3	1,960.10	35.9%
	Salt	17040105	220,799.26	7.64%	6,788.5	2,144.79	31.6%
	Idaho Falls	17040201	1,274.60	0.04%	81.7	5.20	6.4%
	Upper Henrys	17040202	498,468.37	17.24%	25,339.5	3,006.54	11.9%

[1] The Caribou and Targhee Plans have a 2.8.3 Management Prescription for AIZs, and the Curlew Plan has a 2.8.8 Management Prescription for Riparian/Wetland Areas (RWAs).

BASIN	SUBBASIN	4TH LEVEL HUC CODE	FOREST SERVICE ACRES	% OF SUBBASIN WITHIN PROJECT AREA	INFESTED FOREST SERVICE ACREAGE	INFESTED FOREST SERVICE AIZ ACRES	% INFESTATION IN AIZ
	Lower Henrys	17040203	108,224.34	3.74%	2,364.4	347.09	14.7%
	Teton	17040204	282,531.76	9.77%	2,117.6	573.78	27.1%
	Willow	17040205	35,614.74	1.23%	1,086.9	405.00	37.3%
	American Falls	17040206	7,863.21	0.27%	72.8	32.50	44.6%
	Blackfoot	17040207	124,861.02	4.32%	5,323.2	1,330.67	25.0%
	Portneuf	17040208	156,944.27	5.43%	2,220.3	896.88	40.4%
	Beaver-Camas	17040214	154,685.55	5.35%	1,242.6	308.68	24.8%
	Medicine Lodge	17040215	156,166.49	5.40%	173.2	92.52	53.4%
	Birch	17040216	146,498.40	5.07%	126.2	42.34	33.5%
Total			**2,891,372.93**	**100.0%**	**78,715.3**	**11,152.49**	**14.2%**

Table 3-15 shows the percent of invasive plants that are occurring within these riparian areas. Most common being nodding plumeless thistle, leafy spurge, and Canada thistle.

Table 3-15. Invasive plants occurring within the Aquatic Influence Zone (AIZ).

COMMON NAMES	AIZ INFESTED ACRES	PERCENT OF TOTAL AIZ ACRES
nodding plumeless thistle	4,471.8	23.29%
leafy spurge	4,108.2	21.39%
Canada thistle	3,172.1	16.52%
gypsyflower	2,164.8	11.27%
Dyer's woad	1,871.1	9.74%
spotted knapweed	1,356.6	7.06%
butter and eggs	1,333.3	6.94%
black henbane	440.6	2.29%
field bindweed	96.6	0.50%
common St. Johnswort	45.7	0.24%
Dalmatian toadflax	37.3	0.19%
poison hemlock	33.6	0.18%
diffuse knapweed	23.7	0.12%
Scotch cottonthistle	11.8	0.06%
whitetop	10.1	0.05%
common mullein	6.3	0.03%
lesser burdock	5.8	0.03%
bull thistle	4.9	0.03%
spiny plumeless thistle	4.8	0.02%
oxeye daisy	2.1	0.01%
common tansy	1.2	0.01%
broadleaved pepperweed	0.2	0.00%
hardheads	0.1	0.00%
toadflax	0.0	0.00%
Total	**19,202.7**	**100.00%**

3.4.2.4 Water Quality

The quality of water within the CTNF and CNG is characterized as being generally good overall. However, some streams have been degraded below state water quality standards for State-designated beneficial uses. These streams have been identified by the States under Section 303(d) of the Clean Water Act. There are no streams identified within the CTNF or CNG within the states of Utah or Wyoming. All states are required to submit updated reports to the EPA every 2 years. It should be noted that no streams have been identified as being degraded by pesticides. The current 303(d) list, along with a description of the Idaho DEQ 303(d) process is located at http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx. The State of Idaho has identified these water bodies most recently in their 2016 Integrated 303(d)/305(b) report. The 2016 integrated report shows the 303(d) or impaired listing of 149 Assessment Unit Water Bodies totaling 1,218.5 miles, and 2 reservoirs (Weston Creek Reservoir and Stone Reservoir as part of Deep Creek) totaling 254 acres, within the project area. The primary pollutant identified that is causing water quality degradation is sediment (40% of the stream miles) and fecal Coliform/Ecoli (35% of the stream miles). However, some stream pollutants also include temperature, Selenium, dissolved oxygen, total phosphate, mercury, and others. The Integrated (303(d)/305(b)) Report provides assessment unit level water quality information concerning support of designated uses. Units determined to not be in support of designated uses are placed on the 303(d) list until a TMDL is approved by the EPA.

Total maximum daily loads (TMDLs) and subbasin Assessments: TMDLs and subbassin assessments (http://www.deq.idaho.gov/water-quality/surface-water/tmdls/table-of-sbas-tmdls.aspx) have been developed for 11 subbasins (Subbasin codes) within the project area that include: Bear River Basin/Malad River Subbasin (16010201, 16010102, 16010204, 16010202) , Beaver-Camas Subbasin (17040214), Blackfoot River Subbasin (17040207), Curlew Valley Subbasin (16020309), Henrys Fork (Upper and Lower) Subbasin (17040202, 17040203), Palisades Subbasin (includes Fall Creek watershed), Salt River Subbasin (17040105), and Teton River Subbasin (17040204). These are also identified in the State of Idaho's Final 2016 305b Integrated Report on the IDEQ web site, at https://mapcase.deq.idaho.gov/wq2012/default.html.

A total of 4,919 acres of inventoried invasive plant infestations occur within 300 feet of the 303(d)-listed and impaired water bodies within the project area. Impaired water bodies with the largest concentrations of inventoried invasive plants within 300 feet falls within the Bear Lake Subbasin (16010201) with 1,271 acres (Table 3-16).

3.4.2.5 Groundwater

Information on ground water quality within the Forest is limited. Some well tests have been conducted by municipalities and other ground water users in association with domestic use within and adjacent to the Forest. Some groundwater monitoring has also been completed by mining companies in association with phosphate mining within south east Idaho. Some degradation of water quality by pesticides has been noted in heavy agriculture-use areas off-Forest, but there are no known pesticide problems within the Forest boundary.

Table 3-16. Acres of inventoried invasive plant infestations within 300 feet of a 303(d) listed waterbody by subbasin.

SUBBASIN CODE	INFESTED ACRES WITHIN 300 FEET
ID16010201	1,270.9
ID16010202	141.8
ID16010203	309.0
ID16010204	41.5
ID16020309	292.0
ID17040104	336.6
ID17040105	631.3
ID17040201	8.8
ID17040202	34.2
ID17040203	84.6
ID17040204	396.7
ID17040205	42.1
ID17040207	770.8
ID17040208	275.8
ID17040214	218.0
ID17040215	65.2
Grand Total	**4,919.1**

Through a Memorandum of Understanding (MOU) with the State of Idaho, the Forest is responsible for implementing nonpoint source pollution control measures during all management activities (USDA Forest Service 1994). The State's antidegradation policy also pronounces that the designated uses and the level of water quality necessary to protect those uses shall be maintained and protected. USDA Forest Service Policy is to maintain or improve water quality (RFP and FSM 25002 (2520.3)). The State recognizes BMPs and project design criteria as an effective process for protecting beneficial uses and ambient water quality.

3.4.2.6 Water Uses

Water uses within the project area include diversions for irrigation, small-scale stockwater developments, domestic water from wells, domestic use from municipal watersheds, and small-scale hydropower development. Numerous permitted diversions are located on NFS lands throughout the area, resulting in decreased flows downstream. Wells on NFS lands provide drinking water for campgrounds and other USDA Forest Service facilities within the project area.

Idaho DEQ, Wyoming DEQ and the Utah DEQ have Source Water Protection Programs that identify Source Water Areas for waters that supply both public drinking water and wells used for public consumption. In Wyoming and Utah, no Source Water Protection Areas are identified on NFS lands. Source Water Protection Areas are identified in Idaho and IDEQ maps the source water protections areas (https://mapcase.deq.idaho.gov/swa/default.html) and these areas overlap and some extending into Wyoming such as with the City of Driggs and into Utah such as with the City of Franklin.

There is about 160 public water sources that contain 429,075 acres of overlapping source water protection areas that extent onto or are on NFS lands. On NFS lands there are 177,319 acres of source water protection areas that are within the project area. Source water protection areas within the project area include source waters for various cities and towns, NFS ranger

[2] Section 2520.3: "Apply management practices that meet requirements for protecting, maintaining, restoring, or improving watershed conditions."

stations/facilities, private and public campgrounds, summer homes, subdivisions, lodges, ski areas, and private wells. The two federally designated municipal watersheds (Mink Creek and Gibson Jack) have also been include in the source water protection areas. A total of 2,703 acres of invasive plant infestations occur within these delineated areas comprising 1.5 percent of the total delineated areas.

3.4.3 Environmental Consequences

3.4.3.1 Alternative 1—No Action/Current Management

Alternative 1, the No action, which is the Current Management Alternative, continues the adaptive, IWM program as it is currently implemented in the project area. In general, this alternative includes the treatment of invasive terrestrial plants utilizing biological, mechanical, and\or herbicide treatments. Herbicide application under this alternative is limited to the treatment of terrestrial invasive plants with 12 herbicides and utilizing ground-based application techniques exclusively. These effects are detailed in this section. Invasive plant infestations within the project area are expected to continue to spread, but the percentage of annual expansion of invasive plants would be less in Alternative 2 than that found under Alternative 1.

The effects analysis of Alternative 1, Current Management, will be used and referenced in Alterative 2 effects analysis as a foundation for other effects to be added to.

The effectiveness of methods approved under the current management strategy for treatment of invasive plant infestations is limited. Biological controls do not act quickly and may only be effective when combined with other effective treatment methods. Manual/mechanical and rehabilitation/restoration controls are the least cost-effective methods and cannot be used to treat large infested areas. Ground-based herbicide control methods are more cost effective than manual/mechanical methods but cannot effectively treat large infested areas. The herbicides currently approved for use provide limited options for treatment in riparian areas. Even when implemented together, the use of these methods under existing budgetary constraints is not likely to be sufficient to treat the existing infestations and prevent the further spread of invasive plants.

The current management strategy focuses on EDRR, treating small infestations that have the potential to spread into un-infested areas, and treating larger infestations along established vectors. However, the current management strategy is not likely to be able to effectively treat large, more remote infestations using the currently approved methods.

Although aquatic invasive plants are not currently present in the project area, the potential exists for their introduction into the area. The spread of an invasive species such as Eurasian watermilfoil could cause drastic effects on lakes over a short period of time. With limited mechanisms for controlling such an infestation under the Current Action Alternative, the effects of such an infestation would negatively impact water chemistry.

Treatment of invasive plants under the Current Action Alternative would have minimal direct adverse effects on soil and water resources, largely because of the small number of acres that would be treated within the 2.9-million-acre project area. Established design criteria, BMPs, and Label direction for herbicide control would minimize the potential for herbicides to affect water resources.

Without any additional treatments, existing invasive plant infestations are expected to spread into susceptible areas along vectors such as roads, trails, livestock, wildlife, wind, and water;

additional factors include various human uses and fire. The spread of invasive plants has been shown to occur at an average rate of 1.3 to 35.0 percent per year, based on a synthesis of data for the spread of 16 invasive plants throughout the United States (Duncan et al. 2004; Duncan and Clark 2005). This study depicts annual rates of spread of 1 to 24 percent for spotted knapweed, 10 to 12 percent for Canada thistle, 12 to 22 percent for musk thistle, and 12 to 16 percent for leafy spurge. The actual rate of spread of invasive plants within the project area has not been quantified. However, based on the existing acreage of known infestations and an implied annual rate of spread of 10 to 24 percent could be expected to occur on the CTNF and CNG and would depend on specific invasive species.

The expansion of invasive plant infestations into areas containing native vegetation could over time drastically alter vegetation composition, having indirect effects on sediment yield, soil productivity, water availability, runoff potential, and riparian function in these areas. Impacts would be concentrated where vectors allow the spread of invasive plants. However, some vectors such as wind can affect large areas. Because treatments under the Current Action Alternative would limit the spread of some new infestations and potentially decrease the severity of some existing infestations resulting in a slower rate of expansion of invasive species. These potential effects are discussed in terms of the established measurement indicators in the following sections.

Although the CTNF and CNG do not contain aquatic invasive plant species, a likely threat exists that aquatic weeds could become established within NFS lands. Eurasian watermilfoil, the only listed an aquatic noxious weed listed by Idaho Department of Agriculture is gaining a foothold in Idaho's lakes, ponds, rivers, and other waterways, with approximately 4,000 surface acres of the plant identified through State surveys.

Once established, aquatic invasive plant species are extremely difficult to eradicate and pose serious threats to the ecological integrity of aquatic environments. An integrated management strategy allowing for implementing timely and effective invasive plant control and eradication programs for the CTNF and CNG is critical to preventing these species from becoming established. Without an effective control method (such as the use of aquatic herbicides), the general effects of establishment occurring could be severe, depending on the characteristics of the water body. Invasion of Eurasian watermilfoil, which can quickly outcompete native aquatic vegetation, is considered to be one of the most serious aquatic invasive plant issues in the Northwest. Under the No Action Alternative, impacts to water chemistry could include decreased dissolved oxygen, increased nutrient loading (nitrogen and phosphorus), altered biomass turnover, changes in water temperature, and increased turbidity (Parkinson et al. 2011). These effects could have impacts on water quality and stream health.

3.4.3.1.1 Effect on Riparian Health and Function

Currently, 19,203 acres of inventoried invasive plant infestations are located within AIZs in the project area (Table 3-15). The extent of riparian infestations ranges from small, localized occurrences to expansive occurrences as explained in the Affected Environment-Riparian Areas section above.

3.4.3.1.1.1 Direct Effects

The action alternatives would have minimal direct effects on riparian function. Biological control methods would have no adverse effects on riparian function, because treatment would be target-

specific, and no off-target impacts to riparian vegetation would occur. Similarly, herbicide control methods would have minimal adverse effects because only target-specific, ground-based spot applications would follow label direction when applying next to streams and ponded water bodies, with no likely effects to nontarget species. Ground-based broadcast application in AIZs could result in some off-target impacts to native riparian vegetation, depending on the herbicide used.

A small amount of short-term localized disturbance to existing riparian vegetation would occur as a result of mechanical methods and rehabilitation/restoration methods that take place within riparian areas. These short-term negative effects would be overshadowed by long-term beneficial effects, with the overall result being a decrease in invasive plant infestations at treated sites. Impacts to riparian function would be minimal because in many cases where treatments would occur, and particularly in the case of rehabilitation/restoration treatments, riparian function may already be compromised by invasive plant infestations.

3.4.3.1.1.2 Indirect Effects

The action alternatives would have a number of indirect adverse effects on riparian function related to the spread of invasive plants in AIZs. Because these alternatives limit treatment methods within riparian areas to biological control, ground-based spot herbicide application, ground-based broadcast application, manual/mechanical control, and rehabilitation/restoration, it is unlikely that these treatments would keep up with the spread of invasive plants in riparian areas or result in a reduction in total invasive plant infestations within AIZs. The total acres of infestations within AIZs is likely to increase slightly over the next 10 to 15 years under the action alternatives.

Potential indirect effects related to the continued spread of invasive plants in riparian areas under the Current Management Alternative could have a number of indirect effects on the conditions of riparian areas within the project area. Native woody riparian shrubs provide an essential function within riparian areas, particularly in lower-gradient streams, because their roots provide structure and stability to stream banks. Loss of this native riparian vegetation to invasive plant species that do not provide this woody root structure has the potential to cause decreased bank stability and increased bank erosion in some channel types, which in turn can lead to channel widening, channel instability, and increased sediment loads (Polvi et al. 2014). Additional indirect effects related to the loss of native riparian vegetation could include channel widening, filling of pools, increased fine bed sediments, decreased large woody debris recruitment, loss of aquatic habitat, decreased shading of streams, and increased stream temperatures.

These effects would occur on a continual basis over the long term (greater than 10 years), with gradually increasing severity as the extent of invasive plant infestation in riparian areas increases.

Colonization of riparian areas with invasive plants has resulted in dramatic effects in many parts of the United States. The invasion of salt cedar along rivers and streams of the western United States has, in some places, resulted in almost complete loss of native willow vegetation, affecting water availability, soil properties, channel morphology, and numerous other ecological processes (Urgenson 2006). Although salt cedar is present (but not prevalent) within the project area, it has the potential to spread further and displace native riparian vegetation. Japanese knotweed has invaded riparian forests in the Pacific Northwest, altering the composition of the forest and understory, which in turn affects streambank stability, channel morphology, and nutrient

dynamics (Dawson and Holland 1999; Urgenson 2006). Knotweed has been shown to outcompete native juvenile trees, affecting the riparian forest succession over time, thereby decreasing root strength that provides bank stability and inputs of large woody debris to the channel (Urgenson 2006). Knotweed has been identified it also has the potential to spread further into the area.

Riparian areas can be highly susceptible to colonization by nonnative plants as a result of regular disturbance regimes (flooding, erosion, deposition, drought, human and animal sources), availability of water and nutrients, and habitat connectivity (Planty-Tabacchi et al. 1996; Urgenson 2006). Under certain conditions, small infestations of invasive plants could spread rapidly and dramatically change the function of a riparian area in a short period of time (less than 5 years). Functional riparian areas, however, are characterized by a high diversity in not only species, but also physical processes, which allows for high species diversity and heterogeneous morphology (Schmitz and Jacobs 2007). A review of literature suggests that many invasive species infestations in riparian areas are largely the result of flow alterations, such as reduction in peak flows downstream of dams, which prevents the natural disturbance regime that allows native plant diversity to occur. For example, widespread infestations of salt cedar on regulated southwestern rivers have essentially adapted to altered flow regimes, while native willows cannot compete under those conditions. Studies have suggested that restoration of a natural flow regime is the only way to restore native plant communities in these altered riparian ecosystems (Junk et al. 1989; Poff et al. 1997; Schmitz and Jacobs 2007). Large-scale flow alterations do not generally occur within the project area; however, flow reductions related to diversions, as well as prolonged periods of drought, are likely to result in higher susceptibility to invasive plant infestations in some riparian systems.

Existing invasive species infestations are likely to expand in the project area if, under Current Management Alternative. Duncan et al. (2004) have cited average annual rates of spread of 1.3 to 35.0 percent per year for a variety of invasive species. Under the No Action Alternative, the rate of spread in healthy, functional riparian areas is likely to be at the low end of that range. However, the rate of spread would likely be higher in riparian areas impacted by stressors such as flow reduction from upstream diversions or prolonged drought, livestock use, fire, or a variety of human uses. Because natural conditions are generally well protected within riparian areas in the project area as a result of Forest Plan direction and other BMPs, and because extreme flow alterations are limited, the annual rate of expansion in riparian areas would be relatively low. Based on the existing acreage of known infestations of Canada thistle within AIZs and an estimated annual rate of expansion of 5 to 15 percent. This could result in areas of detrimental changes to riparian character and function in the long term. The most severe indirect stream channel effects would likely occur in unconfined, low-gradient, meandering stream channels with wide floodplains, where riparian vegetation provides a large influence on channel form. This could then lead to decreased bank stability, increased bank erosion, and changes to channel morphology related to the decreased rooting strength of invasive plants compared to native woody shrubs in the long term.

Because existing large invasive plant infestations within AIZs would continue to spread, the riparian ecosystem within and around these infestations would likely continue to decline in structure and productivity. However, current management strategies would allow for effective treatment of some small, localized infestations in riparian areas.

3.4.3.1.2 Effects of Herbicides on Surface and Ground Water Quality

3.4.3.1.2.1 Direct Effects

Biological, manual/mechanical, and rehabilitation/restoration control methods would have no direct effects on the concentrations of herbicides in water because no herbicides would be applied using these methods.

Herbicide applications under Alternatives 1 and 2 have the potential to directly affect concentrations of herbicide in surface water and groundwater, depending on a number of factors including the type of herbicide, the amount of herbicide applied, the size of the treatment area, proximity of the application to water, the characteristics of the water body, soil characteristics such as infiltration, environmental factors such as rainfall, runoff, and wind, and chemical properties of the herbicides as they interact with soil. This section provides a discussion of herbicide properties, pathways to water, and other factors related to potential herbicide delivery to water sources common to the action alternatives.

Eradication of invasive plant infestations and reestablishment of native vegetation would allow for the recovery of soil microbes in the long term that would benefit native plants and vegetative ground cover. Trevors (1998) has suggested that most effects to soil microbes occur when herbicides are applied at higher than recommended concentrations. A review of research also indicates that the effects of herbicides on soil microbes are highly variable and dependent on numerous environmental conditions. Furthermore, any potential short-term impacts would occur to a very small percentage of soils on a watershed scale because of the limited extent of treatments that would occur.

3.4.3.1.2.2 Herbicide Properties

USDA Forest Service Risk Assessments have been completed by SERA for all herbicides proposed under the action alternatives (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006, 2011a, 2011c, 2011d). These risk assessments provide detailed information about the toxicity and environmental fate of each herbicide. Information from these risk assessments and from Tu et al. (2001) regarding herbicide behavior in soil and water is referenced Table 3-17. Summaries are provided in the Hydrologist Specialist Report (USDA Forest Service 2020c). Alternative 1 (current) and Alternative 2 (proposed action) chemical use numbers vary as stated in the alternative description above, but all are included for comparative purposes and to be in one central location. Tebuthiuron is currently authorized to be used but is not included in the list below because we are not using that chemical.

3.4.3.1.2.3 Herbicide Pathways to Water

Norris et al. (1983) described five ways in which herbicides applied for invasive plant treatment can enter surface water or groundwater:

- Direct application
- Drift
- Mobilization in ephemeral streams and channels
- Overland flow
- Leaching
- Spills or Leaks

Table 3-17. Current and proposed herbicide characteristics in soil and water.

HERBICIDE (ACTIVE INGREDIENT)	HALF LIFE IN WATER (DAYS)	WATER SOLUBILITY (MG/L)[a]	GUS GROUND -WATER MOVEMENT RATING[b]	HALF LIFE IN SOIL (DAYS)[c]	SORPTION COEFFICIENT (SOIL K_{OC}) [d]	PESTICIDE MOVEMENT RATING (LEACH ABILITY)	TOXICITY TO SOIL MICROBES	DEGRADATION MECHANISMS
2,4-D amine	45	569	0.9–3.7 Ext low to high	6.2 Non	61.7 Mobile	Moderate	Short Term	Soil microbes
Aminopyralid	447	205,000	1.8–10.1 Low to very high	32–533 Mod to persistent	10 Very mobile	High	Low	UV light Soil microbes
Chlorsulfuron	200	27,900	3.0–5.2 Mod to very high	37–168 Mod to persistent	40 Mobile	High	Low	Soil microbes
Clopyralid	261	1,000	2.0–10.5 Mod to very high	14–29 Non	0.4–12.9 Very mobile	Mod–High	Low	Soil microbes
Dicamba	39	6,500	4.8 Very high	31 Moderate	2.4–32.5 Mobile to very mobile	High	Low	Soil microbes
Glyphosate	21	12,000	0–6.1 Ext low to very high	5.4 Non	2,000–24,000 Nonmobile to slightly mobile	Low	Low	Soil microbes
Imazamox (new—Alt. 2)	365	4,410	4.1 High	81 Moderate	67 Mobile	Low	Unknown	Soil microbes
Imazapic	30	36,000	0.1–8.2 Ext low to very high	113 Persistent	112 Mobile	Low	Unknown	Soil microbes
Imazapyr (new—Alt. 2)	20	11,000	5.2 Very high	210 Persistent	53 Mobile	High	Low	UV light Soil microbes
Metsulfuron methyl	1,213	2,700	2.6–8.1 Mod to very high	120 Persistent	35 Mobile	High	Short Term	Soil microbes Water
Picloram	2.6–15	200,000	2.9–6.9 Mod to very high	18–513 Non to persistent	2.2–92.9 Mod to very mobile	Mod–High	High	UV light Soil microbes
Rimsulfuron (new—Alt. 2)	4	135-7,300	2.9-3.7 High	2.3 Non	19-74 Mobile	Unknown	Unknown	UV light Soil microbes
Sulfometuron methyl	113	300	4.2 Very high	10–100 Non to persistent	78 Mod	Mod–High	Indirect>Direct	UV light Soil microbes
Triclopyr TEA (triethylamine salt)	426	440	2.6–4.5 Mod to very high	8–28.4 Non	25–134 mobile	Mod–High	Short Term	Soil microbes

Source: Data from USDA Forest Service herbicide risk assessments (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006, 2011a, 2011c, 2011d).

[a] Pesticide values are categorized as one of the following: insoluble ≤0.1 ppm, moderately soluble = 100 to 1,000 ppm, highly soluble ≥10,000 ppm. As pesticide water solubility increases, greater potential for degraded water quality through runoff and leaching exists.

[b] GUS rating = groundwater ubiquity score, after Gustafsen (1989). GUS = log (half-life) x (4 –log Koc). Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential = <1.0, low = 1.0 to 2.0, moderate = 2.0 to 3.0, high = 3.0 to 4.0, or very high = >4.0.

[c] Soil half-life values for herbicides are from the Herbicide Handbook (Ahrens 1994). Pesticides that are considered nonpersistent are those with a half-life of less than 30 days; moderately persistent herbicides are those with a half-life of 30 to 100 days; pesticides with a half-life of more than 100 days are considered persistent.

[d] Organic adsorption rating (abbreviated as Koc) is the amount of herbicide that adsorbs to a given amount of organic carbon in the soil. <15 = Very mobile, 15–75 = Mobile, 75–500 = Moderately mobile, 500–4,000 = Slightly mobile, >4,000 = Nonmobile (PSD 2005).

The potential for herbicides to enter water through ground-based spot and broadcast treatment operations by any of the above mechanisms is low. The following discussion applies to the ground-based spot and broadcast herbicide applications proposed in the action alternatives but does not apply to aerial or aquatic application methods as these will be discussed components of the proposed action in Alternative 2.

Direct Application

Direct application of herbicide to water using ground-based spot and broadcast treatment under these alternatives is very unlikely to occur during direct herbicide application. Most invasive plant treatments would occur a considerable distance from water. For focused spot treatments within riparian areas label directions would be followed to avoid direct contamination. Some herbicides labeled for aquatic use, such as aquatic 2,4-D and aquatic glyphosate, could be applied up to the ordinary high-water mark using hand selective methods (wicking, wiping, etc on individual plants) that would follow label directions. Label requirements would be followed, and applications would only be performed by or under the direct supervision of licensed Idaho professional herbicide applicators, providing a high level of assurance that herbicides would be applied correctly.

Drift

Ground Applications: Rates of contamination by wind drift are largely dependent on droplet size, elevation of the spray nozzle, wind speed, and weather conditions (heat and humidity) that can cause the water droplets to evaporate, leaving the chemicals suspended in the air (Rashin and Graber 1993). During periods when there is virtually no wind, little vertical air mixing occurs, and drift can travel long distances. The complete absence of winds can cause herbicide particles to remain suspended in air for hours. But this circumstance is not likely to routinely occur in mountainous regions, due to daily convective cycles that heat the air and generate winds during the day. Convective winds occur daily, except under heavy cloud cover; consequently, periods without any wind are rare during the weed spraying season, but they may occur occasionally on cloudy days.

Unfavorable weather conditions that can cause high wind drift rates are likely to be encountered occasionally during periods with low relative humidity and high temperatures, which are common from July through September. During hot and dry conditions, herbicides can quickly volatize when the carrier evaporates. Even under the most extreme heat and low humidity, volatilization is unlikely to be a significant cause of wind drift, since there is little opportunity for the spray to evaporate because it will be applied by hand with the nozzle close to the target. The proposed action does not include specifications for controlling droplet size during hot and dry conditions, but droplet size is not likely to be a significant factor affecting wind drift when herbicides are applied by hand and single nozzle. If droplets are small enough to become volatilized, they are likely to become suspended and dispersed as they travel. If a small volume of an herbicide is dispersed over a wide area, the likelihood of settling directly into water is low since water comprises only a small percentage of the surface area.

Occasional incidents may occur when herbicides are applied near streams. Spray streams typically include a range of droplet sizes, and a fraction of the droplets are small enough to be blown off-target and into the water. The majority of the material in a spray stream delivered by hand with a marker dye typically hits the target, leaving only a fraction of the chemicals subject to drift.

Water contamination from wind drift will be further reduced by: (1) ensuring a certified herbicide applicator oversees all spray projects; (2) restricting herbicide application near water to hand-spraying with a single nozzle; (3) following herbicide wind speed restrictions on product label; (4) applicators obtaining a weather forecast prior to initiating spraying to ensure no precipitation or wind events could occur during or immediately after (at least 24 hours) spraying that could allow drift into surface waters; and (5) applicators using a marker dye to provide the operator the ability to accurately see the locations where herbicides are applied.

Drift of herbicide into water bodies during ground-based spot and broadcast herbicide application is also very unlikely to occur under the proposed action. These treatments would have very low potential for drift because herbicide would be applied directly to plants near ground level. Water contamination will further be minimized from wind drift will be reduced by design criteria outlined in the Proposed Action Alternative description above such as: (1) ensuring a certified herbicide applicator oversees all spray projects; (2) only focused spot spraying and hand selective applications would be permitted closer to water: (3) Specific label directions, recommendations, and guidelines would be followed to reduce drift potential (i.e., nozzle size and pressure, additives, wind speed).

Mobilization in Ephemeral Streams and Channels

The potential for mobilization of herbicide in ephemeral streams (those channels that flow only in response to rainfall events) and channels during subsequent runoff events would be minimal under the action alternatives. Ground-based spot applications could be applied in these areas but would target specific plants. Ground-based broadcast applications would not occur within specified buffer zones near perennial and intermittent streams or along roadside ditches with standing or flowing water. Broadcast application could be applied to dry ephemeral channels or roadside ditches that have no standing or flowing water. Ephemeral channels have infrequent flow. Herbicide uptake by plants, as well as ultraviolet and microbial breakdown of herbicides applied, would in many cases limit the amount of herbicide that could be mobilized by the first runoff event following application, depending on the persistence and mobility of the herbicide. An herbicide such as picloram would have the highest potential for mobilization in ephemeral stream channels because of its high solubility and persistence. The most likely scenario in which herbicide could be mobilized in ephemeral stream channels would occur if a runoff-producing rainstorm occurred immediately after application. Design criteria requiring weather forecasting to ensure no precipitation events is occurring or is imminent (within 24 hours of immediately following application) would minimize this risk.

Overland Flow

Overland flow is the most likely mechanism for herbicides to reach surface water under the action alternatives. Overland flow occurs when the rate of precipitation or snowmelt exceeds the rate of infiltration. Within the project area, this occurs occasionally during spring runoff and high-intensity summer thunderstorms. Ground-based spot applications are designed to target specific plants, with limited application directly to the ground. Ground-based broadcast applications would result in some application of herbicide directly to the ground, but the extent of coverage would be limited. Design criteria, BMPs, and label requirements would help ensure maximum efficiency of herbicide applications. Generally, small infestations would be treated and the percentage of any watershed that is treated would be very small.

Herbicides such as clopyralid and picloram, which have high water solubilities and low sorption coefficients, have the greatest potential for being mobilized by overland flow (Table 3-17), while herbicides, such as glyphosate, with high sorption coefficients are unlikely to be mobilized by overland flow. Mobilization by overland flow is also dependent on the occurrence of rainfall, which varies spatially and temporally. Rates of herbicide uptake by plants, breakdown by soil microbes or ultraviolet light, and bonding with soil particles vary by herbicide. In most cases, the levels of remaining herbicide would be very small by the time the first runoff occurs after treatment. Design criteria specifying that no herbicide application would occur if rain is forecast immediately after treatment decreases the potential for herbicide mobilization from runoff. However, herbicides with long persistence in soil, such as picloram, have the potential to be mobilized by overland flow occurring weeks or even months after application. It is also important to note that herbicide concentrations in runoff would be diluted in most situations because of the limited amount of herbicide that would be applied to the ground, as compared to the area contributing to runoff.

Research suggests that ground-based herbicide applications following label requirements are not likely to impair surface waters. A study conducted on the Salmon-Challis National Forest (Rose 2002) concluded that herbicide applications similar to those proposed under this alternative did not impact surface water quality. After application of 1 pound per acre of picloram on study plots adjacent to streams in Texas grasslands, Haas et al. (1971) measured concentrations of picloram of 0.029 mg/L after the first rainfall event. This is substantially less than the 0.5 mg/L maximum contaminant level set by the EPA for drinking water (see National Drinking Water Regulations section above). In this study, picloram was undetectable in surface waters after subsequent rainfall events. In a study of the environmental fate of picloram used for roadside invasive plant control in Montana, Watson et al. (1989) detected no concentrations of picloram in adjacent streams and suggested that after application to a small portion of the watershed (1%), increased streamflow volume following storms would dilute any picloram mobilized to streams to low levels.

Because of the variety of processes influencing overland flow discussed above, it is not possible to disclose the effects of every possible treatment within the 2.9-million-acre project area. Delivery of herbicides to surface water via overland flow is dependent on a number of chemical and environmental factors. The effects of these factors on the delivery of herbicides to surface water are discussed below.

Rate of herbicide application and area treated: Following label recommendations would minimize the potential for mobilization of abundant herbicide during runoff.

Runoff characteristics: The timing and magnitude of runoff may be the largest factor influencing delivery of herbicides to surface water via overland flow (McBroom et al. 2013). Because some herbicides degrade quickly, very little may be left by the time the first rainstorm occurs. Within the project area, rainstorms can be rare during mid-summer but frequent during late summer.

Soil infiltration capacity: Soil properties influence how runoff is generated. Soils with low infiltration capacity will have the highest potential for runoff and therefore the highest potential to result in the transport of herbicides to water bodies.

Herbicide properties: Herbicide properties including soil half-life, sorption coefficient, solubility, and the amount of time until an herbicide is “weatherfast” on leaves and soil

influence the amount of herbicide that would be mobilized by overland (Table 3-17). Herbicides such as aminopyralid, imazamox, chlorsulfuron, clopyralid, dicamba, metsulfuron methyl, and picloram with low sorption coefficients and high solubility are most susceptible to transport by overland flow. Herbicide degradation occurs through microbial activity, water, and/or ultraviolet light, depending on the chemical. Herbicides such as 2,4-D and glyphosate degrade relatively quickly by microbial activity and are not likely to be mobilized during runoff unless a storm occurs immediately following application.

Amount of plant uptake of herbicide: By nature, aerial herbicide application is not target-specific. In areas where invasive plants create dense ground cover (e.g., moist riparian areas), herbicide uptake is likely to be higher than in areas with sparse ground cover (e.g., dry slope with spotted knapweed). Where uptake by plants is low, more herbicide would be residing on the soil surface and could potentially be mobilized by overland flow.

Proximity of application to surface water: A longer flow path to a water body would result in greater potential for herbicide degradation, adsorption to soil particles and organic matter, and dilution prior to entering the water body.

Streamflow characteristics: Low streamflow would result in higher concentrations of herbicide, whereas high streamflow would cause rapid dilution. A high ratio of treated area to contributing watershed drainage area would result in higher risk of water quality impacts. For example, a 100-acre treatment in a small upland watershed draining 2 square miles would have a much higher risk to water quality than the same treatment along larger river, which drains 5,500 square miles.

Leaching

Leaching of herbicides through the soil could potentially result in contamination of surface water or groundwater. Movement of a pesticide can be described in terms of the relationship between the sorption coefficient and the half-life (Vogue et al. 1994). Herbicides with a low sorption coefficient and a long half-life, such as chlorsulfuron, dicamba, metsulfuron methyl, and picloram (Table 3-17) have the greatest ability to leach through soils and reach groundwater or surface water.

Once in the soil, the persistence of many herbicides can be relatively short, as they can break down quickly (as discussed in the Herbicide Properties section above). Herbicide persistence in soil depends on a number of factors including microbial decomposition, hydrolysis, photodegradation, and volatilization. A variety of organisms can contribute to decomposition, including bacteria, actinomycetes, and fungi. Herbicide decomposition occurs most quickly in conditions that favor these organisms, such as warm, moist, and nutrient-rich soils (National Council for Air and Stream Improvement Inc. 2009). In the proposed project area, herbicide decomposition likely varies with soil composition, landtype, aspect, and elevation. Arid slopes with thin soils would favor photodegradation over microbial decomposition. Riparian valley bottom soils would be more favorable to microbial decomposition.

Of the herbicides considered under the action alternatives, picloram has the highest potential for leaching into soil and contamination of groundwater and surface water due to its high leachability, long persistence, and high solubility. Picloram is broken down by ultraviolet light, and degradation by microorganisms is slow. Watson et al. (1989) conducted studies of picloram

soil mobility and persistence at two sites in western Montana after ground-based herbicide invasive plant treatments. At the first site, they measured rapid photo decay related to high sunlight and low precipitation, and no herbicide was detected below a depth of 20 inches. At the second site, with 4 times the concentration of herbicide (1 pound/acre) applied adjacent to a stream on sandier soils with abundant shade, they measured half the rate of photo decay, and the herbicide was detected to a depth of 40 inches. The second site represents a scenario of application of picloram over a shallow water table. In both of these cases, the herbicide was not detected in groundwater or surface water, indicating that minimal leaching occurred.

Other herbicides with low sorption coefficients and moderate leachability, such as 2,4-D, have a much lower potential for leaching through soils. Radosevich and Winterlin (1977) studied the persistence of 2,4-D and 2,4,5-T in soil after ground-based application in chaparral vegetation in California. They found that although 50 percent of the recovered herbicide was found on the soil surface litter, only 0.1 to 0.2 percent of the recovered herbicide was found in the soil, and no herbicide was found below 5 centimeters soil depth. In this study, herbicide residues decreased rapidly within 30 days following treatment.

Under the action alternatives, herbicide applications would be unlikely to enter either surface water or groundwater by way of leaching through soils. Spot treatments would result in minimal contact of herbicide with soils, while some contact would occur through ground-based broadcast applications. Research suggests that with the exception of herbicides applied over shallow water tables, leaching is an unlikely mechanism for herbicides to enter water due to limited chemical mobility and relatively short persistence (Norris et al. 1983). Under the action alternatives, ground-based application of herbicides over shallow aquifers would be minimal. Shallow aquifers are limited within the project area to narrow bands below riparian areas along primarily narrow valley floors, and no ground-based broadcast application would occur within 100 feet of streams or ponded water bodies.

Water Contamination by Spills and Leakage

Most of the herbicides in the proposed action will be applied in a liquid solution, which requires transferring liquids from one container to another and occasional mixing of different chemicals in the field. Liquids are prone to spills through leaky spray equipment or containers and when mixing or transferring chemicals from one container to another. In general, minor amounts of herbicides leakage are likely to occur throughout the spray season from dripping while using spray equipment, but this type of leakage would occur at concentrations far below the target application rate, and it would not cause any meaningful increase in water contamination over the amount expected based on the target rate.

Chemical contamination of water involving larger amounts of herbicides from spilled or leaking containers is likely to be an uncommon event because a significant leak or spill must occur, and the spilled chemicals must reach the water. The likelihood of a significant spill is difficult to predict, but is constrained by design criteria that limit the amounts of chemicals that are transported at any given time (i.e. herbicides will be transported for daily use will be limited by container size and amount of what is anticipated to be used on any given day). Spilled chemicals reaching water is restricted by the amount of storage and mixing of chemicals to locations where a spill would be too distant from water to reach it before clean up would occur (i.e. no herbicide storage, mixing or post-application cleaning would be authorized within 100 feet of any live waters or over shallow groundwater areas; mixing and loading operations must take place in an

area where an accidental spill would not contaminate a stream or body of water before it could be contained). Consequently, spills and leakage from handling are not likely to be a significant source of routine water contamination, but a significant spill from a transporting accident could occur.

There is no practical away to transport chemicals in the field without crossing bridges or using roads or trails in close proximity to streams; consequently, transportation-related spills cannot be prevented. Although the likelihood of accidents is unknown, the risks from any spill that occurs is limited by several factors: all chemicals must be transported in US Department of Transportation (DOT)-approved containers, which are likely to withstand minor accidents without spillage; the amount of chemicals handled at any given time are limited by provisions of the proposed action; the applicator being familiar with and carrying an Herbicide Emergency Spill Plan; having a spill cleanup kit available whenever herbicides are transported; and mixing and chemical transfers must take place in a location where the chemicals can be contained before they can directly enter the water. As a result of these factors, direct water contamination from a spill is unlikely to occur from mixing or transferring chemicals.

3.4.3.1.2.4 Other Factors Related to Potential Herbicide Delivery to Water Sources

Herbicide Modeling

USDA Forest Service risk assessments for herbicides considered under the action alternatives (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006, 2011a, 2011c, 2011d) provide results of GLEAMS and Gleams-Driver modeling for herbicide application adjacent to streams (Table 3-18 and Table 3-19) and ponds (Table 3-20 and Table 3-21). In each risk assessment, concentrations of herbicides in water are modeled following application of herbicide in a square treatment area draining directly into a stream and a square treatment area draining directly into a pond. Table 3-18, Table 3-19, Table 3-20, and Table 3-21 show the GLEAMS or Gleams-Driver input parameters and the results, expressed as maximum concentration of herbicide in water.The risk assessments modeled herbicide delivery for a variety of soil types and a variety of climates, representing conditions nationwide. Clay, loam, and sandy soils all exist within the project area. Results for the range of climates found within the project area are summarized, representing a generic arid lowland site (average annual precipitation of 5 inches for Gleams-Driver modeling and 10 inches for GLEAMS modeling) and a generic cooler, moister, upland site (average annual precipitation of 33 inches for Gleams-Driver modeling and 25 inches for GLEAMS modeling).

Results of GLEAMS and Gleams-Driver modeling suggest that no herbicides would be delivered to streams or ponds in arid locations (average annual precipitation of 5 to 10 inches). In locations with higher annual precipitation (25 to 33 inches), herbicides could potentially be delivered to surface waters. Aside from precipitation, soil type is the largest factor influencing herbicide delivery. Runoff is the primary delivery mechanism in clay soils, while percolation is the primary mechanism in sandy soils. GLEAMS modeling suggests that in general, runoff is associated with higher concentration of herbicide in streams and ponds than percolation.

Table 3-18. Summary of groundwater loading effects of agricultural management systems (GLEAMS) and Gleams-Driver modeling results from USDA Forest Service herbicide risk assessments for herbicide application adjacent to a stream.

HERBICIDE	MAXIMUM CONCENTRATIONS OF HERBICIDE IN A STREAM (µg/L per lb/acre applied)					
	Average Annual Precipitation: 10 inches			Average Annual Precipitation: 25 inches		
	Clay	Loam	Sand	Clay	Loam	Sand
2,4-D amine[a]	0	0	0	236	0	0.00000997
Chlorsulfuron[b]	0	0	0	42.45427	0	1.56313
Clopyralid[b]	0	0	0	8.50807	0.42790	2.65217
Dicamba[b]	0	0	0	0.12122	0.00004	0.00820
Imazapic[b]	0	0	0	0.15831	0	0.02283
Metsulfuron methyl[b]	0	0	0	0.46168	0.00992	0.08221
Sulfometuron methyl[b]	0	0	0	0.27655	0	0.02907

[a] For this herbicide, the GLEAMS model assumes herbicide treatment of a 10-hectare field with a 60-inch root zone, draining directly into a 2-meter-wide stream that flows at a rate of 710,000 L/day and with a velocity of 0.08 m/sec. Additional input parameters provided in SERA (2006).

[b] For this herbicide, the GLEAMS model assumes herbicide treatment of a 10-acre-square field with a 60-inch root zone and four soil layers that drains directly into a 2-meter-wide, 1-foot-deep stream that flows at a rate of 4,420,000 L/day and with a velocity of 0.08 m/sec. Additional input parameters provided in SERA (2004a, 2004b, 2004c, 2004d, 2004e, 2004f).

Table 3-19. Gleams-Driver modeled maximum peak concentrations of herbicide in a stream.

HERBICIDE	MAXIMUM PEAK CONCENTRATIONS OF HERBICIDE IN A STREAM (median value of 100 simulations; µg/L per lb/acre applied)					
	Dry/Temperate Location[a]			Average Rainfall/Cool Location[b]		
	Clay	Loam	Sand	Clay	Loam	Sand
Picloram[c]	0.7	0	0	2.49	1	19
Glyphosate[d]	0.00016	0	0	6.3	0.08	0
Triclopyr TEA[c,e]	0.004	0	0	0.4	0	0

[a] Standard Gleams-Driver site based on climate of Bishop, CA (average annual rainfall 5.34 inches, average annual temperature 56.02 degrees F).

[b] Standard Gleams-Driver site based on climate of Sault Ste. Marie, MI (average annual rainfall 32.94 inches, average annual temperature 40.07 degrees F).

[c] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 36-inch root zone that drains directly into a 2-meter-wide stream that flows at a rate of 710,000 L/day and with a velocity of 6,900 m/day. Additional input parameters provided in SERA (2011c, 2011d).

[d] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 60-inch root zone that drains directly into a 2-meter-wide stream that flows at a rate of 710,000 L/day and with a velocity of 6,900 m/day. Additional input parameters provided in SERA (2011a).

[e] Following application of Triclopyr TEA.

Table 3-20. Summary of groundwater loading effects of agricultural management systems (GLEAMS) and Gleams-Driver modeling results from USDA Forest Service herbicide risk assessments for herbicide application adjacent to a pond.

HERBICIDE	MAXIMUM CONCENTRATIONS OF HERBICIDE IN A POND (µg/L per lb/acre applied)					
	Average Annual Precipitation: 10 inches			Average Annual Precipitation: 25 inches		
	Clay	Loam	Sand	Clay	Loam	Sand
2,4-D amine[a]	0	0	0	17.8	0	0.00000237
Chlorsulfuron[b]	0	0	0	36.77989	0	4.33955
Clopyralid[b]	0	0	0	4.94710	1.15098	6.41084
Dicamba[b]	0	0	0	0.06974	0.00002	0.00964
Imazapic[b]	0	0	0	0.14009	0	0.00970
Metsulfuron methyl[b]	0	0	0	0.40388	0.03358	0.46725
Sulfometuron methyl[b]	0	0	0	0.21133	0	0.04038

[a] For this herbicide, the GLEAMS model assumes herbicide treatment of a 10-hectare field with a 60-inch root zone, draining directly into a 1-hectare pond with a depth of 2 meters and a 0.01 sediment fraction. Additional input parameters provided in SERA (2006).

[b] For this herbicide, the GLEAMS model assumes herbicide treatment of a 10-acre-square field with a 60-inch root zone and four soil layers that drains directly into a 1-acre pond with a depth of 2 meters and a 0.01 sediment fraction. Additional input parameters provided in SERA (2004a, 2004b, 2004c, 2004d, 2004e, 2004f).

Table 3-21. Gleams-Driver modeled maximum peak concentrations of herbicide in a pond.

HERBICIDE	MAXIMUM PEAK CONCENTRATIONS OF HERBICIDE IN A POND (median value of 100 simulations; µg/L per lb/acre applied)					
	Dry/Temperate Location[a]			Average Rainfall/Cool Location[b]		
	Clay	Loam	Sand	Clay	Loam	Sand
Picloram[c]	0.24	0	0	0.9	0.5	13.5
Glyphosate[d]	0.00006	0	0	3.5	0.03	0
Triclopyr TEA[c,e]	0.0013	0	0	0.13	0	0

[a] Standard Gleams-Driver site based on climate of Bishop, CA (average annual rainfall 5.34 inches, average annual temperature 56.02 degrees F).

[b] Standard Gleams-Driver site based on climate of Sault Ste. Marie, MI (average annual rainfall 32.94 inches, average annual temperature 40.07 degrees F).

[c] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 36-inch root zone that drains directly into a 1-acre pond with a depth of 2 meters and a sediment depth of 2 cm. Additional input parameters are provided in SERA (2011c, 2011d).

[d] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 60-inch root zone that drains directly into a 1-acre pond with a depth of 2 meters and a sediment depth of 2 cm. Additional input parameters are provided in SERA (2011a).

[e] Following application of Triclopyr TEA.

The results presented in Table 3-18, Table 3-19, Table 3-20, and Table 3-21 are generic, applied herbicide concentrations (pound/acre). These results can be applied to scenarios within the project area, although with some limitations. For example, under the Current Management Alternative, application of 0.75 pounds per acre of picloram across a 10-acre field adjacent to a stream with similar characteristics as the input parameters in the GLEAMS modeling would likely result in no concentrations of herbicides in water when applied on loamy or sandy soils in arid regions. This same herbicide application scenario applied in a wetter climate within the project area could potentially result in concentrations in an adjacent stream of 0.75 µg/L for

application on loamy soils and 14.25 µg/L for application on sandy soils. These concentrations comprise very small fractions of the 0.5 mg/L drinking water standard established by the EPA for picloram.

Also, because treatment areas under this alternative would likely be small and isolated (i.e., it is unlikely that an entire 10-acre plot would be treated using ground-based methods), any impacts would be less severe than those shown in the modeling.

This modeling also assumes that the precipitation is evenly distributed in a uniform amount each day for the first year of simulations (SERA 2007a). It is possible that this modeling underestimates herbicide delivery from storms, as herbicide delivery from high-intensity summer thunderstorms would possibly be better modeled using a higher average annual precipitation value.

Adjuvants

Adjuvants are solution additives mixed with herbicide solution to improve performance of a spray mixture. A list of adjuvants typically used may be found in Appendix J. Adjuvants can increase the effectiveness of an herbicide, sometimes by as much as 5 or 10 times, as well as the selectivity of an herbicide (Tu et al. 2001). These factors could result in less herbicide being required for a specific application, potentially decreasing the effects that an herbicide might have on water quality. Adjuvants can also decrease the potential for herbicide to wash off plant leaves after application, reducing the amount of herbicide that could potentially leach into soil or be mobilized by overland flow.

The potential exists, however, for adjuvants to mobilize and enter water bodies. Risk assessments have been completed for the typical adjuvants that may be used in this project (see Appendix J). The toxicities of herbicides when combined with adjuvants are not generally known, and the environmental fate of many adjuvants is not always known or disclosed; however, the adjuvants proposed in this project are not listed as toxic compounds when used as intended and when label direction is followed. Label direction would always be followed, providing additional assurance that the proper adjuvant would be combined with the correct herbicide at appropriate mixing rates.

Accidental Spills of Herbicide

Under all action alternatives, the potential for normal herbicide application to adversely affect water quality is minimal. With typically small areas being treated, the amount of herbicide involved in a spill would likely be low. Accidental spills of herbicide occurring at staging areas or treatment areas have the potential to impact water quality. These concerns are addressed through numerous design criteria, BMPs, and label direction requiring spill prevention plans, cleanup kits, equipment inspections, secure transport of only the amount of herbicide needed, stipulations to mix and load herbicides at least 100 feet from water, and the requirement that herbicides are applied by or under the direct supervision of a licensed applicator.

Public Sources of Drinking Water

Herbicide control could potentially occur within the source water protection areas (SWPAs) established by the Idaho Department of Environmental Quality (see Water Uses section above). Any treatments in these areas would likely be limited to ground-based spot treatments with minimal herbicide output. Furthermore, because most of these areas are undeveloped and will

likely remain so, vectors such as roads and trails that could accelerate the spread of invasive plant infestations are not present, and large-scale invasive plant infestations that would require extensive herbicide control are less likely to occur than in more developed areas.

Additional design criteria, BMPs, and label direction limit the application of herbicides near water and in riparian areas. Based on the analysis above and considering that only ground-based herbicide application would occur under these alternatives, the effects of herbicide application on water quality would be minimal and would not likely result in exceedances of the EPA water quality standards for drinking water.

3.4.3.1.2.5 Indirect Effects

Herbicide treatments could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover, particularly in monoculture stands of invasive plants or if non-target species are widely affected by herbicide treatments. This would be most likely to occur with broad-spectrum herbicides during ground-based or aerial broadcast applications. However, design criteria, BMPs, and appropriate selection of herbicide would limit these effects by ensuring that methods minimize to the extent possible the application of herbicide to non-target species. These potential effects are likely to occur in the short term (less than 1 year), prior to reestablishment of native vegetation.

Any short term increases in sediment delivery caused by vegetation mortality after herbicide treatment would likely be overshadowed by the long term indirect beneficial effects occurring as a result of reestablishment of native vegetation. The proposed biological, herbicide, manual/mechanical, and rehabilitation/restoration methods would result in increased groundcover and improved root structure that would stabilize soils and protect soils from erosive forces such as wind, rain drop impact, and runoff. This would result in decreased sediment delivery to streams in the long term and improve water quality and stream health.

Although the indirect effects of existing invasive plant infestations may currently include increased sediment loads, increased turbidities, channel aggradation, and decreased channel stability, these effects would gradually diminish over time under action alternatives as invasive plant infestations are controlled.

3.4.3.1.3 Cumulative Effects

Cumulative effects are defined as “the incremental impacts of the proposed action and alternatives when added to effects of other actions both on NFS lands and other adjacent federal, state, or private lands” (40 CFR 1508.7). This analysis considers the effects of other ongoing and foreseeable future activities but does not consider past activities, as CEQ regulations do not require agencies to comprehensively list and analyze all individual past actions.

Impacts of past activities are typically captured in the current state of the project area, as described under this report’s Affected Environment section, and do not generally provide useful information for the prediction of cumulative effects of the Proposed Action and other alternatives. A list of ongoing and reasonably foreseeable activities within the project area is presented in Appendix H.

Under Alternative 1, the current management strategy would continue with the following array of standard invasive plant management practices currently used within the CTNF and CNG:

- Biological control through the use of predators, parasites, and pathogens, target grazing.
- Herbicide control using ground-based spot and broadcast application methods.
- Mechanical and manual methods such as hand-pulling, mowing, cutting, or torching.

Under the umbrella of the Clean Water Act, states are responsible for identifying waterbodies that do not meet designated beneficial uses and identify pollutants that are causing or contributing to water quality degradation. To date, there are not any streams within the CTNG and CNG in Idaho, Wyoming, or Utah that have herbicides identified as a degrading agent. Therefore, current water quality is not being substantially affected throughout the Forest by past or present applications of herbicides.

Counties may continue to undertake invasive-plant control on their road right-of-way within NFS lands. Active invasive-plant treatments, including ground-based herbicide application, mechanical control, and biological control releases, would continue to occur on private, county, state, and adjacent land managed by the BLM through those land managers and through actions conducted by CWMA participants.

This alternative would be expected to result in some localized eradication, control, and containment of noxious weeds within NFS and non-NFS lands. However, weed infestations on NFS lands would be expected to continue to increase, which would impede the efficacy of ongoing CWMA efforts to eradicate, control, or contain new weeds that have spread to adjacent lands from infestations within the CTNF and CNG. The resultant continued spread of noxious weeds could potentially adversely affect aquatic and riparian habitats both on and off NFS lands through increased erosion and sediment delivery to drainages. The potential for adverse cumulative effects on aquatic resources would be greatest on adjacent non-NFS lands which may not be treated.

Cooperative Weed Management Area herbicide applications to private, state, county, or BLM-administered lands adjacent to CTNF and CNG non-wilderness areas would continue to occur under Alternative 1, as would chemical applications on private lands by landowners within the project area. Potential cumulative effects to NFS lands would be limited primarily to areas downstream from private inholdings where the potential for adverse effects to aquatic and riparian resources would exist if a spill- or wind-drift-related impact occurred close to NFS boundaries. The Forest has no direct jurisdiction over weed control methods by the counties or private landowners. However, by law, their weed control activities are required to follow EPA label requirements. Assuming county and private landowner weed control activities follow requirements, no measurable direct/indirect cumulative effects should occur on water quality.

However, if county and private landowners violate EPA label requirements or have herbicide spills in or near steam, lakes, or wetlands then adverse impacts to the aquatic systems could occur.

The direct and indirect effects of these treatments would include localized areas of ground disturbance and a low risk of herbicides entering bodies of water. Any adverse effects that would occur would likely be short term and would be followed by long-term beneficial effects related to the control of invasive plant infestations and reestablishment of native vegetation in those areas.

The Current Management Alternative would result in minimal cumulative effects related to the direct and indirect effects of treating invasive plants using biological, mechanical, herbicide, and rehabilitation/restoration control methods.

3.4.3.1.3.1 Biological Control Methods

Biological control methods would have no cumulative effects on water and soil condition because no ground disturbance would occur.

3.4.3.1.3.2 Mechanical and Rehabilitation/Restoration Control Methods

Mechanical and rehabilitation/restoration control methods would have minimal cumulative effects in addition to other activities occurring in the area because of the highly localized nature of the disturbance and the very small percentage of the project area that would be treated. This short-term disturbance would not exacerbate the effects of other activities in the project area and would ultimately provide a long-term benefit.

3.4.3.1.3.3 Herbicide Control

Ground-based herbicide control would have minimal cumulative effects on soil condition because of the highly localized nature of the disturbance and the very small percentage of the project area that would be treated annually. Other potential sources of soil condition impairment within the analysis area include county herbicide application and application of herbicide on private lands. Herbicides are applied by CWMAs by county, as well as by the BLM. This report's numbers do not include herbicide applied by private landowners. Because these treatments have little overlap with the treatments proposed in this project, label application rates per acre would not be exceeded, and the cumulative effects on soil condition would be minimal. Although herbicide use rates on private lands are unknown, the application of herbicide on NFS lands is likely to be considerably less than that on private agricultural lands because of differing treatment objectives.

3.4.3.1.3.4 Invasive Plant Infestations

Because methods under the Current Management Alternative are not sufficient to cause an overall decline in invasive plant infestations on a watershed scale, the indirect effects of this alternative include gradually increasing sediment yield and sediment loads as a result of the gradual spread of invasive plants and decreased ground cover. Cumulative effects related to these indirect effects combined with other ongoing and foreseeable future activities could occur in the long term, but to a lesser degree because of the expected slower rate of spread.

3.4.3.2 Alternative 2—Proposed Action

Alternative 2, the Proposed Action, includes a variety of methods to prevent the establishment of new invasive plant species, prevent further spread of existing invasive plant infestations, and maintain native plant communities. The Proposed Action would implement an adaptive, IWM strategy to eradicate or control existing or newly discovered invasive plants over the next 10 to 15 years, as budgets allow. Herbicide control would occur through ground-based, aerial, and aquatic application methods. Two herbicides would be dropped from use (diflufenzopyr and Tebuthiuron) and three new herbicides would be added for use (imazapyr, imazamox, and Rimsulfuron), as compared to Alternative 1. Under Alternative 2 the number of herbicides to use in riparian areas or AIZs would increase from three in Alternative 1 (Table 2-2) to 11 in

Alternative 2 (Table 2-3) that would increase the flexibility treating invasive non-native plants in the AIZs.

Under the Proposed Action, existing invasive plant infestations are expected to gradually decline as existing invasive plant infestations are treated and the spread of new infestations into susceptible areas is prevented through an EDRR approach. The Proposed Action would utilize a variety of methods to halt the spread of invasive plants and reintroduce native vegetation to existing infested areas. It is expected that vegetative cover would improve in the long term over existing conditions, resulting in beneficial effects to water resources.

Treatment of invasive plants under the Proposed Action would have minimal direct adverse effects on soil and water resources. Design criteria, BMPs, and label direction would minimize the potential for herbicides to adversely affect water resources. Potential effects are discussed in the following sections.

As opposed to the Current Management Alternative, the Proposed Action would be able to effectively and efficiently treat a large number of acres using aerial herbicide control. This treatment method would avoid the ground-disturbing effects that could occur if ground-based mechanical and herbicide treatments were used to treat these same acres. However, aerial application of herbicide also increases the potential for nontarget application of herbicide and the potential for herbicide to be mobilized into surface water or groundwater. These potential effects are discussed in the following sections.

Aquatic herbicide control is also a component of the Proposed Action that is not proposed in the Current Management Alternative. Potential effects of aquatic herbicide control on water quality include short-term direct adverse effects, short-term indirect adverse effects, and long-term beneficial effects. These effects are discussed in the following sections.

Indirect effects of the Proposed Action would include potential short-term adverse effects and long-term beneficial effects to soil and water resources. A reduction in the size of existing invasive plant infestations would, over time, lead to improved vegetative cover, decreased sediment yields, improved soil condition, and improved riparian function. These effects were discussed in the Current Management Alternative and apply to the effects discussed in the following sections.

3.4.3.2.1 Effect on Riparian Health and Function

3.4.3.2.1.1 Direct Effects

The Proposed Action would have minimal direct adverse effects on riparian function in the short term. Biological control methods would have no adverse effect on riparian function because treatments would not affect nontarget vegetation. Manual/mechanical methods would have minimal effect on nontarget vegetation as a result of minor disturbance to existing riparian vegetation during treatments. Rehabilitation/restoration treatments would have minimal effect on existing riparian vegetation because these methods would only be used where invasive plant infestations have already replaced most or all native riparian vegetation. All of these treatments would have beneficial effects to riparian function in the long term by eradicating or reducing invasive plant populations and allowing native riparian vegetation to recover. This would also lead to healthier stream health and function as identified in the indirect effects section below.

Herbicide control methods would have a slight potential to cause nontarget mortality of native vegetation within riparian zones. The potential for nontarget application of aerial herbicide in riparian areas is highest where treatment units would be adjacent to riparian areas. In this situation, a small percentage of aerially applied herbicide would likely reach a portion of the riparian area through drift. Design criteria, BMPs, and label direction, including stipulations on wind speed, atmospheric conditions, and droplet size, would minimize the amount of drift occurring in riparian areas. The amount of herbicide reaching riparian vegetation would decrease substantially with distance from the treatment area. Bird et al. (1996) showed pesticide deposition at 30 meters and 150 meters downwind of treatment to be 5 and 0.5 percent, respectively, of the rate within the treatment area.

Depending on the herbicide being used, herbicide drift into riparian areas could cause some short-term adverse effects to existing native riparian vegetation. However, because of the distance from the treatment area, this would have minimal or no effects to near-stream riparian vegetation, maintaining riparian function in relation to stream channel function and stability. Any short-term adverse effects to riparian vegetation would be overshadowed by the long-term benefits to riparian function gained by eradicating or reducing invasive plant infestations and reestablishing native vegetation in its place.

3.4.3.2.1.2 Indirect Effects

Because the Proposed Action would over time decrease the extent of invasive plant infestations within riparian areas, indirect effects of the Proposed Action on riparian function would primarily be beneficial improvements to riparian condition as a result of invasive plant eradication and reestablishment of native riparian vegetation in the long term. This would result in maintained or increased bank stability, channel stability, and shade, as well as a riparian structure capable of maintaining large woody debris inputs to stream channels. This would improve overall stream health and function.

3.4.3.2.2 Effects of Herbicides on Surface and Ground Water Quality

Under the Proposed Action, annual treatment acres could increase with herbicide use by treating larger acres with ground and aerial applications. Aquatic applications could also be used to treat an unspecified number of acres using an EDRR approach. Depending on the proportion of these acres that would occur as aerial application versus ground application, as much as twice the maximum herbicide application could occur as compared to the Current Management Alternative and approximately 10 times the annual amount applied over the last 3 years. Three additional herbicides not considered in the Current Management Alternative would also be available for specified uses under the Proposed Action: imazapyr, imazamox and Rimsulfuron.

3.4.3.2.2.1 Direct Effects

The effects of ground application of herbicides and mechanisms of herbicides to enter water are discussed under the Effects Common to All Action Alternatives. The following discussion highlights additional effects that would occur under the Proposed Action as a result of 1) additional application methods (aerial and aquatic), 2) additional herbicides to be used, and 3) additional acres that would be treated.

As in the Current Management Alternative, herbicide applications under the Proposed Action have the potential to affect levels of herbicide in water, depending on a number of factors. However, adherence to design criteria, BMPs, and label direction would minimize the potential

for any adverse impacts to water quality from herbicide application. Biological control, manual/mechanical methods, and rehabilitation/restoration methods would have no effects on concentrations of herbicides in water.

3.4.3.2.2.2 Herbicide Properties

USDA Forest Service risk assessments have been completed by SERA for the herbicides proposed under this alternative (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006, 2007b, 2009a, 2010, 2011a, 2011b, 2011c, 2011d and USDA Forest Service 2006a). Information from these risk assessments for these herbicides regarding herbicide behavior in soil and water is referenced in Table 3-17. Summaries are provided in the Hydrologist Specialist Report (USDA Forest Service 2020c).

3.4.3.2.2.3 Herbicide Pathways to Water

The potential for herbicides to enter water under each of the mechanisms described in Norris et al. (1983) was presented in Effects Common to All Action Alternatives. Additional discussion of these mechanisms under the context of the Proposed Action is presented below.

Direct Application

Ground Applications: Similar to the Current Management Alternative, the potential for direct application of herbicide to water under the Proposed Action would be minimal for ground applications and ground-based spot applications are highly unlikely to result in direct application to water.

Aquatic Applications: Direct application to water would occur by design for aquatic herbicide treatments. Under this method, four herbicides would be available for use. Although label direction dictates the maximum application rates for the volume of water being treated, proposed typical application rates would generally be less than the label maximum. The Idaho Rapid Response Strategy from the Idaho Aquatic Nuisance Species Plan (ID ISCTC 2007) would be followed for all aquatic applications, providing site-specific analysis that takes into consideration the dimensions of the water body, water chemistry, and other factors to minimize the potential effects and provide coordination with state and other agencies. Under these specifications, impairment of water quality as a result of herbicide concentrations would be unlikely to occur. The largest water quality concern likely to occur with aquatic herbicide treatments is the potential effects of oxygen depletion from decaying plant matter following treatment. Following of the EDRR strategy, Aquatic Invasive Plan Control Strategy, and label direction would minimize these effects as well. Determinations regarding the need for ESA consultation, and determining agency responsibilities for conducting it, would be made on a case-by-case basis in collaboration with USDA Forest Service, USFWS, and National Marine Fisheries Service. Because herbicide could be transported and applied over water, the potential exists for a spill directly into water. This unlikely scenario is mitigated by a variety of design criteria and is further discussed in the *Accidental Spills of Herbicide* section below.

Aerial Applications: Aerial spray units and all live water within those proposed units (perennial and intermittent streams, perennial seeps, ponds, springs, and wetlands) would be identified prior to spraying using mapping, local knowledge and best available information. The treatment unit would be mapped before the flight and a Global Positioning System (GPS) system would be used in spray aircraft to ensure that only areas marked for treatment are treated. Locations of waterbodies would be ground verified in each aerial spray unit. Because herbicides are delivered

from aircraft flying at low elevations at very narrow weather parameters, pilots would have good visibility of live water to allow avoiding aquatic habitats. Pilots would be certified pesticide applicators and would be required by law to follow label directions for herbicides applied. They would avoid herbicide applications to waterbodies. Drift monitoring would be conducted to ensure direct herbicide application avoid waterbody contact. See Appendix I for specific drift monitoring procedures. The potential for drift of herbicide to reach water is further discussed in the Drift section below.

Drift

Ground Applications: The potential for drift of herbicide to enter water bodies for ground applications under the Proposed Action would be minimal, the same as under the Current Management Alternative. Design criteria restricting application during windy conditions, BMPs, label requirements for buffers, and the lack of broadcast application within riparian areas would minimize the possibility of drift.

Aquatic Applications: Aquatic applications of herbicide would have no risk of drift occurring because herbicides would be applied directly to the water.

Aerial Applications: The greatest potential for drift to occur under the proposed action is during aerial applications. However, drift from aerial applications is unlikely to enter surface water if the design criteria are followed such as following label directions for wind speed, boom lengths, and height above ground; no aerial herbicide treatments during inversions, below minimum relative humidity, or above maximum temperature, as stated on the label; and requirement to obtain a weather forecast for the area prior to initiating a spraying project to ensure no precipitation or wind events are predicted to occur during or immediately after spraying that could allow runoff or drift into water bodies. The primary factors influencing drift are wind direction, wind speed, presence of inversion, droplet size, and interception by vegetation. Design criteria and label direction would restrict aerial application to conditions that avoid surface water contamination. Monitoring using spray cards near waterbodies would detect the herbicide, allowing applicators to modify practices and prevent any additional impacts. Monitoring procedures (Appendix I) specifies how personnel would monitor weather conditions, handle drift cards, and determine and report any drift detection.

A number of studies have been conducted to monitor the amount of drift that has occurred during aerial applications through drift card monitoring as well as through water quality monitoring. Studies within the Lolo National Forest as discussed in the Current Management section above demonstrates that aerial application of herbicides can safely and effectively treat noxious weeds. Gluns (1989) detected no concentrations of glyphosate in surface water draining a harvest unit in British Columbia treated with an aerial application of 1.78 kg/ha of glyphosate, with 100-meter no-spray buffers on water courses. In a study measuring drift of clopyralid during aerial treatments of starthistle in a California grassland, clopyralid was undetectable in surface water following application of 6 ounces per acre of clopyralid with a 30-meter buffer on stream courses and a slight (5 mph) breeze toward the sampled aquatic sites (DiTomaso et al. 2004). These studies suggest that drift potential would be minimal and that the 30-meter (approximately 100’) no spray distance which would be incorporated into planning and implementation efforts and following design criteria.

The Oregon Department of Forestry studied the potential effects of drift to water quality on 26 stream sample sites adjacent to aerial application of herbicides to forests in western Oregon

(Dent and Robben 2000). The study examined applications of glyphosate, chlorothalonil, 2,4-D ester, triclopyr, clopyralid, hexazinone, and sulfometuron, using prescribed buffers under the forest practice rules (60-foot and 300-foot buffers, depending on stream type). Post-spray results showed no detectable concentrations of herbicides at or above 1 ppb. For the seven samples tested at a minimum detection limit of less than 1 ppb, concentrations of hexazinone and 2,4-D ester in water ranged from 0.1 to 0.9 ppb. This study concluded that the buffers prescribed under the forest practice rules effectively protect water quality during aerial herbicide applications.

Abundant research has been conducted on off-target deposition of pesticides used for aerially applied agricultural applications. Riley and Wiesner (1989) concluded that a 100-meter buffer zone "would ensure at least a 10-fold decrease" when compared to the edge of the treatment area, even when winds exceed the maximum recommended wind speed. Bird et al. (1996) showed pesticide deposition at 30 meters downwind of treatment to be 5 percent of the rate within the treatment area. This value was 0.5 percent at 150 meters downwind.

Bird et al. (1996) suggested that droplet size is the variable with the largest effect on off-target drift, even more so than wind speed. The researchers suggested that the use of a coarse spray (volume median diameter of 500 µm) could result in a 10-fold decrease in off-target drift as compared to a fine spray (volume median diameter of less than 200 µm).

Design criteria for the proposed action requiring the use of larger droplet size to the extent possible such as no application when sustained wind speeds exceed label direction, drift cards, and no application during periods of inversions would minimize the potential for adverse effects to water quality related to drift.

Mobilization in Ephemeral Streams and Channels

Ground Applications: The potential for herbicide to enter water bodies through mobilization in ephemeral channels would be minimal for ground applications under the Proposed Action, the same as under the Current Management Alternative.

Aquatic Applications: Aquatic applications of herbicide would have no risk of mobilization in ephemeral channels because herbicides would not be applied to ephemeral channels.

Aerial Applications: Aerial application could occur on ephemeral or intermittent stream channels that do not have flowing water at the time and do not have defined riparian vegetation. In this situation, herbicide could potentially be mobilized during the first runoff event following application, depending on the persistence and other properties of the herbicide. This is further discussed in the "Overland Flow" section below.

Overland Flow

Ground Applications: The potential for herbicide to enter water bodies through mobilization by overland flow under the Proposed Action would be the same as under the Current Management Alternative for ground applications. Applications under the Proposed Action are likely to cover more acres, but they would occur as scattered, targeted treatments of small infestations and would have minimal effects on water quality on a watershed scale.

Aquatic Applications: Aquatic applications of herbicide would have no risk of mobilization by overland flow because herbicides would be applied directly to water bodies.

Aerial Applications: Aerial herbicide applications are capable of covering large areas with a uniform cover of herbicide. This is the most likely mechanism for herbicides to reach surface

water under the proposed action. Rainfall can mobilize herbicide applied to plants or soil, depending on the herbicide properties.

A number of studies have measured concentrations of herbicides in streams adjacent to aerial herbicide treatment units. The Oregon Department of Forestry measured herbicide concentrations following aerial herbicide applications in western Oregon using buffers prescribed under the forest practice rules (60 feet or 300 feet, depending on stream type). In that study, herbicide concentrations were not detected in any of the seven samples from three sites after the first runoff event following the aerial application (Dent and Robben 2000). McBroom et al. (2013) conducted herbicide runoff studies in paired watersheds in Texas after aerial and ground application of herbicides. They found that herbicides were only detected in streams during storm events, and the peak concentrations were short lived. In this study, approximately 1 to 2 percent of applied imazapyr and less than 1 percent of applied hexazinone and sulfometuron were measured in the storm runoff. Aerial broadcast application resulted in higher concentrations in runoff than ground-based banded applications. However, it was also determined that the timing and magnitude of runoff is the largest factor influencing herbicide dispersal.

Because of the variety of processes influencing overland flow discussed above, the mobility of herbicide after aerial treatment would vary greatly with the herbicide being used, the location, and environmental factors. Therefore, it is not possible to disclose the effects of every possible treatment within the 2.9-million-acre project area. Delivery of herbicides to surface water via overland flow is dependent on a number of chemical and environmental factors. The effects of these factors on the delivery of herbicides to surface water via overland flow are discussed above in the common to all action alternatives. Prior to any aerial application of herbicide in the Proposed Action, design criteria require that the Aerial Herbicide Application Coordination and Safety Implementation Plan (see project record) is followed. This coordination would include site-specific analysis of the following factors and explained in more detail in the common to all action alternatives above.

- Rate of herbicide application and area treated
- Runoff characteristics
- Soil infiltration capacity
- Herbicide properties
- Amount of plant uptake of herbicide
- Proximity of application to surface water
- Streamflow characteristics

Leaching

Ground Applications: The potential for herbicide to enter water bodies through leaching as a result of ground application would be unlikely under the Proposed Action, the same as under the Current Management Alternative section above. Applications would likely cover more acres, but they would occur as scattered, targeted treatments of small infestations and would have minimal effects on a watershed scale.

Aquatic Applications: Aquatic applications of herbicide would have no risk of leaching because herbicides would be applied directly to water bodies.

Aerial Applications: The potential for herbicides to contaminate groundwater or surface water by way of leaching through soil would be greater than under the Current Management Alternative because aerial application would result in more direct contact of herbicides with soil.

Under the Proposed Action, the potential to contaminate groundwater by leaching of herbicides through soils is low. As discussed in the Current Management Alternative 1, leaching is generally not a prominent mechanism for herbicide mobility because many herbicides are quickly degraded in soil by microorganisms, but the highest potential for groundwater contamination occurs when herbicide is applied over a shallow water table. Neary and Michael (1996) suggest that forest herbicide use poses little risk to groundwater because the rate, frequency, and extent of application are minimal on a watershed scale. The presence of shallow water tables would also be an avoidance factor for consideration in the Aerial Herbicide Application Coordination and Safety Implementation Plan (see project record).

3.4.3.2.2.4 Other Factors Related to Potential Herbicide Delivery to Water Sources

Herbicide Modeling

Modeling of herbicide delivery to a stream and a pond were conducted in the USDA Forest Service herbicide risk assessments (SERA 2004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2006, 2007b, 2010, 2011a, 2011b, 2011c, 2011d). Results of modeling for the 10 herbicides used in the Current Management Alternative 1 are presented in Tables 3-18 through 3-21. Results of modeling for the three additional herbicides that would also be used in the Proposed Action are presented in Tables 3-22 and 3-23.

Table 3-22. Summary of Gleams-Driver modeling results from USDA Forest Service herbicide risk assessments for herbicide application adjacent to a stream, for additional herbicides considered in the Proposed Action.

HERBICIDE	MAXIMUM PEAK CONCENTRATIONS OF HERBICIDE IN A STREAM (median value of 100 simulations; µg/L per lb/acre applied)					
	Dry/Temperate Location[a]			Average Rainfall/Cool Location[b]		
	Clay	Loam	Sand	Clay	Loam	Sand
Imazamox[c]	3.7	0	0	25.4	1.51	0.0027
Imazapyr[d]	2.14	0	0	5.2	0.31	5.3

[a] Standard Gleams-Driver site based on climate of Bishop, CA (average annual rainfall 5.34 inches, average annual temperature 56.02 degrees F).

[b] Standard Gleams-Driver site based on climate of Sault Ste. Marie, MI (average annual rainfall 32.94 inches, average annual temperature 40.07 degrees F).

[c] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 60-inch root zone that drains directly into a 2-meter-wide stream that flows at a rate of 710,000 L/day and with a velocity of 6,900 m/day. Additional input parameters provided in SERA (2007a, 2010).

[d] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 36-inch root zone that drains directly into a 2-meter-wide stream that flows at a rate of 710,000 L/day and with a velocity of 6,900 m/day. Additional input parameters provided in SERA (2011b).

Table 3-23. Summary of Gleams-Driver modeling results from USDA Forest Service herbicide risk assessments for herbicide application adjacent to a pond, for additional herbicides considered in the Proposed Action.

HERBICIDE	MAXIMUM PEAK CONCENTRATIONS OF HERBICIDE IN A POND (median value of 100 simulations; µg/L per lb/acre applied)					
	Dry/Temperate Location[a]			Average Rainfall/Cool Location[b]		
	Clay	Loam	Sand	Clay	Loam	Sand
Imazamox[c]	1.63	0	0	24.2	1.16	0.005
Imazapyr[d]	0.8	0	0	2.12	0.29	9.4

[a] Standard Gleams-Driver site based on climate of Bishop, CA (average annual rainfall 5.34 inches, average annual temperature 56.02 degrees F).

[b] Standard Gleams-Driver site based on climate of Sault Ste. Marie, MI (average annual rainfall 32.94 inches, average annual temperature 40.07 degrees F).

[c] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 60-inch root zone that drains directly into a 1-acre pond with a depth of 2 meters and a sediment depth of 2 cm. Additional input parameters provided in SERA (2007b, 2010).

[d] For this herbicide, the Gleams-Driver model assumes herbicide treatment of 10-acre-square field with a 36-inch root zone that drains directly into a 1-acre pond with a depth of 2 meters and a sediment depth of 2 cm. Additional input parameters provided in SERA (2011b).

Applications of this modeling to the project area are discussed the in Section 3.4.1, above. Additional potential effects to water quality related to the three additional herbicides considered in the Proposed Action would be minimal. In arid climates, herbicide delivery to water bodies would be minimal. The highest delivery of herbicide to water bodies would occur in clay soils or sandy soils, depending on the herbicide. Unlike most other herbicides, concentrations of imazapyr would be highest after application on sandy soils because of high leachability and long persistence. No water quality standards exist for the three additional herbicides considered in the Proposed Action. As previously discussed, actual concentrations of herbicide reaching water would likely be lower than suggested by modeling because no broadcast application would occur in riparian areas, and buffers would capture a portion of the herbicide.

Adjuvants

The effects of the use of adjuvants on water quality would be minimal, similar to the Current Management Alternative. The proper use of adjuvants would likely result in an increase in efficiency in aerial herbicide applications and potentially a decrease in adverse effects.

Public Sources of Drinking Water

The potential effects of herbicide concentrations on public sources of drinking water from the Proposed Action would be minimal. The design criteria of herbicide control using aerial application methods in designated municipal watersheds, and State designated source water protection areas would be reviewed by the Forest Hydrologist and/or the Forest Fisheries Biologist and coordinated with State DEQ and other federal agencies; and utilizing corresponding chemical label directions would ensure protection of drinking water sources.

Accidental Spills of Herbicide

Although highly unlikely, the accidental spill of herbicide into or near a water body during herbicide application or staging could potentially affect water quality, depending on the amount spilled and the characteristics of the water body. The risk of accidental spill of herbicide into water under the Proposed Action is higher than under the Current Management Alternative because of the larger quantities of herbicide that would be transported and mixed. However,

design criteria under the Proposed Action would minimize these risks by stipulating that mixing and loading of herbicides occur more than 100 feet from water and in places where spilled materials would not flow into groundwater, wetlands, or streams. Procedures in the Caribou and Targhee National Forest spill plans would be followed (Appendix K), and a site-specific emergency response plan would be developed for each aerial application, as specified under the Aerial Herbicide Application Coordination and Safety Implementation Plan (see project record). Because these design criteria minimize the potential for the majority of spill scenarios, spill scenarios are not analyzed in this document.

3.4.3.2.2.5 Indirect Effects

Herbicide treatments could result in water contamination due to increased soil exposure and erosion potential in the short term as a result of vegetation mortality and decreased groundcover, particularly in monoculture stands of invasive plants or if non-target species are widely affected by herbicide treatments. This would be most likely to occur with broad-spectrum herbicides during ground-based or aerial broadcast applications. However, design criteria, BMPs, and appropriate selection of herbicide would limit these effects by ensuring that methods minimize to the extent possible the application of herbicide to non-target species. These potential effects would likely occur in the short term (less than 1 year), prior to reestablishment of native vegetation.

Any short term increases in sediment delivery caused by vegetation mortality after herbicide treatment would likely be overshadowed by the long term indirect beneficial effects occurring as a result of reestablishment of native vegetation. The proposed biological, herbicide, manual/mechanical, and rehabilitation/restoration methods would result in increased groundcover and improved root structure that would stabilize soils and protect soils from erosive forces such as wind, rain drop impact, and runoff. This would result in decreased sediment delivery to streams in the long term and improve water quality and stream health.

Although the indirect effects of existing invasive plant infestations may currently include increased sediment loads, increased turbidities, channel aggradation, and decreased channel stability, these effects would gradually diminish over time under action alternatives as invasive plant infestations are controlled.

3.4.3.2.3 Cumulative Effects

Under the Proposed Action, biological, mechanical, herbicide, and rehabilitation/restoration control of invasive plant infestations would occur. The direct effects of these treatments would include localized areas of ground disturbance and low risk of herbicides entering water bodies. Any adverse effects that would occur would likely be short term and would be followed by long-term beneficial effects related to the control of invasive plant infestations and reestablishment of native vegetation in those areas. Indirect effects related to vegetation mortality following herbicide treatment could occur in the short term, with long-term beneficial effects following.

Under the umbrella of the Clean Water Act, states are responsible for identifying waterbodies that do not meet designated beneficial uses and identify pollutants that are causing or contributing to water quality degradation. To date, there are not any streams within the CTNF and CNG in Idaho, Wyoming, or Utah that have herbicides identified as a degrading agent. Therefore, current water quality is not being substantially affected throughout the Forest by past or present applications of herbicides.

Weed treatments with herbicides will also continue to occur within and adjacent to the Forest by county weed control districts, treating weeds along roads, adjacent to private landholdings, and other areas. The Forest has no direct jurisdiction over weed control methods by the counties or private landowners. However, by law, their weed control activities are required to follow EPA label requirements. Assuming county and private landowner weed control activities follow requirements, no measurable direct/indirect cumulative effects should occur on water quality.

However, if county and private landowners violate EPA label requirements or have herbicide spills in or near steam, lakes, or wetlands then adverse impacts to the aquatic systems could occur.

The Proposed Action would result in minimal cumulative effects related to the direct and indirect effects of treating invasive plants using biological, mechanical, herbicide, and rehabilitation/restoration control methods.

3.4.3.2.3.1 Biological Control Methods

Biological control methods would have no cumulative effects on soil condition because no ground disturbance or water impairment would occur.

3.4.3.2.3.2 Mechanical and Rehabilitation/Restoration Control Methods

Mechanical and rehabilitation/restoration control methods would have minimal cumulative effects in addition to other activities occurring in the area because of the highly localized nature of the disturbance and the very small percentage of the project area that would be treated. This short-term disturbance would not exacerbate the effects of other activities in the project area and would ultimately provide a long-term benefit.

3.4.3.2.3.3 Herbicide Control

Ground-based, aerial, and aquatic herbicide control would have minimal cumulative effects on soil condition. Although herbicide control would be more widespread than under the Current Management Alternative, this treatment would still cover only a very small percentage of the project area. Other potential sources of water quality impairment within the analysis area include county, BLM, and private landowner application of herbicide. Because these treatments have little overlap with USDA Forest Service treatments, label application rates per acre would not be exceeded, and the cumulative effects on water quality would be minimal. Although herbicide use rates on private lands are unknown, the application of herbicide on NFS lands is likely to be considerably less than that on private agricultural lands because of differing treatment objectives.

Invasive plant control methods under the Proposed Action would result in a gradual decline in invasive plant infestations in the project area and on a watershed scale. Therefore, the Proposed Action would result in decreasing cumulative effects related to the indirect effects caused by the presence of invasive plants.

The Proposed Action would provide the best scenario for overall decline in invasive plant infestations on a watershed scale, the indirect effects of this alternative would include gradually decreasing sediment yield and sediment loads as a result of the decreased spread of invasive plants and increased ground cover. The Proposed Action Alternative would result in decreasing cumulative effects related to the indirect effects caused by the presence of invasive plants.

3.5 Issue 4: Vegetation

The botany and vegetation resource specialist report was developed for this analysis and is included by reference (USDA Forest Service 2020d).

3.5.1 Methodology for Analysis

3.5.1.1 Analysis Scale

The project area forms the area of analysis for the CTNF and the CNG, for all alternatives. The area of analysis for cumulative effects to the sensitive plant species includes all of the CTNF counties and all of the CNG counties, which are: Bannock, Bear Lake, Butte, Bonneville, Caribou, Clark, Franklin, Fremont, Lemhi, Madison, Oneida, Power, and Teton Counties (Idaho); portions of Teton and Lincoln counties (Wyoming); and portions of Box Elder and Cache Counties (Utah).

Temporally, the alternative implemented will direct invasive plant management efforts for 10 to 15 years. According to the Forest Plans, in this analysis the term *temporary effects* refers to a duration of less than 3 years, *short-term effects* refers to time frames of 3 to 15 years, and *long-term effects* refers to a time frame lasting longer than 15 years.

3.5.1.2 Methodology

The potential effects of invasive plant control methods are predictable and well documented. On the basis of the foregoing, it is our determination that we have considered science relevant to the effects of this project on vegetation and special-status plants, along with their pollinators, within the project area.

Not all nonnative plants are considered deleterious to the environment and subject to eradication efforts, as defined by federal and state weed-management requirements (USDA Forest Service 2013). The proposed management activities deal only with noxious and invasive plant species identified as damaging to human health, to economic interests, or to the environment by county, state, or federal entities (Executive Order 13112). Invasive plants, which include invasive annual grasses such as cheatgrass are defined as “a nonnative plant whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order [EO] 13112).

The State of Idaho has declared 67 nonnative, invasive aquatic and terrestrial plant species as noxious (Table 3-24), the State of Utah has declared 27 nonnative, invasive aquatic and terrestrial plant species as noxious (Table 3-25), and the State of Wyoming has declared 30 plant species as noxious weeds (Table 3-26). In addition, Lincoln County has designated four species, and Teton County has designated 29 species as weeds. Thirty-nine of these species are known to infest lands within the project area. The remaining species, however, are present elsewhere in Idaho, Utah, Wyoming, and neighboring states, and these have the potential to become established in the project area. The CTNF and CNG also tracks a number of nonnative invasive plant species that may not be listed as noxious in Idaho, Utah, Wyoming, or other western states, but which are recognized as causing economic or environmental harm. This analysis incorporates management activities for controlling all legally designated as noxious weeds by the states of

Idaho, Utah, and Wyoming, and other nonnative invasive plants causing economic or environmental harm.

Table 3-24. Idaho terrestrial and aquatic noxious weeds: Early detection/rapid response, control, and containment lists. Species in bold font are known to occur within the CTNF or CNG.

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND	PRESENT IN IDAHO
Heardheads (aka Russian knapweed)	***Acroptilon repens***	Upland	Yes
Jointed Goatgrass	*Aegilpos cylindrica*	Upland	Yes
Small Bugloss	*Anchusa arvensis*	Upland	Yes
Feathered Mosquitofern	*Azolla pinnata*	Aquatic	No
Hoary Alyssum	***Berteroa incana***	Upland	Yes
White Bryony	*Bryonia alba*	Upland	Yes
Flowering Rush	*Butomus umbelltus*	Wetland/Aquatic	Yes
Carolina Fanwort	*Cabomba caroliniana*	Aquatic	No
Whitetop	***Cardaria draba***	Upland	Yes
Plumeless Thistle	***Carduus acanthoides***	Upland	Yes
Musk Thistle	***Carduus nutans***	Upland	
Red Star-thistle	*Centaurea calcitrapa*	Upland	Yes
Meadow Knapweed	*Centaurea debeauxii*	Upland	Yes
Diffuse Knapweed	***Centaurea diffusa***	Upland	Yes
Iberian Knapweed	*Centaurea iberica*	Upland	No
Yellow Star-thistle	*Centaurea solstitialis*	Upland	Yes
Spotted Knapweed	***Centaurea stoebe* ssp. *Micranthos***	Upland	Yes
Squarrose Knapweed	*Centaurea virgata*	Upland	No
Rush Skeletonweed	*Chondrilla juncea*	Upland	Yes
Canada Thistle	***Cirsium arvense***	Upland	Yes
Poison Hemlock	***Conium maculatum***	Riparian/Wetland	Yes
Field Bindweed	***Convolvulus arvensis***	Upland	Yes
Common Crupina	*Crupina vulgaris*	Upland	Yes
Gypsyflower (Hound's Tongue)	***Cynoglossum officinale***	Upland	Yes
Scotch Broom	*Cytisus scoparius*	Upland	Yes
Common Viper's Bugloss	*Echium vulgare*	Upland	Yes
Vipers Bugloss	*Echium vulgare*		
Brazilian Waterweed	*Egeria densa*	Aquatic	Eradicated
Water Hyacinth	*Eichhornia crassipes*	Aquatic	Yes
Leafy Spurge	***Euphorbia esula***	Upland	Yes
Giant Hogweed	*Heracleum mantegazzianum*	Upland	No
Orange Hawkweed	*Hieracium aurantiacum*	Upland	Yes
Meadow Hawkweed	*Hieracium caespitosum*	Upland	Yes
Yellow Hawkweed	*Hieracium caespitosum*		
Queen-devil Hawkweed	*Hieracium glomeratum*	Upland	Yes
Tall Hawkweed	*Hieracium piloselloides*	Upland	Yes
Waterthyme (aka hydrilla)	*Hydrilla verticillata*	Aquatic	Yes
Common Frogbit	*Hydrocharis morsus-ranae*	Aquatic	No
Black Henbane	***Hyoscyamus niger***	Upland	Yes
Ornamental Jewelweed	*Impatiens glandulifera*	Wetland	Yes
Paleyellow Iris	*Iris pseudacorus*	Aquatic/Wetland	Yes

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND	PRESENT IN IDAHO
Dyer's Woad	***Isatis tinctoria***	Upland	Yes
Broadleaved Pepperweed	***Lepidium latifolium***	Upland/Riparian/ Wetland	Yes
Oxeye Daisy	***Leucanthemum vulgare***	Upland	Yes
Dalmatian Toadflax	***Linaria dalmatica* ssp. *dalmatica***	Upland	Yes
Butter and Eggs	***Linaria vulgaris***	Upland	Yes
Purple Loosestrife	*Lythrum salicaria*	Riparian/Wetland	Yes
Spring Milletgrass	*Milium vernale*	Upland	Yes
Parrot Feather Watermilfoil	*Myriophyllum aquaticum*	Aquatic	Yes
Twoleaf watermilfoil	*Myriophyllum heterophyllum*	Aquatic	No
Eurasian Watermilfoil	*Myriophyllum spicatum*	Aquatic	Yes
Matgrass	*Nardus stricta*	Upland	Yes
Yellow Floatingheart	*Nymphoides peltata*	Aquatic	Yes
Scotch Cottonthistle	***Onopordum acanthium***	Upland	Yes
Common Reed	*Phragmites australis*	Wetland	Yes
Bohemian Knotweed	*Polygonum bohemicum*	Upland	Yes
Japanese Knotweed	*Polygonum cuspidatum*	Upland	Yes
Giant Knotweed	*Polygonum sachalinense*	Upland	Yes
Curly Pondweed	*Potamogeton crispus*	Aquatic	Yes
Mediterranean Sage	*Salvia aethiopis*	Upland	Yes
Kariba-weed (aka giant salvinia)	*Salvinia molesta*	Aquatic	No
Tansy Ragwort	***Senecio jacobaea***	Upland	Yes
Buffalobur Nightshade	***Solanum rostratum***	Upland	Yes
Dyer's Woad	***Sonchus arvensis***	Upland	Yes
Johnsongrass	*Sorghum halepense*	Upland	Yes
Saltcedar	***Tamarix ramosissim*a**	Riparian	Yes
Water Chestnut	*Trapa natans*	Aquatic	No
Puncturevine	*Tribulus terrestris*	Upland	Yes
Syrian Beancaper	*Zygophyllum fabago*	Upland	Yes

Source: http://invasivespecies.idaho.gov/terrestrial-plants.

Table 3-25. Utah noxious weeds: Early detection/rapid response, control, and containment lists. Species in bold font are known to occur within the CTNF or CNG.

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND	PRESENT IN UTAH	OCCURRENCE IN BOX ELDER COUNTY
Utah Statewide Class A Weeds (Early Detection/Rapid Response List)				
Diffuse Knapweed	*Centaurea diffusa*	Upland	Yes	Yes
Yellow Star-thistle	*Centaurea solstitialis*	Upland	Yes	Yes
Spotted Knapweed	***Centaurea stoebe* ssp. *micranthos***	Upland	Yes	Yes
Leafy Spurge	***Euphorbia esula***	Upland	Yes	Yes
Black Henbane	***Hyoscyamus niger***	Upland	Yes	Yes
St. Johnswort	***Hypericum perforatum***	Upland	Yes	Yes
Oxeye Daisy	***Leucanthemum vulgare***	Upland	Yes	Yes
Butter and Eggs	***Linaria vulgaris***	Upland	Yes	Yes
Purple Loosestrife	*Lythrum salicaria*	Riparian/Wetland	Yes	Yes

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND	PRESENT IN UTAH	OCCURRENCE IN BOX ELDER COUNTY
Sulphur Cinquefoil	*Potentilla recta*	Upland	Yes	No
Johnsongrass	*Sorghum halepense*	Upland	Yes	Yes
Medusahead	*Taeniatherum caput-medusae*	Upland	Yes	Yes
Utah Statewide Class B Weeds (Control List)				
Heardheads	***Acroptilon repens***	Upland	Yes	Yes
Whitetop	***Cardaria draba***	Upland	Yes	Yes
Nodding Plumeless Thistle	***Carduus nutans***	Upland	Yes	Yes
Squarrose Knapweed	*Centaurea virgata*	Upland	Yes	No
Poison Hemlock	***Conium maculatum***	Riparian/Wetland	Yes	Yes
Bermudagrass	*Cynodon dactylon*	Upland	Yes	Yes
Dyer's Woad	***Isatis tinctoria***	Upland	Yes	Yes
Broadleaved Pepperweed	***Lepidium latifolium***	Upland/Riparian/ Wetland	Yes	Yes
Dalmatian Toadflax	***Linaria dalmatica* ssp. *dalmatica***	Upland	Yes	Yes
Scotch Cottonthistle	***Onopordum acanthium***	Upland	Yes	Yes
Utah Statewide Class C Weeds (Containment List)				
Canada Thistle	***Cirsium arvense***	Upland	Yes	Yes
Field Bindweed	***Convolvulus arvensis***	Upland	Yes	Yes
Gypsyflower (Hound's Tongue)	***Cynoglossum officinale***	Upland	Yes	Yes
Quackgrass	*Elytrigia repens*	Upland/Riparian/ Wetland	Yes	Yes
Saltcedar	***Tamarix ramosissisma***	Riparian	Yes	Yes

Sources: USDA Plants Database website, plants.usda.gov; Utah Weed Control Association, Noxious Weeds web site, http://www.utahweed.org/weeds.htm; Noxious Weed Field Guide for Utah, Utah State University Cooperative Extension, 2009.

Table 3-26. Wyoming State and County-listed noxious weeds. Species in bold font are known to occur within the CTNF or CNG.

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND
Quackgrass	*Agropyron repens*	Upland/Riparian/Wetland
Common burdock	***Arctium minus***	Upland
Hoary cress (whitetop)	***Cardaria draba and Cardaria pubescens***	Upland
Plumeless thistle	***Carduus acanthoides***	Upland
Musk thistle	***Carduus nutans***	Upland
Diffuse knapweed	***Centaurea diffusa***	Upland
Spotted knapweed	*Centaurea maculosa*	Upland
Russian knapweed	*Centaurea repens*	Upland
Yellow starthistle	*Centaurea solstitialis*	Upland
Ox-eye daisy	*Chrysanthemum leucanthemum*	Upland
Canada thistle	***Cirsium arvense***	Upland
Field bindweed	***Convolvulus arvensis***	Upland
Houndstongue	***Cynoglossum officinale***	Upland

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND
Russian olive	***Elaeagnus angustifolia***	Riparian/Upland
Leafy spurge	***Euphorbia esula***	Upland
Skeletonleaf bursage	*Franseria discolor*	Upland
Black Henbane	***Hyoscyamus Niger***	Upland
Common St. Johnswort	***Hypericum perforatum***	Upland
Dyer's woad	***Isatis tinctoria***	Upland
Perennial pepperweed (giant whitetop)	***Lepidium latifolium***	Upland
Dalmatian toadflax	***Linaria dalmatica***	Upland
Yellow toadflax	***Linaria vulgaris***	Upland
Purple loosestrife	*Lythrum salicaria*	Wetland/Riparian
Scotch thistle	***Onopordum acanthium***	Upland
Perennial sowthistle	*Sonchus arvensis*	Upland
Medusahead rye	*Taeniatherum caput-medusae*	Upland
Saltcedar	***Tamarix spp.***	Riparian
Common Tansy	***Tanacetum vulgare***	Upland
Ventenata	*Ventenata dubia*	Upland
Common Mullein	***Verbascum thapsus***	Upland
Lincoln County		
Bull thistle	***Cirsium vulgare***	Upland
Poision hemlock	***Conium maculatum***	Upland
Western water hemlock	*Cicuta douglasii*	Wetland
Wild oat	*Avena fatua*	Upland
Teaton County		
Yellow chamomile	Anthemis tinctoria	Upland
Absinth wormwood	Artemisia absinthium	Upland
Hoary alyssum	**Berteroa incana**	Upland
Cheatgrass / downy brome	Bromus tectorum	Upland
Meadow knapweed	Centaurea pratensis	Upland
Squarrose knapweed	Centau rea virgata	Upland
Rush skeltonweed	Chondrilla juncea	Upland
Chicory	Cichorium intybus	Upland
Bull thistle	**Cirsium vulgare**	Upland
Poison hemlock	**Conium maculatum**	Upland
Teasel	Dipsacus fullonum	Upland
Cypress spurge	Euphorbia cyparissias	Upland
Myrtle spurge	Euphorbia myrsinites	Upland
Japanese knotweed	Fallopia japonica	Wetland-Upland
Giant knotweed	Fallopia sachalinensis	Wetland-Upland
Baby's Breath	Gypsophila paniculata	Upland
Dames rocket	Hesperis matronalis	Upland
Orange hawkweed	**Hieracium aurantiacum**	Upland
Field scabious	Knautia arvensis	Upland
Scentless chamomile	Matricaria perforata	Upland
Eurasian watermilfoil	Myriophyllum spicatum	Wetland
Himalayan knotweed	Polygonum polystachyum	Upland

COMMON NAME	SCIENTIFIC NAME	AQUATIC, WETLAND, RIPARIAN, OR UPLAND
Curly-leaf pondweed	Potamogeton crispus	Wetland
Sulfur cinquefoil	Potentilla recta	Upland
Tall buttercup	Ranunculus acris	Wetland-Upland
Bohemian knotweed	*Reynoutria x bohemica*	Upland
Fieldcress	Rorippa austriaca	Wetland-Upland
Puncturevine	Tribulus terrestris	Upland
Moth mullein	Verbascum blattaria	Upland

Source: https://wyoweed.org///wp-content/uploads/2018/07/StateDesignatedList_2018.pdf.

Because invasive plant management results may vary based on soils, vegetation (e.g., cover type), climatic regime, the effects of invasive plant management for the action alternatives are based on local and regional information from sites best representing the conditions found in the project area.

The techniques and methodologies used in this analysis consider pertinent available science. The analysis includes a summary of credible scientific evidence relevant to evaluating reasonably foreseeable impacts. The analysis also identifies methods used and references the scientific sources upon which it relies. The conclusions are based on a scientific analysis that shows a thorough review of relevant scientific information.

The relevant science considered for this analysis consists of the following elements:

- ***Scientific literature***—Relevant literature was used for understanding potential effects.
- ***Methods***—The methods used to develop data for quantitative analysis were accomplished using software developed by Environmental Systems Research Institute (ESRI). Attribute queries, spatial queries, and generation of new datasets from the original USDA Forest Service GIS corporate data were the three types of operations utilized. The degree of spatial analysis ranged from simple queries about the spatial events to more complicated combinations of attribute queries, spatial queries, and alterations of corporate data to create new layers for the purpose of this analysis.
- ***Experience***—Integrating science with local conditions, we utilized the IDT members' collective knowledge of the project.

3.5.1.3 Primary Sources Informing the Analysis

Primary sources of information used to assess the effects of the alternatives on sensitive plants are as follows:

- Natural Resource Information System (NRIS) database for invasive plant inventory.
- Idaho and Wyoming Heritage GIS databases for sensitive plant species populations occurring within the project area.
- USDA Forest Service risk assessments (Table 3-1) for herbicides in use or proposed for use.
- Herbicide labels that provide instructions for use of an herbicide.

As the USDA Forest Service's database for storing and using natural resource data, the NRIS comprises modules for natural resources such as water, wildlife, and vegetation. The data are housed by the USDA National Information Technology Center on servers in Kansas City, Missouri. Invasive plant inventory and treatment data is stored nationally in this database. National forests enter and query invasive plant inventory and treatment data through the USDA

Forest Service's Natural Resource Manager System, which is responsible for maintaining the NRIS. Sensitive plant population data for the CTNF is not currently stored in the NRIS database, but is available from the Idaho and Wyoming Natural Heritage Databases.

The USDA Forest Service bases the ecological effects of herbicides on risk assessments that utilize EPA studies and other peer-reviewed articles from the body of open scientific literature. Information from laboratory and field studies regarding herbicide toxicity, exposure, and environmental fate were used to estimate the risks of adverse effects on nontarget vegetation (Appendix B of the Botany and Vegetation Resources Specialist Report (USDA Forest Service 2020d)). The USDA Forest Service risk assessments also evaluated available scientific studies of the potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. Table 3-1 identifies the risk assessments of herbicides used or proposed for use, by active ingredient.

Every herbicide container must carry an EPA-approved label providing highly specific directions for use of the herbicide. A herbicide label provides valuable information to an applicator and is also federal law; applicators must read and follow label directions on the herbicides they intend to use. Herbicide labels help an applicator in selecting the appropriate herbicide, determining the lowest effective application rate, and determining the proper equipment. Herbicide labels also provide information surrounding plants that are susceptible to or resistant to an herbicide and how to reduce nontarget damage or mortality.

3.5.2 Affected Environment

3.5.2.1 Sensitive Plant Species Presence and Distribution

The CTNF provides habitat for one federally listed threatened terrestrial plant species and one candidate species (Table 3-27). Ute ladies'-tresses, listed as threatened, is currently known to occur in riparian and wetland habitat associated with the South Fork of the Snake River floodplain and Henrys Fork of the Snake River below the coniferous forest zone (Fertig et al 2005). Whitebark pine, a candidate species, occurs on both forests. Specifically, within the Caribou National Forest, it occurs within the Caribou Mountain in the upper treezone. Within the Targhee National Forest, white bark pine is a mapped existing vegetation type common in the upper tree zone.

A more detaild description of the habitat requirements, threats, and status on the forest for each species carried into analysis can be found in the botany and vegetation resource specialist report (USDA Forest Service 2020d). Table 3-28 provides a summary of the habitat and threats for each species.

The Regional Forester's sensitive species list identifies three sensitive plant species for the Caribou National Forest and one federally listed sensitive, one candidate, and 11 sensitive plant species for the Targhee National Forest (Intermountain Region (R4) Threatened, Endangered, Proposed, and, Sensitive Species list, June 2016, Table 12). No USDA Forest Service sensitive species are currently known to occur within the CNG.

Table 3-27. Federally listed and sensitive plant species within the Caribou-Targhee National Forest (CTNF).

SPECIES	CARIBOU NATIONAL FOREST	TARGHEE NATIONAL FOREST
Proposed Threatened		
Ute ladies'-tresses *Spiranthes diluvialis*		X
Candidate		
Whitebark Pine *Pinus albicaulis*		X
Sensitive		
Pink agoseris *Agoseris lackschewitzii*		X
Sweet-flowered rock jasmine *Androsace chamaejasme* ssp. *carinata*		X
Meadow milkvetch *Astragalus diversifolius* var. *diversifolius*		X
Starvling milkvetch *Astragalus jejunus* var. *jejunus*	X	
Payson's milkvetch *Astragalus paysonii*		X
Dainty moonwort *Botrychium crenulatum*		X
Centennial rabbitbrush *Chrysothamnus parryi* ssp. *montanus*		X
Welsh rockcress draba *Draba globosa* (*D. densifolia* var. *apiculata*)		X
Payson bladderpod *Lesquerella paysonii*	X	X
Cache beardtongue *Penstemon compactus*	X	
Marsh's Bluegrass *Poa abbreviata* ssp. *marshii*		X
Salmon twin bladderpod *Physaria didymocarpa* var. *lyrata*		X
Alkali primrose *Primula alcalina*		X
Total Special Status Species	**3**	**13**

Source: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5370041.pdf.

Table 3-28. The habitat and threats to the federally listed and sensitive plant species within the Caribou-Targhee National Forest (CTNF).

SPECIES	HABITAT	THREATS
Proposed Threatened		
Ute Ladies'-Tresses	Moist soils in mesic or wet meadows near water.	Habitat loss and modification, loss of riparian habitat, invasive weeds, recreational activities and livestock grazing.
Candidate		
Whitebark Pine	Cold and windy high-elevation habitat, typically with stands of mixed species.	Habitat loss, white pine blister rust, mountain pine beetle, fire and fire suppression, and climate change.
Sensitive		
Pink Agoseris	Subalpine wet meadows where soil is saturated throughout the growing season.	Habitat loss.
Sweet-flowered Rock Jasmine	Rocky ridge crests and slopes, outcrops, talus, and rock meadows.	Recreation and livestock grazing.
Meadow Milkvetch	Moist, salt-accumulating habitats.	Habitat loss.
Starvling Milkvetch	Dry hilltops, barren ridges, calcareous clay knolls, gullied bluffs, or river terraces.	Habitat loss and livestock grazing.
Payson's Milkvetch	Disturbed areas on sandy soils with low vegetation cover.	Habitat loss and degradation, fire suppression.
Dainty Moonwort	Moist grass/forb meadows, open woodlands and montane forests near riparian habitat.	Recreation, off-road vehicles, habitat loss, competition from invasive species and livestock grazing.
Centennial Rabbitbrush	Sparsely vegetated, subalpine grasslands and slopes in rocky soils.	Small population size and local distribution.
Welsh Rockcress Draba	Moist, gravelly alpine meadows and talus slopes.	*
Payson Bladderpod	Sparsely vegetated ridgelines and openings in sagebrush and forested stands.	Recreation, ski development, grazing, and mining.
Cache Beardtongue	Open calcareous slopes and outcrops in subalpine zones.	Recreation, timber harvest, climate change and habitat loss.
Marsh's Bluegrass	Alpine meadows and on granite talus slopes.	Habitat loss, climate change, recreation, mining, competition from non-native species, and livestock grazing.
Salmon Twin Bladderpod	Rocky, sparsely vegetated openings on steep, gravel slopes.	Habitat loss and destruction, mining, herbicide use, grazing, invasive species and climate change.
Alkali Primrose	Wet, alkaline meadows at the headwaters of spring creeks.	Habitat destruction and invasive species.

Of the 15 special-status plant species within the two NFS lands, five have populations co-occurring with invasive plant species (within 0.25 miles). Some of these species are at a greater threat from invasive plant species than others. Table 3-29 shows the acreage of infestation within 0.25 mile of special-status plant populations. Approximately 59 acres of invasive and noxious species infestations occur within a quarter mile of special-status plants. This puts those populations at greater risk, both from the impacts of invasive plant invasion and from the impacts of invasive plant treatments.

Table 3-29. Special-status plant species and acres infested by invasive plant species.[a]

COMMON NAME	INFESTATION WITHIN 0.25 MILES OF SPECIAL STATUS PLANT POPULATIONS
Endangered Species Act List	**Acres**
Ute ladies'-tresses (threatened)	0.1
Whitebark Pine (candidate)	1.0
Forest Service Region 4 Sensitive List	**Acres**
Pink agoseris *Agoseris lackschewitzii*	13.1
Sweet-flowered rock jasmine *Androsace chamaejasme ssp. carinata*	-
Meadow milkvetch *Astragalus diversifolius var. diversifolius*	-
Starvling milkvetch *Astragalus jejunus var. jejunus*	18.1
Payson's milkvetch *Astragalus paysonii*	1.0
Dainty moonwort *Botrychium crenulatum*	-
Centennial rabbitbrush *Chrysothamnus parryi* ssp. *montanus*	-
Welsh rockcress draba (Draba globosa (D. densifolia var. apiculata))	10.0
Payson bladderpod *Lesquerella paysonii*	15.6
Cache beardtongue *Penstemon compactus*	-
Marsh's Bluegrass (Poa abbreviata ssp. marshii)	-
Salmon twin bladderpod *Physaria didymocarpa* var. *lyrata*	-
Alkali primrose *Primula alcalina*	-
Total	58.8
- No Acreage reported in GIS database	

[a] Table 3-29 only reflects noxious weeds mapped relative to mapped occurrences of sensitive plants, refer to description by species for additional information concerning invasive plant threats to specific species and their known occurrences.

Species accounts are presented below for the ESA-listed plant species, Region 4 sensitive plant species, and forest watch species. The specific species' sections generally include the following information:

- Status of species
- Species description
- Habitat characteristics
- Existing condition
- Factors of decline/threats

The accounts of species occurrence are based on Idaho Natural Heritage Program (INHP) and Wyoming Natural Diversity Database (WyNDD) data, USDA Forest Service staff observations and other best available information concerning the species. This information represents the best available scientific data regarding the occurrence of these species.

3.5.2.2 Native Vegetation Communities

The vegetation section analyzes the impacts of invasive plant invasion to native plant communities, the current extent of invasive plant infestations in the project area, the current management actions, and the potential effects of the No Action Alternative and the Proposed Action on invasive plant spread and on nontarget vegetation.

The CTNF and CNG cover aproximately 2.7 million acres and contain a diverse and interspersed mixture of native plant communities. These communities vary according to elevation, topography, and soil type. In general, they may be categorized by cover type; these broad groupings are defined by the predominant vegetation currently occupying a site (e.g., shrubland and conifer). Many of the cover types provide habitat for sensitive plants found within forests (Table 3-30).

Table 3-30. Weed Infestations by mid-scale existing vegetation types within the Caribou-Targhee National Forest (CTNF).

VEGETATION CATEGORY	ACRES OF VEGETATION	ACRES OF NOXIOUS WEED INFESTATION
Agriculture	737	31
Alpine Vegetation	25,427	5
Aspen	218,249	9,116
Aspen/Conifer	83,653	4,167
Barren/Sparse Vegetation	51,328	617
Bigtooth Maple Mix	87,166	3,155
Bridger-Teton Vegetation Type	2,585	11
Conifer Mix	218,535	2,880
Conifer/Aspen	115,601	6,380
Developed	2,639	719
Douglas-fir	575,051	10,182
Douglas-fir/Lodgepole Pine	55,268	2,096
Dry Big Sagebrush Mix	31,403	2,257
Dwarf Sagebrush	33,641	118
Forest/Mountain Shrublands	77,014	1,892
Juniper Mix	27,047	931
Limber Pine/Douglas-fir	51,907	29
Lodgepole Pine	460,387	22,960
Montane Herbaceous	34,680	1,869
Mountain Big Sagebrush	422,476	15,874
Mountain Mahagony Mix	60,490	2,693
Riparian Herbaceous	3,906	450

VEGETATION CATEGORY	ACRES OF VEGETATION	ACRES OF NOXIOUS WEED INFESTATION
Riparian Shrublands and Deciduous Forest	25,709	3,743
Ruderal Grasslands	19,746	744
Spruce/Fir	121,967	175
Subalpine Herbaceous	44,582	868
Water	17,062	309
Whitebark Pine Mix	28,947	1
Total Acres	**2,897,202**	**94,272**

Within the CTNF and CNG, approximately 94,272 acres are occupied by invasive and noxious plant species). These species have been named by the State of Idaho, State of Utah, or the State of Wyoming as official noxious weeds. The 94,272 acres do not include overlapping occurrences of invasive species.

3.5.2.3 Rare Plant Pollinators

Very little information on insect pollinator species occurrence and population trends is known in the CTNF or the CNG. No known surveys have been conducted. Species present are most likely typical for the climate and plant communities present. These include species of bees within the families Apidae (bumblebees), Colletidae, Andrenidae, Halictidae (solitary bees), Megachilidae (leafcutting bees), and Anthophoridae (digger bees and carpenter bees), along with many species within the Order Diptera (flies) (Cane and Tepedino 2001).

Many species of plants rely on insects for pollination. Some species of plants are pollinated by many species and others are more specific (i.e., depending on a single pollinator species). Plant and pollinator diversity have been shown to be positively correlated. Recent evidence suggests that many species of insect pollinators may be in decline due to many factors, including habitat alteration and fragmentation, pesticides, and competition from nonnative species (Kearns and Inouye 1997). Native plant species diversity is essential to maintain pollinator populations.

3.5.2.4 Invasive Species Presence and Distribution

There are 33 known terrestrial noxious invasive plant species infesting plant communities within the counties encompassing the CTNF (Table 3-31). These invasive plant infestations total approximately 102,135 acres (USDA Forest Service 2020e). With a project area of over 2.6 million acres, this means that approximately 3.9 percent of the project area is known to be infested by Idaho, Wyoming, and/or Utah State designated noxious invasive plant species. It is important to note that the acre figures shown in Table 3-31 contain duplicate acreage. This happens because Forest Service NRIS database protocols require that a site-identified invasive plant infestation may consist of only one invasive plant species. So, when more than one invasive plant species occupies a site, then two invasive plant infestations are recorded in the NRIS database, one for each of the invasive plants present, resulting in a double count. This means that the acreage of known invasive plant infestations in Table 3-31 is an overestimate.

Table 3-31. Top terrestrial noxious weed infestations in the project area.

SCIENTIFIC NAME	COMMON NAME	INFESTED ACRES
Euphorbia esula	leafy spurge	31,814.9
Isatis tinctoria	Dyer's woad	15,791.1
Cirsium arvense	Canada thistle	15,236.2
Carduus nutans	nodding plumeless thistle	14,233.3
Centaurea stoebe ssp. micranthos	spotted knapweed	7,260.7
Linaria vulgaris	butter and eggs	6,688.3
Cynoglossum officinale	gypsyflower	6,256.7
Tamarix ramosissima	saltcedar	2,088.4
Hypericum perforatum	common St. Johnswort	1,010.7
Hyoscyamus niger	black henbane	856.3
Onopordum acanthium	Scotch cottonthistle	353.6
Linaria dalmatica ssp. Dalmatica	Dalmatian toadflax	294.6
Convolvulus arvensis	field bindweed	249.6
Total Acres		**102,134.6**

The most common invasive plant species in the project area are leafy spurge, Dyer's woad, Canada thistle, and nodding plume thistle (USDA Forest Service 2020e). These four noxious plant species account for 75 percent of the acreage of known noxious plant infestations. Leafy spurge is the most prevalent invasive plant species, with nearly 32,000 acres infested (USDA Forest Service 2020e).

Nonnative invasive plant species are neither distributed evenly among ranger districts of each Forest nor among plant community cover types (USDA Forest Service 2020e). Topography and plant communities in the project area are variable, ranging from flat to gentle terrain to very steep slopes, and from large expanses of sagebrush–steppe to densely forested areas. However, invasive plant establishment and spread are not determined by topography, but are closely tied to cover types (the type of vegetation currently occupying a site), patterns and sources of disturbance (e.g., fire), invasive plant vectors (e.g., roads and trails), site-specific variables, and the invasion potential of any given nonnative invasive plant species. Overall, the fact that only 3.9 percent of the project area contains infestations of noxious invasive plants means that the project area is dominated by native and desirable plant communities functioning within intact ecosystems.

3.5.3 Environmental Consequences

Herbicide exposure resulting from herbicide drift, residue, or direct application may cause harm to nontarget plants and their pollinators, including special-status species. The CTNF provides habitat for one federally listed threatened terrestrial plant species (Ute ladies'-tresses) and one candidate species (whitebark pine). No federally listed or candidate species have potential habitat in the CNG.

All plant species listed by the Regional Forester as sensitive for the CTNF and CNG have occurences within the CTNF. Four sensitive species are not currently associated with threats

from invasive plant establishment and spread, or from the effects of invasive plant control activities in the project area, including, dainty moonwort, centennial rabbitbrush, Marsh's bluegrass, and Cache beardtongue. These species do not occur within a quarter mile of known noxious weed infestations. Suitable habitat is often away from roads or trails and experience less human activity than the more accessible areas, which provides a greater degree of protection from the effects of invasion and invasive plant control activities.

Based on the available information summarized above, the other nine sensitive plant (Ute-ladies' tresses, white-bark pine, pink agoseris, sweet-flowered rock jasmine, meadow milkvetch, starvling milkvetch, Payson's milkvetch, Welsh rockcress draba, Payson bladderpod, Salmon twin bladderpod, and alkali primrose) could be vulnerable to, and therefore impacted by invasive plant invasion and by invasive plant control measures, because (1) they grow in habitats susceptible to noxious plant invasion and spread, (2) there may be known invasive plant infestations in or in close proximity to populations, or (3) there are roads or trails through or near populations, making these populations more vulnerable to invasive plant invasion due to human presence and activity.

3.5.3.1 Effects Common to All Action Alternatives

Because invasive plant control activities can affect nontarget, native plant species, including special-status plant species, a set of design criteria was developed to provide guidance when planning invasive plant control around special-status plant populations. These criteria are intended to minimize impacts to special-status plants from invasive plant control activities while working toward the desired condition for sensitive plant populations and habitats.

Protecting special-status plants during invasive plant control activities is very attainable. Design criteria include practices such as using mechanical control methods where practicable, using herbicides with very short residual activity, or applying herbicides using highly targeted specific methods such as spot spraying and making sponge, wand, or wiper applications using specialized equipment.

Uncertainty exists regarding the effects of herbicides on nontarget plant species and pollinators because native species are not the usual test species for EPA toxicity studies. The EPA performs studies predominantly on pollinators of crop species (honeybees). It has been suggested that the current suite of tested species was not representative of the habitats found adjacent to agricultural treatment areas and also has been suggested that the current suite of tested species might cause an unacceptable bias and underestimated risk. Given all the uncertainties related to pollinators, the risks must be weighed in relation to impacts to native plant communities and ecosystem processes as a whole and in relation to the ability of the Proposed Alternative to control, eradicate, or contain invasive species.

Although herbicides don't target pollinators, they do eliminate plants that provide a food source. Unless alternate flowers are available nearby, pollinators nesting in an area are subsequently forced to forage more widely for nectar and pollen, which requires more energy and exposes them to more threats. As a result, the pollinators produce fewer offspring to emerge the following year. Many pesticides are acutely toxic to bees and result in death. Carbamates, organophosphates, synthetic pyrethroids, chlorinated cylcodienes, and neonicotinoids are highly toxic to bees. None of the chemicals proposed for use in the project area contain these ingredients.

Very little information is available surrounding the effects of herbicides on native pollinators. Most information concerns the nonnative honey bee. It is known that pollinators can be directly affected by spray or indirectly when plants needed as food for adults or larvae are eliminated by herbicides. Effects on pollinators were derived from risk assessment information regarding direct spray on honey bees (Table 3-32). Herbicide labels were also used for more species-specific information. By using label information about controlled species, however, effects upon closely related species can only be extrapolated. Table 3-34 below shows that the active ingredients to be potentially utilized in the Proposed Action are not expected to exhibit toxic effects when directly sprayed on honey bees at the typical USDA Forest Service application rate. Glyphosate and triclopyr may exhibit some toxic effects if applied at the maximum application rate proposed by the USDA Forest Service (SERA 2011a, SERA 2011d).

Table 3-32. Potential doses for bees in a direct spray scenario.

HERBICIDE	TYPICAL APPLICATION RATE	POTENTIAL DOSE FOR BEES	TOXIC LEVEL FOR BEES
2,4-D amine	1.4 lb/ac	180 mg/kg	>1,000 mg/kg (no mortality)
Aminopyralid	0.093 lb/ac	175 mg/kg	5,000 mg/kg (NOAEC)
Chlorsulfuron	0.056 lb/ac	8.98 mg/kg	>25 mg/kg (LD50)
Clopyralid	0.35 lb/ac	56.1 mg/kg	909 mg/kg (no mortality)
Dicamba	0.56 lb/ac	50.2 mg/kg	>1,000 mg/kg (no mortality)
Glyphosate	2.0 lb/ac	321 mg/kg	540 mg/kg (NOAEC)
Imazamox	0.40 lb/ac	10.1 mg/kg	1,000 mg/kg (no mortality)
Imazapic	0.13 lb/ac	16 mg/kg	387 mg/kg (no mortality)
Imazapyr	0.45 lb/ac	72.1 mg/kg	1,000 mg/kg (no mortality)
Metsulfuron methyl	0.03 lb/ac	4.81 mg/kg	270 mg/kg (NOEC)
Picloram	0.35 lb/ac	56.1 mg/kg	1,000 mg/kg (no mortality)
Rimsulfuron	0.0469 lbs a.i.	unknown	>11µg a.i./bee (LD50)
Sulfometuron methyl	0.045 lb/ac	7.21 mg/kg	1,075 mg/kg (NOEC)
Triclopyr TEA (triethylamine salt)	1.0 lb/ac	160 mg/kg	>1,075 mg/kg (LD50)
NP9E (main generic ingredient in most surfactants)	1.67 lb/ac	268 mg/kg	unknown

Notes: LD50 (lethal dose 50) = The dose of a chemical calculated to cause death in 50 percent of a defined experimental animal population over a specified observation period; NOAEC = No observed adverse effects concentration; NOEC = No observed effects concentration.

Potential impacts to pollinators that reside near invasive plant infestations and would likely be available to pollinate listed plants would be minimized by using techniques that mitigate effects on listed plants.

It is assumed herbicide use will decrease over time as current infestations are treated and as EDRR to newly discovered sites allows treatment with the most effective methods. The remaining USDA Forest Service land base not treated with herbicides should provide adequate habitats for native pollinators to survive and re-establish in areas where they might be impacted. In relation to indirect impacts to rare plants and their habitats, it is assumed that any treatment reducing invasive plants within a native plant community will result in a positive impact on the community as the native component is restored.

Impacts associated with mechanical treatments are variable in their extent. Ground disturbances, soil compaction, and native vegetation removal at small scales could have little negative affect

on pollinators in the area. Large-scale ground disturbances and vegetation removal could alter the native plant communities, causing a species composition shift and subsequent loss of pollen sources for pollinators. This reduction of food availability makes the pollinator's survival more difficult, which in turn has effects throughout the food chain, as reduced pollination leads to reduced fruit on which birds and other animals depend. Ground disturbance and fire could destroy the nests of ground-nesting species and trample individuals. Compliance with mitigation measures, specific targets, treatment timing, and a well-informed treatment crew would result in only localized impacts, preventing native community alteration.

The USDA's APHIS rigorously screens and tests new biocontrol agents for impacts on native insects. Only APHIS-approved biological controls may be used and would be released according to APHIS requirements or USDA Forest Service policy, whichever is more restrictive. Biological treatments with insects or pathogens are usually specific to a single nonnative plant species and not known to negatively affect other native insects. If pollinator species rely on a specific nonnative plant species being treated, the pollinator could experience a reduction in food availability if other food sources are not available in the area, making its survival more difficult.

Prescriptive grazing removes the flowers of perennial species during bloom or before it occurs. If other flowering plants are not available, pollinator species could experience a reduction in food availability, making survival more difficult which, again, has effects throughout the food chain, as reduced pollination leads to reduced fruit on which birds and other animals depend. Goats or sheep used for prescriptive grazing could cause ground disturbance (trampling) and destroy the nests of ground-nesting species. Compliance with mitigation measures, grazing prescription, and an informed treatment crew and herders would minimize the grazing of nontarget species and thus the negative effects on pollinators.

Most of the proposed herbicides are selective, translocated herbicides, some of which remain active in the soil after application, providing an additional period of invasive plant control after the initial application. Selective herbicides kill some plant species, while other plant species may be unharmed. The primary difference between susceptibility to an herbicide and tolerance is metabolic. Tolerant plants resist the herbicide by not absorbing it or by metabolizing the herbicide into natural, nonharmful components. Translocated herbicides move from plant foliage (or in the case of herbicides with soil residual capability, from the soil) into areas of active plant growth in root and leaf tissue. It is here in the growing points of a plant that active ingredients exert their effects.

3.5.3.1.1 2, 4-D amine

The herbicide 2,4-D is a selective, systemic herbicide used to control broadleaf weeds in a wide range of plant families. It works by affecting plant growth processes. Plant roots are usually more sensitive to 2,4-D than shoots, although above-ground vegetation shows typical signs of 2,4-D soon after application (e.g., wilting and chlorosis) as the active ingredient impacts plant growth.

Due to its low toxicity and environmental fate profile (Appendix B of the Botany and Vegetation Resources Specialist Report (USDA Forest Service 2020d), aquatic formulations of 2,4-D are used for invasive plant control primarily in riparian areas and wetlands within 15 feet of surface water. It is also used to control broadleaf weeds in the spring when plants are still young and actively producing basal vegetation. The herbicide 2,4-D has very limited soil residual capability and is useful for sites where herbicide is not desired to remain active in the soil.

Woody species are generally tolerant of 2,4-D applied at rates used to control forbs, although damage can occur to seedlings and saplings. Conifers and evergreen shrubs are more tolerant than deciduous species; deciduous trees and shrubs may exhibit signs of injury on sprayed foliage.

Grass species are generally very tolerant to 2,4-D after the seedling stage of growth. However, grass seed production may be affected when applied to grasses in the boot to dough or milk stage (NuFarm 2010). Grasses are not affected when 2,4-D is applied after grass is established or when not in the flowering stage.

As a broadleaf herbicide, 2,4-D has the potential to affect many different forb species. Mortality (or the degree of injury) depends on the use rate and the application method. While 2,4-D can be quite toxic to plants, using spot applications and the fact that it does not remain active in the soil make precision applications possible in settings where nontarget damage needs to be minimized. 2,4-D is used in a mix with other herbicides to stop seed production quickly, while the other herbicide in the mix provides soil residual capability.

3.5.3.1.2 Aminopyralid

Aminopyralid is a selective systemic herbicide developed for the control of broadleaf weeds (SERA 2007). As a selective herbicide, it works well with dicots but is not effective against monocots (grasses). The most likely uses of aminopyralid involve applications to forest and rangelands, right-of-way, and developed recreational areas (e.g., campgrounds, picnic areas, and trails).

Aminopyralid can be used as a ground or aerial application method. Larger areas are typically treated with either hydraulic spray or aerial applications, whereas smaller areas generally utilize backback sprayers.

This herbicide functions similar to picloram and triclopyr by mimicking indole auxin plant growth hormones. These hormones cause plants to grow abnormally, which eventually limits vital functions in the plant and causes the plant to die.

Aminopyralid has been proposed for use as an alternative to picloram, clopyralid, 2,4-D, dicamba, monosodium methanearsonate, and metsulfuron methyl based on its designation as a reduced-risk herbicide (SERA 2007). In addition, aminopyralid can be used at lower rates, reducing the level of herbicides in the environment. While it has a shorter half-life than clopyralid and picloram, it has a longer half-life than 2,4-D or dicamba (Iowa State University 2006).Aminopyralid is particularly effective against weeds in the composite, legume, and solanaceae (nightshade) families, but is not that effective against plants in the carrot family. Trees that are considered leguminous may be damaged if this herbicide is applied under their dripline (Iowa State University 2006).

Non-target terrestrial plant species are at risk from applications that cause drift outside of the target area.

3.5.3.1.3 Chlorsulfuron

Chlorsulfuron is a selective herbicide formulated as a dry flowable (i.e., small granular pellets) that controls an array of broadleaf weeds (DuPont 2011). It is in the sulfonylurea class of herbicides and works by inhibiting an enzyme, acetolactate synthase, which is essential for plant growth (SERA 2004a). Chlorsulfuron can be applied as a pre- or post-emergent treatment

(DuPont 2011). It works best on plants in the early or vegetative stages of growth. Chlorsulfuron is one of only a few herbicides in use that control invasive plants in the mustard plant family. It is also very useful in controlling invasive plants in the borage family.

Chlorsulfuron is taken up in both the foliage and roots of susceptible plant species. Chlorsulfuron also incorporates into the soil and provides a period of soil residual activity. This period is typically short—at most, a year. Because chlorsulfuron remains active in the soil for some time, it can be transported away from the treatment site in wind or water erosion. The herbicide label cautions users when making applications to powdery or light, sandy soils (DuPont 2011).

Chlorsulfuron can be used up to the water's edge and can be applied to seasonally wet areas when no surface water is present (DuPont 2011). This, and the tolerance that woody species have to chlorsulfuron, makes it a valuable herbicide for treatment in riparian areas or wetlands.

Woody species are tolerant of chlorsulfuron applied at typical use rates for most broadleaf weeds, although seedlings and saplings could be injured or killed by overspray that covers the foliage and stems.

Graminoids are also tolerant of chlorsulfuron, although graminoids stressed by environmental conditions may be injured and experience temporary setbacks in vigor and growth. Chlorsulfuron can injure or kill seedling grasses that have not yet established sufficient root systems. It may also affect seed production in some grasses, depending on the use rate and the stage of seed production.

Members of the borage, mustard, and pea plant families are the most susceptible to chlorsulfuron, while many members of the sunflower family are tolerant at typical use rates. Annual broadleaf weeds are best controlled by chlorsulfuron when in early stages of growth. Perennial weeds are best controlled when in a rosette stage in the spring or fall, or prior to the bloom stage.

3.5.3.1.4 Clopyralid

Clopyralid is a systemic herbicide that controls broadleaf weeds in a number of plant families (SERA 2004b). It is in the same class of herbicides as aminopyralid, picloram, and triclopyr and functions by interfering with plant growth (Trevathan 2002a). Plant uptake of clopyralid occurs in both the foliage and the roots. Members of the sunflower and pea plant families are the most susceptible to clopyralid, while members of the mustard family are tolerant (Tu et al. 2001). Clopyralid is more selective than other herbicides in this same class, such as picloram or triclopyr (Tu et al. 2001).

Clopyralid exhibits much less soil residual capability than aminopyralid or picloram. At best, residual control is usually 1 year or less. Like other members in the same class of herbicide, clopyralid can be mobile in permeable soil and the label recommends caution in making applications in cobbled soil where the water table is shallow.

Woody species are generally tolerant of clopyralid (with the exception of trees and shrubs in the pea family), although transitory or temporary damage may occur. Clopyralid is labeled for invasive plant control in deciduous tree plantations because deciduous trees are tolerant. Likewise, conifers are tolerant of clopyralid.

Newly seeded grass that is not yet well established may be injured by clopyralid, but graminoid species are otherwise tolerant to clopyralid.

Clopyralid controls broadleaf weed species. Clopyralid is most active on members of four plant families: the buckwheat, nightshade, pea, and sunflower families. Conversely, mustards are not at all susceptible to clopyralid. Compared to picloram, clopyralid is less harsh and is used in settings where the use of picloram could result in severe nontarget effects.

A number of field studies from western Montana by Rice and his colleagues have researched the effects of herbicides, including clopyralid, on target and nontarget forbs. Rice and Harrington (2007) found broadcast applications of clopyralid reduced native plant abundance less than picloram. Rice et al. (1997a) also found that reductions in plant community diversity were small and short term. Rice and Toney (1998) found that lower rates of picloram and clopyralid still provided 3 years of control on spotted knapweed.

3.5.3.1.5 Dicamba

Dicamba is a selective herbicide used in control of broadleaf weeds and some woody species (SERA 2004c). There are two forms of dicamba, both of which are approved for use by the USDA Forest Service, a diethylamine salt and a diglycolamine salt (SERA 2004c). The diglycolamine form is preferred because the volatilization potential is much lower compared to the diethylamine form (SERA 2004c). Dicamba translocates through foliage, stems, and roots to growing points.

Dicamba is active in the soil, and if sprayed around nontarget plants it may move laterally and downward and affect the root systems of nontarget plants, potentially resulting in injury or death (NuFarm 2011a). However, dicamba is not persistent in the soil and does not provide residual control.

Dicamba can leach in permeable soils under some environmental conditions, so it is not suitable for use next to water (NuFarm 2011a). Label direction recommends caution when considering dicamba applications in areas with permeable soils and shallow water tables. Label direction for the diethylamine form of dicamba specifies that it may not be applied to soils classified as sand containing less than 3 percent organic matter where water tables are shallow.

Graminoids (grass, sedges, rushes) are generally tolerant of dicamba, although graminoids stressed by environmental conditions (e.g., insect outbreaks or drought) may be injured and experience temporary setbacks in vigor and growth. Dicamba can injure seedling grasses that have not yet established sufficient root systems.

Dicamba is an effective herbicide that controls a wide variety of broadleaf weeds in a number of different plant families. Correspondingly, native forbs are likely to be injured or killed by dicamba applications.

Dicamba is a broad-spectrum herbicide that controls trees and brush and, as such, woody conifer and deciduous species are generally susceptible to dicamba (NuFarm 2011a). There are several methods for applying dicamba to woody weed species, depending on the presence and type of nontarget woody vegetation present. The two primary methods are cut surface or directed foliar spray techniques (SERA 2004c). Cut surface application methods provide a high degree of protection to surrounding nontarget vegetation, while directed foliar spray methods may be used when the potential for nontarget damage is not a concern. For example, cut surface treatments on saltcedar would be appropriate when saltcedar occurs mixed in with native trees or shrubs, while directed foliar spray would be appropriate should saltcedar occur in stands unmixed with native trees or shrubs.

3.5.3.1.6 Glyphosate

Glyphosate is a broad-spectrum, nonselective, post-emergence herbicide that can kill or injure vegetation to which it is applied (NuFarm 2011b). Glyphosate only works when applied to living plant tissue. It cannot be used as a pre-emergent herbicide or as a soil residual herbicide. Glyphosate works by affecting the production of aromatic amino acids essential to plant growth (SERA 2011a).

Glyphosate molecules bind strongly to soil particles, which prevents leaching into areas where it was not applied or into groundwater (Trevathan 2002b, NuFarm 2011b). Glyphosate is not mobile in soil and provides no soil residual activity, as glyphosate molecules bind very strongly to soil particles (NuFarm 2011b).

Woody species can be injured or killed by glyphosate when sprayed on living tissue. Younger age classes (seedlings/saplings) are likely to be killed. Actively growing foliage on mature plants affected by direct spray or drift may be injured, resulting in leaf drop and branch tip necrosis. Spraying thick woody or corky bark with glyphosate will not affect trees and shrubs. However, spraying thin or green bark that is metabolically active could result in injury or, in the case of seedling/sapling trees or shrubs, in mortality. There is no root uptake of glyphosate, so it can be sprayed under foliage and inside the drip line (i.e., circumference of foliage).

Glyphosate is a nonselective herbicide that can kill or damage graminoids, sometimes even at low use rates. Formulations manufactured without surfactant are generally less toxic because surfactants can increase the toxicity of glyphosate (SERA 2011a). Adding a surfactant to glyphosate or applying glyphosate at higher use rates will increase the degree of injury or mortality to grasses.

As a nonselective herbicide, glyphosate kills most forb species. Selectivity can only be achieved through avoidance of nontarget vegetation, including the use of targeted spot applications, barriers, and timing of glyphosate applications. For example, because glyphosate has no soil residual capability, it will have no effect on nontarget forbs when applied during periods when these species are dormant.

3.5.3.1.7 Imazamox

Imazamox is part of the imidazolinone class of herbicides, including imazapic, imazapyr, imazethapyr, imazamethabenz, and imazaquin (SERA 2010). This herbicide inhibits acetolactate synthase, an enxyme essential to plant growth. Imazamox is effective at terrestrial and aquatic weed control. This herbicide may damage non-target terrestrial vegetation, macrophytes, and some species of algae. Non-target terrestrial species are at risk from applications that cause drift outside of the target area.

Imazamox is labeled for ground and aerial applications. It is used as a foliar application as well as cut stump and basal bark applications. Imazamox must be used in conjunction with an adjuvant that has a nonionic surfactant, methylated seed oil or vegetable oil concentrates, or silicone-based surfactants.

The maximum application rate for imazamox in terrestrial systems is 0.5 pounds of acidic equivalents per acre, while the maximum application rate for aquatic systems is 0.5 mg of acidic equivalents per acre (SERA 2010).

3.5.3.1.8 Imazapic

Imazapic is a systemic herbicide that provides selective pre- and post-emergence control of annual grasses (particularly cheatgrass and medusahead), some perennial grasses, and some broadleaf weeds. Imazapic inhibits amino acid production necessary for protein synthesis and cell growth (SERA 2004d). Imazapic is taken up in the foliage, stems, and roots of susceptible plant species. A surfactant must be used in post-emergent applications, most commonly a seed or vegetable oil.

Imazapic incorporates into the soil and provides a moderate period of soil residual activity (one or two growing seasons). Imazapic is not known to move laterally in the soil or leach deeply downward, so it remains within the treatment area (Tu et al. 2001).

Imazapic can be applied to seasonally wet, low-lying areas where the water has drained. However, since imazapic can be mobile in water, it is not recommended for use up to water's edge.

Woody species are generally tolerant of imazapic applied at typical use rates for most graminoid and broadleaf weeds, although seedlings and saplings could be injured or killed by overspray that covers the foliage and stems. Dormant trees are much less likely to be injured. Direct spray to foliage could result in minor damage. Trees or shrubs that are usually tolerant to imazapic but that are experiencing physiological stress due to environmental conditions (e.g., drought, storm damage, or insect or disease outbreaks) may become susceptible to injury.

As a selective herbicide, imazapic controls a specific range of annual and perennial grasses and forbs. Imazapic can be mixed with other herbicides such as picloram to provide dual control of annual grasses and weeds in the sunflower and mustard plant families in a single application (Tu et al. 2001). Post-emergent applications must be made to perennial weed species.

In some cases, target weed species are susceptible to imazapic while desirable native species are tolerant to this active ingredient. This makes imazapic very valuable for restoration projects in which weed control is required as a site preparation measure. For example, many native graminoids and forbs are tolerant of imazapic and can be seeded at the same time as imazapic is applied. Caution must be used, however, if herbicides with soil residual capability have been applied recently because compounded injury or mortality of newly seeded vegetation could result.

Imazapic is also used as a component of IWM for leafy spurge (Tu et al. 2001). Leafy spurge is a rhizomatous, very deep-rooted weed that is difficult to control. Fall applications of imazapic can be followed by seeding with graminoids to provide vegetation can compete with leafy spurge. Additionally, imazapic applications can assist with the establishment of biocontrol agents for leafy spurge by modifying stand structure of the weed infestation.

3.5.3.1.9 Imazapyr

Imazapyr is used to control grasses, broadleaf weeds, vines, brush species, and aquatic macrophytes (SERA 2011b). Imazapyr is a nonselective herbicide that can be used as both pre- and post- emergent control. It is more often used as a post-emergent herbicide, which appears to be the most effective method of weed control when using imazapyr. Imazapyr is applied using ground or aerial broadcast methods, generally directly onto the target species' foliage or through cut treatments.

In general, the herbicide is more toxic to dicots than it is to monocots, particularly in post-emergent applications (SERA 2011b). Imazapyr works relatively slowly, often taking several weeks or months to kill a plant. Imazapyr may not be effective against plants in the legume family, as they appear to actively exude imazapyr from the root system. The high soil mobility can cause surrounding non-target plants to become damaged as they absorb the herbicide through their surrounding root systems. Imazapyr is also easily absorbed through plant tissue and can thus cause harm to surrounding plants from drift during application (Tu et al. 2001).

Imazapyr is not an effective treatment option for submergent vegetation, and no formulations are labeled for submergent applications (SERA 2011b).

3.5.3.1.10 Metsulfuron methyl

Metsulfuron methyl is in the same sulfonylurea class of herbicides as chlorsulfuron and is very similar to chlorsulfuron. It is a selective herbicide formulated as a dry flowable (i.e., small granular pellets) that controls an array of broadleaf weeds. It works by inhibiting an enzyme, acetolactate synthase, which is essential for plant growth (SERA 2004e). Metsulfuron methyl is applied as a post-emergent treatment, unlike chlorsulfuron, which also works as a pre-emergent herbicide. Metsulfuron methyl activity is promoted by warm, moist conditions and is slower in cooler, dry weather (Trevathan 2002c). Metsulfuron methyl works best on plants in the early or vegetative stages of growth. Metsulfuron methyl is one of only a few herbicides in use that control weeds in the mustard plant family. It is also very useful in controlling weeds in the borage family.

Metsulfuron methyl is taken up in both the foliage and, to a lesser degree, the roots of susceptible plant species. It also incorporates into the soil and provides a period of soil residual activity. This period is, approximately one or two growing seasons. Because metsulfuron methyl remains active in the soil for some time, it can be transported away from the treatment site in wind or water erosion. The herbicide label cautions users when making applications to powdery or light, sandy soils. Metsulfuron methyl is also more mobile in alkaline soils as compared to acidic soils (Trevathan 2002c) because it breaks down more quickly in moist, acidic environments.

Metsulfuron methyl can be used up to the water's edge and can be applied to seasonally wet areas when no surface water is present. This makes it a valuable herbicide treatment in riparian areas or wetlands.

Woody species are generally tolerant of metsulfuron methyl applied at typical use rates for most broadleaf weeds, although seedlings and saplings could be injured or killed by overspray that covers the foliage and stems. Conifers are more tolerant than deciduous species. Metsulfuron methyl is labeled for weed control in conifer plantations, including Douglas-fir and ponderosa pine. However, conifer trees or shrubs that are experiencing physiological stress due to environmental conditions, such as drought or insect or disease outbreaks, may be susceptible to injury from metsulfuron methyl.

Although metsulfuron methyl may injure some deciduous tree or shrub species, it generally must be tank mixed with another herbicide (e.g., glyphosate or imazapyr) and applied as a canopy overspray to kill those species. Such applications are not made to native deciduous trees or shrubs.

Graminoids are also tolerant of metsulfuron methyl, although graminoids stressed by environmental conditions may be injured and experience temporary setbacks in vigor and

growth. Metsulfuron methyl can injure or kill seedling grasses that have not yet established sufficient root systems. It may also affect seed production in some grasses, depending on the use rate and the stage of seed production.

Members of the borage, mustard, and pea plant families are the most susceptible to metsulfuron methyl, while many members of the sunflower family are tolerant at typical use rates for most broadleaf weeds. Annual broadleaf weeds are best controlled by metsulfuron methyl when in early stages of growth. Perennial weeds are best controlled when in a rosette stage in the spring or fall, or prior to the bloom stage.

3.5.3.1.11 Picloram

Picloram is a systemic herbicide that provides excellent control of broadleaf and woody weed species in a number of different plant families. It is in the same class of herbicides as aminopyralid, clopyralid, and triclopyr. It functions by interfering with plant growth processes and is particularly active on broadleaf plants in the sunflower family and pea family, providing excellent control of weeds such as spotted knapweed at low use rates. It also works very well on deep-rooted perennial weed species such as leafy spurge and toadflax that are difficult to control. Plant species in the mustard family are tolerant of picloram and must be controlled with other herbicides.

Picloram is moderately to highly active in the soil (Trevathan 2002d) and can provide 1 to 2 years of residual control, reducing weed control costs. However, because picloram is persistent in the soil and because it is also very mobile in water, it can move through permeable soils into groundwater (Tu et al. 2001). For these reasons and because picloram is highly toxic to plants, picloram is a restricted-use herbicide that can only be used by trained and licensed herbicide applicators.

Because picloram controls woody species as well as broadleaf forbs, picloram can injure evergreen and deciduous tree and shrub species. Care must be taken during applications to control forbs to avoid spraying picloram on trees and shrubs and to remain well outside the drip line (i.e., outer circumference of the foliage). Mature plants are less susceptible than seedlings or saplings. Tolerance to picloram varies by species as well. Mountain mahogany and bitterbrush are highly susceptible to picloram, while many sagebrush species are tolerant to picloram at the rates applied to control broadleaf weeds.

Graminoids (grass, sedges, rushes) are generally tolerant of picloram. Graminoid growth and biomass may be set back by picloram, but the effects are temporary. Because picloram is so toxic to forbs, while graminoids are tolerant, picloram applications favor graminoids. Graminoid abundance and density in a plant community often increase when broadleaf weeds such as spotted knapweed are controlled with picloram. Although this can be a favorable outcome, for example, when native grasses replace spotted knapweed, unintended side effects may occur. Researchers have noticed secondary invasion of nonnative weedy mustards and cheatgrass (Pearson and Ortega 2009), especially when picloram is applied at high rates or applied repeatedly without a rest and recovery period. This is most likely to occur in areas that are highly infested with weeds such as spotted knapweed and with little desirable relict vegetation.

Picloram is highly toxic to forbs, even at low use rates (12–16 ounces/acre). One notable exception is the mustard family. Nonnative invasive plants as well as native members of the mustard family are tolerant of picloram. Numerous studies have examined the effects of picloram

to target and nontarget forbs in other plant families, particularly in the sunflower family. Results from short-term and long-term studies in western Montana all note the effectiveness of picloram to target broadleaf weeds and the potential injury or mortality it may cause to nontarget forbs (Rice et al. 1997a). Broadcast applications of picloram result in much greater impacts to nontarget plant species than do spot applications (Ortega and Pearson 2011).

Rice and his colleagues have studied spotted knapweed control in western Montana for several decades using a variety of herbicides including aminopyralid, clopyralid, dicamba, and picloram. Their research results show that plant communities are capable of recovery after weed invasion and weed control, including from picloram applications. Picloram can provide effective control of weeds for multiple years, and a recovery period between re-applications allows desired and native plant species to re-establish.

A 10-year study on big game winter range in the Lolo National Forest showed that lower picloram use rates provided good weed control for up to 3 years and had less effect on plant community diversity and more rapid recovery rates than did higher application rates. To counteract secondary invasion, imazapic was mixed with picloram; this provided early reductions in cheatgrass.

3.5.3.1.12 Rimsulfuron

Rimsulfuron is part of the sulfonylurea class of herbicides that inhibit acetolactate synthase. This leads to cessation of growth and visual deformations. Effects generally appear within a few days of treatment in target species. Rimsulfuron is mixed with water or surfactants for non-selective weed control.

Rimsulfuron is used in upland habitat but is not currently approved for aquatic applications. Rimsulfuron is considered highly toxic to aquatic macrophytes. Applications are carried out through both aerial and ground applications. Non-target terrestrial species are at risk from applications that cause drift outside of the target area.

Rimsulfuron is typically applied at 0.0469 pounds of active ingredient per acre, with a maximum application rate of 0.0625 pounds of active ingredient per acre.

Rimsulfuron is most often used as a post-emergent herbicide that targets annual and perennial broad-leaf weeds. However, it can also act as a pre-emergect herbicide to prevent the growth of weeds that have not yet emerged through soil application (USDI BLM 2014).

3.5.3.1.13 Sulfometuron methyl

Sulfometuron methyl is in the same sulfonylurea class of herbicides as chlorsulfuron and metsulfuron methyl. It is a broad-spectrum, nonselective herbicide (SERA 2004f). It is formulated as a dispersible granule that controls a wide range of graminoid and broadleaf weeds. It works by inhibiting an enzyme, acetolactate synthase, which is essential for plant growth (SERA 2004f). Sulfometuron methyl is taken up in both the foliage and roots. Sulfometuron methyl is one of only a few herbicides in use that control weeds in the mustard plant family. It is also very useful in controlling weeds in the borage family.

Sulfometuron methyl can be used for pre- and post-emergent weed control and is applied at very low rates. For post-emergent applications, sulfometuron methyl provides the best control when applied to weeds in the early stage of growth. Higher use rates are required when making

applications to established plants. Sufficient soil moisture is required to activate sulfometuron methyl and move it into the root zone, especially for pre-emergent applications.

Sulfometuron methyl incorporates into the soil and provides a period of soil residual activity. This period is typically short, about one or two growing seasons. Because it remains active in the soil for some time, it can be transported away from the treatment site in wind or water erosion. The herbicide label cautions users when making applications to powdery or light, sandy soils.

Sulfometuron methyl can be applied to seasonally wet areas when no surface water is present. When surface water is present, the label direction requires a 15-foot buffer from the water's edge when making hand-held spot applications. The label specifies this buffer when applying sulfometuron methyl near water to protect aquatic vegetation and surface water from drift (Appendix C of the Botany and Vegetation Resources Specialist Report (USDA Forest Service 2020d).

Conifer species are generally tolerant of sulfometuron methyl applied at typical use rates for most graminoid and broadleaf weeds, although seedlings and saplings could be injured or killed by overspray that covers the foliage and stems. Dormant trees are much less likely to be injured. Douglas-fir, lodgepole pine, and ponderosa pine are tolerant of sulfometuron methyl; it is labeled for weed control in conifer plantations. However, conifer trees or shrubs experiencing physiological stress due to environmental conditions, such as drought or insect or disease outbreaks, may be susceptible to injury from sulfometuron methyl. The addition of a surfactant increases the risk of injury or mortality.

Overall, deciduous trees and shrubs are less tolerant than conifers. Some deciduous species are tolerant of sulfometuron methyl, while others are susceptible. Tolerance or susceptibility depends on the species, age class, season of application, use rate, and environmental stress. Seedlings and saplings could be injured or killed by overspray that covers the foliage and stems. Dormant trees are much less likely to be injured. Trees or shrubs growing in acidic soils are more susceptible to sulfometuron methyl. Trees or shrubs experiencing physiological stress due to environmental conditions, such as drought or insect or disease outbreaks, may be susceptible to injury from sulfometuron methyl. The addition of a surfactant increases the risk of injury or mortality.

As a broad-spectrum, nonselective herbicide, sulfometuron methyl is toxic to many annual and perennial graminoid and broadleaf species. Because moisture is necessary for activation of sulfometuron methyl, this herbicide in arid regions (less than 20 inches of precipitation per year) must be used in seasons when soils are moist and some level of precipitation can be expected. Higher use rates may be required to provide control in arid regions.

3.5.3.1.14 Triclopyr

Triclopyr is a selective, systemic herbicide used in the control of aquatic, broadleaf, and woody weed species. Triclopyr works by disrupting plant growth processes. Triclopyr breaks down quickly and does not typically persist in the soil for more than a few weeks to a few months. Triclopyr does persist in plant material until it dies and begins to decay (Tu et al. 2001).

Triclopyr comes in two forms (SERA 2011d), but only the amine is used in the salt form, as the ester form volatilizes easily. Both forms degrade rapidly to the parent compound, triclopyr acid, in the soil (Tu et al. 2001). Triclopyr can leach in permeable soils. The amine salt form is more mobile in soil than the ester form; however, leaching is considered minor in a field setting (Tu et

al. 2001). Label direction recommends caution when considering triclopyr applications in areas with permeable soils and shallow water tables. Triclopyr is also considered highly mobile in water, the amine form more so than the ester form, although this is not a problem because triclopyr degrades very quickly to the parent acid in an aquatic environment and does not persist (Tu et al. 2001).

As an aquatic herbicide, triclopyr can be applied directly to water to control aquatic weeds. Triclopyr can also be applied to seasonally dry wetlands (e.g., floodplains) and to transitional areas to control broadleaf and woody weed species.

Triclopyr has very little to no effects on graminoids. Likewise, triclopyr is primarily an herbicide for the control of woody species and controls only a limited number of broadleaf weeds in a few plant families. Triclopyr would seldom be used to control broadleaf weeds.

Triclopyr is a selective herbicide that controls trees and brush and, as such, woody conifer and deciduous species are generally susceptible to triclopyr. The amine form of triclopyr does not readily penetrate woody plant cuticles, so directed foliage sprays with the addition of an effective surfactant or cut surface treatments are needed (Tu et al. 2001). The method of application depends on the presence and type of nontarget woody vegetation. Cut surface application methods provide a high degree of protection to surrounding nontarget vegetation, while directed foliar spray methods may be used when the potential for nontarget damage is not present (SERA 2011d). For example, cut surface treatments on saltcedar would be appropriate when saltcedar occurs mixed in with native trees or shrubs, while directed foliar spray would be appropriate should saltcedar occur in stands unmixed with native trees or shrubs.

3.5.3.1.15 Monitoring and Treatment Effectiveness

Both the CTNF and CNG routinely implement a variety of monitoring practices. These include design criteria implementation monitoring, effectiveness monitoring, field observations, photo points, and reports that summarize annual invasive plant management activities. These various types of monitoring help to assess progress with invasive plant management and comply with USDA Forest Service protocols.

Monitoring informs invasive plant managers of the effectiveness of invasive plant control measures and impacts to nontarget vegetation, and detects the trend, up or down, of vegetation and soil resources. This includes sensitive plant populations. Monitoring performed in sensitive plant populations helps invasive plant program managers determine the efficacy of the invasive plant control treatments, the response of nontarget vegetation, including sensitive plants, and the habitat condition. Managers use the monitoring to make adjustments to IWM, as needed, to achieve the desired condition for the site.

3.5.3.2 Alternative 1—No Action/Current Management

The No Action Alternative continues the IWM program as it is currently implemented in the project area. In general, this alternative includes the treatment of invasive terrestrial plants utilizing biological, mechanical, or herbicide treatments. Herbicide application under this alternative is limited to the treatment of terrestrial invasive plants with 13 herbicides and ground-based application techniques exclusively.

3.5.3.2.1 Direct and Indirect Effects

3.5.3.2.1.1 Treatment Methods

The current invasive plant management program utilizes a variety of tools, used alone or in combination, to treat invasive plants (Table 3-33). Treatment methods include the following:

- Classical biological control through the use of predators, parasites, and pathogens.
- Biological control using livestock (targeted grazing).
- Herbicide control using ground-based spot and broadcast application methods.
- Mechanical methods, such as hand-pulling, mowing, cutting, or torching.

Table 3-33. Acres of Weed Treatment by treatment method within the Caribou-Targhee National Forest (CTNF).

YEAR	METHOD OF TREATMENT (ACRES)				
	Pesticide Application	Mechanical	Biocontrol-Classic	Biocontrol Livestock	Total Acres Treated
2010	53	-	-	-	53
2012	19,448	-	59	-	19,507
2013	28,885	114	150	-	29,149
2014	43,834	2,774	30	-	46,638
2015	47,767	118	41	2,774	50,700
2016	63,378	58	42	118	63,596
2017	77,605	980	8,119	-	86,704
2018	24,105	-	-	-	24,105
2019	32,899	-	-	-	32,899
Totals	**337,974**	**4,044**	**8,441**	**2,892**	**353,351**

Table 3-34 displays herbicides currently approved for use in the CTNF and the CNG. Combinations of herbicides may be the most appropriate treatment where several species of noxious invasive plants occur together, or where the herbicides affect invasive plants differently. For example, a mixture of picloram and imazapic, which are both broadleaf-selective herbicides, is commonly used to simultaneously treat invasive plants in the sunflower family (picloram) and in the mustard family (imazapic). Herbicide treatment is also used in conjunction with, or preceding, cultural or mechanical treatments, depending on invasive plant species composition, infestation level, and environmental setting.

3.5.3.2.1.2 Biological Control

The current use of biological treatments includes the use of biological control techniques and targed grazing. Biocontrol agents and targeted grazing are used to supplement herbicide control in larger infestations where treatment cannot be accomplished regularly due to its cost. Table 3-33 displays the 3-year average number of annual biological control releases in the project area (USDA Forest Service 2020e).

Table 3-34. Herbicides, by active ingredient, currently approved for use in the Caribou-Targhee National Forest (CTNF) and the Curlew National Grassland (CNG).

HERBICIDE (ACTIVE INGREDIENT)	COMMONLY USED BRAND NAMES[a]	MAXIMUM LABEL APPLICATION RATE (LBS AI[b] OR AE[c]/ACRE)	TYPICAL APPLICATION RATE (LBS AI[b] OR AE[c]/ACRE)	APPLICATION SETTING[d]	
				Nonaquatic	Aquatic
2,4-D amine	Amine 4, Weedar® 64	2.0 lbs ae/acre/application 2 apps per year	1.0–2.0 lbs/acre	X	X
Aminopyralid	Milestone	0.11	0.078–0.11	X	
Chlorsulfuron	Telar	2.6 oz product/acre/year (0.12 lb ai/acre/year)	0.01–0.02 oz/acre	X	X
Clopyralid	Transline®	0.5 lb ae/acre/year	0.1–0.5 lb/acre	X	X
Dicamba	Banvel®	2.0	0.5–2.0		X
Glyphosate	Rodeo®, Roundup®, Accord®	1.7 lbs ae/acre/app ≤8.0 lbs ae/acre/year	0.5–3.0 lbs/acre	X	X
Imazapic	Plateau®	0.19 lb ai/acre/year	0.09–0.16 lb/acre	X	X
Metsulfuron methyl	Escort®	4.0 oz product/acre/year (0.15 lb ai/acre/year)	0.01–0.02	X	X
Picloram	Tordon™	1.0 lb ai/acre/year	0.25–1.0 lb/acre	X	
Sulfometuron methyl	Oust Weed Killer and DPX 5648	8.0 oz product/acre/year (0.37 lb ai/acre/year)	2.0–6.0 oz/acre (0.09–0.28 lb/acre)	X	X
Triclopyr TEA (triethylamine salt)	Grandstand®, Forestry Garlon® XRT, Pathfinder®	2.0	1.0–2.0	X	X

[a] List represents brands most commonly used, although brands other than those listed may also be used.
[b] AI = active ingredient.
[c] AE = acid equivalent.
[d] Some formulations are suitable for aquatic application; suitability for aquatic or nonaquatic application is noted on product labels.

Biological control treatment data for the years 2010 through 2019 identify 8,441 acres treated by classic biological control (insects) and an additional 2,892 acres treated by targeted livestock grazing within the project area.

Some biocontrol agents have noticeably affected the target species, such as thistle seed head weevil on nodding plumeless thistle. Others have had little to no apparent effect in reducing plant vigor, seed production, plant density, or any of the other factors associated with successful biological control. Many of these agents were released 10 or more years ago, so the agents have had sufficient time to adapt to local conditions and build population levels high enough to impact target invasive plants. Even those agents that are common and widespread throughout the range of the target species, however, display effects insufficient to provide desirable control levels. Although biological control itself, including targeted grazing, has not produced desired control levels, it is an important component to an IWM approach and can increase control efficacy in conjunction with other treatment methods.

Native Vegetation Communities

There are many reasons why invasive plants are able to overwhelm native plant communities and establish themselves as the dominant plant species even on undisturbed sites in excellent condition. One reason is that most invasive plant species arrived in the United States, often as seeds, without the array of natural enemies that keep their populations in check in their native ranges (Westbrooks 1998). These natural enemies include insect pests, fungi, parasitic organisms, and pathogens, as well as birds and mammals that consume plant material. Native plants are often competitively disadvantaged compared to invasive plants because the native plants still must contend with natural enemies and foraging animals.

Classical biological control is the introduction of host-specific plant pests and pathogens from their native ranges into new areas across the world, where they can be used to control invasive plants (Harris 1991). Many factors influence the success of biocontrol agents that target invasive plants (Morin et al. 2009, Van Driesche et al. 2010). While some biocontrol agents can fly and readily spread to other invasive plant infestations, others have to crawl from host plant to host plant, which slows their rate of spread. Habitat conditions must be right to establish and reproduce, and some agents cannot survive the annual variations in our climatic regime. Others are difficult to obtain and are expensive to rear or purchase. Some reproduce, and therefore spread, more slowly, and supplemental releases may be required. The impacts of biological control also appear to be cyclic, meaning that invasive plant populations can vary as the populations of biocontrol agents wax and wane in response to invasive plant populations, site conditions, and other factors.

As a result, biocontrol is a slow, long-term process that is often less successful than other forms of invasive plant control, especially where it is the sole form of management. Biological treatment is typically implemented when other treatment methods are not an option.

In some cases, biological control does not provide a long-term solution to invasive plant control objectives. Biocontrol agents may not be well adapted to an area and may have difficulty becoming established, reproducing, and spreading. The negative impacts to the target plant may be insufficient to have an impact on the larger target plant populations because the biocontrol agents may be unable to substantially reduce seed production or only slightly reduce plant vigor. As a result, the target plants can maintain root reserves and are able to recover from the effects of the biocontrol agent. In recent years, a more promising biocontrol agent for spotted knapweed, a root weevil (*Cyphocleonus achates*), has been introduced. This agent has proven able to successfully establish, overwinter, and spread independently (albeit very slowly) within the project area. However, substantial reductions to spotted knapweed populations have not yet been observed except for a few localized settings. Ongoing field observations elsewhere indicate that it may take 10 to 20 years for this agent to begin to effectively reduce plant density, vigor, and seed production in spotted knapweed infestations (Randall 2014). Additionally, one biocontrol agent used to manage nodding plumeless thistle, the thistle crown weevil (*Trichosirocalus horridus*), has been shown to be successful in reducing nodding plumeless thistle's establishment and spread, both within Idaho and elsewhere (Randall 2014). As part of an IWM program, control agents can help reduce plant density and vigor. Treatment efficacy cannot usually be determined at a release site for at least 3 to 5 years; often it may take many more years for agents to establish, spread, and build to population densities sufficient to show impacts to the target invasive plant infestations.

Targeted grazing also is unlikely to independently achieve management objectives of an invasive species, but can be an important tool when used in combination with other control methods, including classcical biological control and herbicides.

Special-status Plant Species

Classical biological control is the introduction of host-specific plant pests and pathogens from their native ranges into new areas across the world where they can be used to control invasive plants (Harris 1991, Sheley and Petroff 1999). Within the project area, biocontrol agents have no direct effects on nontarget plants. APHIS regulates the approval process for biocontrol agents, and extensive testing is required to be certain biocontrol agents demonstrate host species specificity prior to being approved for use. In the past, when standards were not as strict, some agents were found to shift to nontarget plants that were closely related to the host plant species (Simberloff and Stiles 1996). Typically, biocontrol agents are only approved when they have been shown to be host specific; thus, they do not pose a threat to nontarget species.

The effect of biocontrol agents on native plant communities is usually expressed indirectly. If agents are successful in reducing seed production, impacting host plant vigor, or slowing the rate of invasive plant spread, then desirable plant communities may be better able to withstand the impacts associated with invasive plant infestation and maintain a viable presence in the altered plant community. However, unless a biocontrol agent is very successful, this beneficial effect may be minor. The indirect benefits may also be short-lived or cyclical, as populations of biocontrol agents naturally fluctuate based on environmental conditions and host plant populations.

Another potential scenario could occur in a sensitive plant population infested by multiple invasive plant species. There could be a reduction in density of one invasive plant due to an effective biocontrol agent, thereby resulting in an increase in density of other invasive plants occupying the site. In such a case, this would not result in a reduced need for mechanical or herbicide treatment.

Another option for biological control is the use of targeted grazing. This usually involves the use of goats that have been trained to target noxious and invasive species. This method does pose more of a threat to nontarget species than classical biological control, but the impacts tend to be incidental (trampling and nipping). However, the overall benefit of less competition from nonnative species is positive to native vegetation, including special-status plant species.

3.5.3.2.1.3 Herbicide Control

Native Vegetation Communities and Special-status Plant Species

Herbicides are usually classified based on their chemical structure or mode of action and are taken up by plant roots or through foliage and transported within the plant through the vascular system. Herbicides kill or stress plants by inhibiting enzymes involved in photosynthesis, respiration, and other physiological processes (Bussan and Dyer 1999).

Herbicide application, utilized properly, is an important tool in managing invasive plants. Management of invasive plants that allows desired vegetation to recover from invasive plant infestation and strongly re-establish following herbicide treatment can be accomplished by applying the appropriate herbicides at appropriate rates and by using appropriate application techniques that minimize effects on desirable species. The use of design criteria and application

techniques contributes to successful herbicide management by minimizing impacts to desirable plant communities.

The intention of an herbicide application is to eradicate or suppress infestations of invasive plants through direct mortality, decreased plant density, reduced competitiveness, and cessation of seed production or root system expansion (Bussan and Dyer 1999). The intended result is expressed in an increase in desirable plant abundance and vigor, creating more invasive plant-resistant plant communities.

Although herbicides have the potential to affect both invasive plants and desirable plants, there are differences in susceptibility to herbicides among plant species and families (Rice and Toney 1998). Some plants metabolize herbicides, which reduces toxic effects. Some species do not readily absorb herbicides through foliage and roots. For herbicides to be effective, they must be taken into the plant and impair physiological processes (Bussan and Dyer 1999).

Plant species that have similar growth forms and genetic composition often are similarly affected by herbicides; consequently, herbicides have the potential to adversely affect invasive plants and desirable plants possessing similar growth forms, genetic makeup, and life history characteristics (Rice and Toney 1998). In general, most herbicides currently being used (with the exception of glyphosate) have a higher potential to affect broadleaf plants than to affect graminoids (grasses and sedges) (Rice and Toney 1998, Bussan and Dyer 1999). Therefore, desirable broadleaf species have a higher potential to be adversely affected by herbicide application than do desirable graminoids.

A particular herbicide is chosen based on the target invasive plant species, presence of desirable nontarget vegetation, proximity to water, and distribution of desirable species. Site factors and season of use are also considerations. Clopyralid is an example of one of the most selective herbicides currently in use, while glyphosate is a nonselective herbicide that will kill most plant species, including graminoids.

In addition to herbicide selection, technique is also an important decision. The two primary types of herbicide application used are spot treatment and broadcast application. Spot treatment is performed by spraying individual plants and the area directly adjacent to them, avoiding the application to nontarget plants as much as possible. Within the CTNF and CNG most herbicide application is made as spot treatments.

Broadcast application is only chosen when the number of spot applications necessary to treat an infestation is so large as to make it impractical or where the areas adjacent to the invasive plants overlap. Managers make the decision to spot treat or broadcast spray based primarily on the size and density of the invasive plant population, terrain, and proximity to water. The size of infestations (larger) and the density of invasive plant cover (higher) sometimes result in a need for broadcast applications. Also, on flatter terrain, mechanized equipment may be preferred for broadcast applications due to cost considerations. In order to keep nontarget impacts to a minimum, it is important to maintain application equipment properly functional and calibrated, select herbicides less likely to cause damage, and use the lowest effective application rate.

Spray units may be mounted on vehicles such as trucks or utility vehicles (UTVs). A vehicle-mounted sprayer is not synonymous with broadcast application, since these units are set up to perform spot or broadcast applications. Personnel perform very little broadcast application on the CTNF or CNG. First, most infestations in the project area are small (less than 1 acre in size) and

do not yet consist of monocultures of invasive plants. The invasive plant cover in infestations managed for eradication or control is typically very low, often amounting to only about 10 percent of the vegetation within the infestation. The areas where large infestations exist are typically not accessible by ground-based equipment and are not treated. Secondly, spot applications are preferred wherever possible to reduce impacts to nontarget plant species to the extent possible. Mechanized equipment is not suitable for finely tuned spot applications, although some target selectivity can be achieved by turning nozzles off and on as needed when invasive plant distribution is patchy. Almost all vehicle-mounted broadcast applications are made along year-round open roads that receive heavy recreational traffic. This level of traffic greatly increases the number of infestations that establish, necessitating annual invasive plant control. Crews using vehicle-mounted sprayers apply herbicide only where invasive plants are found, creating stretches of broadcast application interspersed with stretches where no herbicide is applied because no invasive plants are found.

Native forbs are important components of many plant communities (Pokorny et al. 2004), and most native forbs serve as pollinator plants for a variety of insect pollinators. Native forbs are best for native insect pollinators, such as bees or butterflies, for several reasons. Native forbs and their pollinators are a) well-adapted to one another, with native forbs providing habitat across the landscape at the right time of the year for various populations of pollinators, b) native forbs provide not only forage in the form of nectar and pollen, but also habitat for resting, mating, or laying eggs, and c) native plants are adapted to local growing conditions.

Processes such as weed invasion and weed control disrupt plant community composition, structure, and function (Pearson and Ortega 2009). Although some invasive plants, such as spotted knapweed, can provide forage for native pollinators, their overall impacts on an ecosystem far outweigh the possible benefits. In some cases, insect pollinators are even known to contribute to the spread of nonnative invasive plants by increasing the number of pollinated flowers and, therefore, seed production (Barthell et al. 2001).

Likewise, weed control can also impact nontarget forbs. Herbicide application, in particular, has the potential to affect pollinator plants, for example, favoring graminoids over forb species (Crone et al. 2009). CTNF and CNG weed program managers have multiple options to reduce the impact of herbicide application on native pollinator plants, including herbicide selection, application technique, lowest effective use rate, season of herbicide application, and using spot applications wherever possible. Researchers note specifically that utilizing spot applications everywhere possible helps to reduce this impact (Pokorny et al. 2004, Crone et al. 2009, Pearson and Ortega 2009, Ortega and Pearson 2011). Spot herbicide application is the preferred method wherever possible.

In addition, in the project area, the effects of herbicide application are moderated by the scale at which invasion and herbicide application occurs. About 4 percent of the project area is infested by noxious weeds and, in general, native plants are still present in invaded areas (USDA Forest Service 2020e). A majority of areas treated with herbicide application are small, less than 1 acre in size (USDA Forest Service2020e). The persistence of even low densities of native forb species and seed banks furnish the components to restore pollinator plant species and their pollinators, even in invaded areas. Herbicide application would result in short-term impacts to pollinator plants, but could yield long-term benefits when implemented as part of an IWM strategy.

In addition to plant mortality, several other considerations are associated with herbicide application, including spray drift, herbicide movement in soil and water, and spray adjuvants. Herbicide label direction and design criteria address these considerations. Spray drift is easily managed and there are a number of design criteria (such as maximum allowable wind speed) that address the management of spray drift.

The possibility of herbicide movement in soil depends on a number of factors, including properties of the herbicide selected for use, site-specific conditions (such as topography, soil type, and depth to the water table), and the climatic regime. Motility varies among herbicides; some are highly mobile in soil while others are not (SERA 2011 a-d, 2010, 2007 a-b, 2004 a-f). Picloram, for example, can be highly mobile in soil depending on site conditions, while glyphosate is not mobile. Herbicide is more likely to move in soil on steep slopes and on porous soils, especially soils with little organic matter. Areas with high annual precipitation are usually more prone to the risk of movement than arid climates, as are areas experiencing high intensity rainstorms.

There are two primary concerns regarding the movement of herbicide through soil or water, away from the application site. The application cannot perform as intended if the herbicide moves downward in the soil profile below the target invasive plant root zone. Likewise, leaching through the soil could affect nontarget vegetation off site while not accomplishing the purpose of the application.

The other concern is that the herbicide could unintentionally be moved into water, whether through water flow that washes the herbicide away (such as a high-intensity rainstorm) or via movement of the herbicide into the water table or a waterbody. Herbicide that enters water unintentionally at high enough concentrations could potentially harm aquatic organisms such as aquatic vegetation, invertebrates, or fish. Although this scenario is unlikely given the type of herbicide applications made, managers are aware of the possibility of herbicide movement off site and therefore consult herbicide labels with the objective of avoiding movement when making decisions on herbicide selection and use rates.

Herbicides are registered by the EPA and every herbicide, as required by federal law, has a label that provides EPA and manufacturer guidance and instructions on the safe and proper use of the herbicide. Federal law requires compliance with an herbicide label. Adherence to label guidance and instructions are identified as design criteria. Instructions on herbicide labels provide measures to minimize the likelihood of herbicide movement in soil, such as specifications on how close to water an herbicide may be applied. For example, the label for clopyralid notifies the applicator that "clopyralid is a chemical that can travel (seep or leach) through soil." The label instructs the user not to apply clopyralid directly to water, to areas where surface water is present, or to intertidal areas below the mean high-water mark. The label also advises applicators not to apply this herbicide to soils with rapid permeability. The fisheries (USDA Forest Service 2020b) and soil and water (USDA Forest Service 2020c) technical reports further discuss the effects of herbicide soil and water motility to these resources.

The term "spray adjuvant" is a catchall phrase for substances added to an herbicide or spray mix to aid in mixing and applying or to improve the efficacy of an herbicide application (Tu et al. 2001). These substances commonly include adjuvants such as water conditioning agents to buffer hard water, surface active agents (surfactants) to reduce the surface tension of water drops (so that spray solution spreads out on plant surfaces and does not run off), or indicator dye (used

to show sprayed areas so that applicators do not over-apply or miss patches of invasive plants). Adjuvants may be added to the herbicide formulation at the manufacturing facility or added when applicators are mixing spray at the application site. To be effective, some herbicides, such as imazapic, require the addition of a surfactant-like vegetable or seed oil. Other herbicides, especially when applied to young plants, may need no surfactants. Herbicide labels advise or instruct applicators on the selection and use rates of adjuvants.

Because adjuvants do not contain active ingredients that cause plant mortality, these substances are not subject to same federal laws that govern herbicides. However, this does not mean that all adjuvants are without potential to cause harm to nontarget vegetation. Some, such as indicator dye, do not pose a risk of harm to plants while others, such as some surfactants, are capable of inflicting plant injury. As an example, some surfactants contain acidifying agents. These agents can be useful in damaging the epidermal surface of plants, allowing an herbicide to more easily penetrate the leaf surface of target plants. However, the acidifying agent can have the same effect on the leaves of nontarget plants and increase the potential for injury or mortality to nontarget plants. Weed program managers routinely consult herbicide label direction when making decision about adjuvant use to select the proper adjuvant for a particular herbicide and to select the lowest effective use rate to reduce nontarget plant damage.

Although herbicides have the potential to affect both invasive plants and desirable plants, there are differences in susceptibility to herbicides among plant species and families (Rice and Toney 1996). Some plants (both invasive plants and desirable plants) metabolize herbicides, which reduces toxic effects. Some species do not readily absorb herbicides through foliage and roots. For herbicides to be effective, they must be taken into the plant and impair physiological processes (Bussan and Dyer 1999).

Plant species that have similar growth forms (e.g., leaf structure and root systems) and genetic composition often are similarly affected by herbicides; consequently, herbicides have the potential to adversely affect invasive plants and desirable plants that have similar growth forms, genetic makeup, and life history characteristics (Rice and Toney 1996). In general, most herbicides currently being used (with the exception of glyphosate) have a higher potential to affect broadleaf plants than graminoids (grasses and sedges) (Rice and Toney 1998, Bussan and Dyer 1999).

The most common direct effect of herbicide to susceptible plants is mortality, since that is the function of an herbicide. Nonlethal effects include reduced plant growth, reduced biomass and vigor, and reduced reproductive success. Indirect adverse effects can be more difficult to observe and ascertain than the direct effects. For example, an impacted plant may have difficulties with photosynthesis and in acquiring and storing nutrients or water (Bussan and Dyer 1999). Its competitive ability may be reduced for a period of time. Detrimental indirect effects on nontarget plants may involve a prolonged period of recovery to restore biomass and regain the root reserves needed to resume seed production or vegetative reproduction.

Nontarget plants can also be affected by residual herbicide activity (Bussan and Dyer 1999). Herbicides that are short-lived and become detoxified in a few days or weeks, such as 2,4-D, have less potential to indirectly affect nontarget plants through soil activity. Other herbicides, such as picloram, can remain active in the soil for more than 1 year. As an example, native plants that were dormant during a late summer herbicide application could be damaged by residual amounts of picloram the following spring when plant growth resumes. Nonlethal damage could

include reduced biomass, vigor, and reproductive success. However, studies from western Montana using picloram, clopyralid, and 2,4-D found no evidence of lingering damage from residual herbicide concentrations at the plant community level (Rice et al. 1997a, Rice and Toney 1998).

Applications of a nonselective herbicide, such as glyphosate, made during active growth stages would kill or injure individual plants of most of the sensitive plant species most likely to be affected (with the exception of whitebark pine; only foliage that was directly sprayed would be affected). However, glyphosate does not have any soil residual activity and if applied at a time when invasive plants were actively growing, but sensitive plants were dormant, then the application would have no direct or indirect adverse effects.

Across the forest, whitebark pine habitat is little infested with invasive plants at present, although abundant roads and trails increase the susceptibility of the habitat to invasion (Prather 2007). Due to its growth form as a tree, mature whitebark pine would seldom be exposed directly to herbicide, although seedlings and saplings could be.

Herbicide applications to control invasive plants within populations of sensitive plant species would have the potential to adversely affect individual plants and small groups of plants, especially when plants actively grow in the spring and early summer. Herbicide applications made in the late summer or fall, when plants are dormant, would have less potential for direct effects.

Spot spraying of invasive plants in and near sensitive plant populations would greatly reduce the risk of mortality to individual plants. Other standard operating practices that reduce the impacts of herbicide application to sensitive plant species include herbicide selection and the lowest effective herbicide use rate.

In addition to herbicide selection and lowest effective application rates, technique is also an important decision. The two primary types of herbicide application used are spot treatment and broadcast application. In a broadcast application, herbicide is sprayed over the top of vegetation and is applied to both target and nontarget vegetation. Broadcast application is not used in and directly adjacent to known sensitive plant populations. In contrast, spot treatment is performed by spraying individual invasive plants and the area directly around them, avoiding application to nontarget plants. Only spot herbicide application is made in and directly adjacent to known sensitive plant populations. Spot application of herbicides greatly reduces the impacts to individual sensitive plants and therefore to sensitive plant populations as well.

Overall, the amount of herbicide applied annually throughout the project area is very low. Some invasive plant managers also consider other aspects of herbicide application, such as volatilization, drift, and movement of herbicide through soil or water. Herbicides can move with eroding or windblown soil or with surface or subsurface water. Herbicides can also move through the air as spray drift, which occurs during herbicide application, and volatilization, which could occur after application. Spray drift is dependent on spray equipment parameters such as nozzle orifice size, boom height and pressure, and wind speed (Branham and Hanson 1987). Volatility is dependent on the physical properties of the herbicide, primarily vapor pressure.

Volatilization is the conversion of a liquid or solid chemical to a gas. In the case of an herbicide that volatilizes, the vapor can then move, via air currents, away from the treatment site and affect

nontarget plants. The amount of volatilization occurring is dependent upon climactic and microclimactic conditions. Soil moisture is the primary environmental condition that influences the rate at which herbicides volatilize; in general, herbicides volatilize more rapidly from moist soils than from dry soils (Menalled and Dyer 2005). Volatilization also increases with higher air and soil temperatures and increasing windspeed. Ester formulations of herbicides have higher vapor pressures and volatilize more than amine formulations (Nice 2004).

The potential for volatilization can be minimized in a number of ways, some of which are operational and some environmental. Both the CTNF and CNG only use herbicides with low volatilization potential. The Invasive Plant Management program uses only amine formulations and no ester formulations (which are more likely to volatilize). Only water is used as a carrier. Adherence to label directions, such as the use of specific adjuvants, further reduces the likelihood of volatilization.

The climatic regime in the project area is one of low annual precipitation and soils are naturally dry, which reduces the potential for volatilization from the soil. Application does not occur in areas where rain is expected within hours, based on twice-daily weather forecasts from the National Interagency Fire Center. These conditions further reduce the likelihood of volatilization.

Because weed programs use only herbicide with low volatilization potential and further reduce the risk of volatilization with standard operating practices based on USDA Forest Service risk assessments and herbicide label direction, it is very unlikely that any nontarget vegetation or special-status plants would be affected by volatilization.

Spray drift is the movement of herbicide, generally via spray droplets, away from the target area. Spray drift is easily managed through standard operating practices. The primary way in which spray drift can be reduced is by increasing droplet size. This can be done by reducing spray pressure, increasing nozzle orifice size, using drift reduction nozzles, and adding adjuvants to the mixture. Design criteria, such as maximum allowable wind speed, help further reduce the potential for spray drift. Spray drift is more likely to have an effect on nontarget vegetation, including sensitive plants, than is volatilization.

Individual plants could come into contact with, and be harmed by, spray drift. Effects of spray drift to individual plants could include nonlethal damage to vegetation or to reproductive structures, such as flowers or developing seeds. Depending on how much spray drift contacts the plant, damage could be minimal and transient; in this case the plant would quickly recover. Conversely, drift that covered a plant could severely injure it or even kill it. The probability of spray drift affecting an entire population is very low, however; effects would most likely occur to individual plants or to small groups of plants.

The possibility of herbicide movement in soil depends on a number of factors, including properties of the herbicide selected for use, site-specific conditions (such as topography, soil type, and depth to the water table), and the climatic regime (e.g., annual precipitation and season of highest precipitation). Motility varies among herbicides; some are highly mobile in soil, while others are not (USDA Forest Service risk assessments). Picloram, for example, can be highly mobile in soil depending on site conditions, while glyphosate is not mobile. Herbicide is more likely to move in soil on steep slopes and on porous soils, especially soils with little organic matter. Areas with high annual precipitation are usually more prone to the risk of movement than arid climates, as are areas that experience high-intensity rainstorms.

Lateral downslope movement of an herbicide through the soil could affect nontarget vegetation off site. While it is conceivable that herbicide movement in soil could affect special-status plants, the likelihood is slight. Soils in the project area are not greatly affected by wind erosion, and major movement of soil at a landscape scale is rare.

Attention to herbicide label directions, standard operating practices (e.g., herbicide selection), and adherence to design criteria successfully minimize the effects of invasive plant control upon nontarget vegetation and special-status plant populations.

Individual plants or small groups of plants may be affected by invasive plant control; however, overall distribution in suitable habitats and metapopulation structure would not be affected. In conclusion, although indirect means (i.e., volatilization, drift, movement in soil or water) of herbicides contacting individual plants or groups of plants or special-status plant species cannot be completely discounted, the fact remains that the most likely way nontarget vegetation is impacted by herbicides is by direct spray.

Herbicide application can also have beneficial effects, via indirect improvements in plant community composition, function, and structure, as a result of invasive plant control. The first and most immediately observable indirect effect of invasive plant control is the reduction in cover, density, and vigor of the invasive plant species. This effect results in an increased availability of water and nutrients that were previously claimed by the more competitive, invasive plants (Bussan and Dyer 1999). The canopy cover of invasive plants is reduced, allowing native plants greater access to sunlight for photosynthesis. Eventually, native plants are able to regain vigor in the absence of competing invasive plants. Increased biomass and reproductive success are then possible, as is recruitment of new plants into the native plant community.

Vegetation Group

The following sections address specific nontarget vegetation groups and the direct and indirect effects of herbicides to these groupings. Invasive plant species currently present in the project area have the highest potential to invade grasslands, shrublands, and low-elevation conifer cover types, especially sites where the soil and native vegetation have been disturbed. Grasslands and low-elevation mixed evergreen shrub cover types are especially vulnerable to invasive plants, due to lower annual precipitation, longer growing seasons, higher degree of human use, the lack of a forest overstory to inhibit shade-intolerant invasive plants, and the open structure and distribution of plants. For this reason, analysis is directed more toward graminoids and forbs than other vegetation groups.

Coniferous Trees

The frequency of weed invasion and rate of weed expansion in conifer plant communities often depends on disturbance: the type of disturbance, the frequency and severity of disturbance, the scope of the disturbance, and the amount of time it takes an area to recover vegetatively from disturbance (Zouhar et al. 2008).

Conifers as a group are not very susceptible to many herbicides, but they may be variably affected based on species and age as well as the herbicide, the application rate, and the application techniques used. Direct effects are most common on conifer seedlings; they are most likely to experience direct contact with herbicides because they have not yet grown beyond the height of most targeted invasive plant species. Effects may include lethal or nonlethal damage.

Older trees (from the sapling stage up) are much less likely to experience any direct or indirect effects, because their foliage is well above the height of understory plants and their bark has thickened.

Within the project area, invasive plant infestations in conifer cover types occur in two very different settings. Moist conifer cover types occur at higher elevations with higher annual precipitation, have colder night-time temperatures, shorter growing seasons and, often, dense overstory canopies and multiple layers of understory vegetation. Many invasive plants within the project area are shade-intolerant, meaning that the density and vigor of invasive plants are inversely related to shading and competition from overstory trees, saplings/seedlings, and understory vegetation. These characteristics tend to preclude invasion by those invasive plant species that presently infest the CTNF and CNG, except along dispersal corridors and routes where conifer overstory has been cleared within the right-of-way of the road or trail (Parks et al. 2005, Pollnac and Rew 2013). Invasive plant infestations occur where roads and trail corridors intersect these cover types, but the infestations generally do not extend into the conifer plant communities (USDA Forest Service 2020e). Herbicide is applied as needed along the road and trail corridor, with no effects on the moist conifer cover types.

At the other end of this spectrum are the dry conifer cover types. Many of the noxious weed species infesting landscapes within the 2-forest area readily invade lower elevation forests, particularly where these cover types have been disturbed repeatedly by road construction, timber harvest, and fire. Most noxious weed infestations in the project area occurring within a conifer cover type are located in open forest stands on southerly and westerly aspects, at lower elevations (USDA Forest Service 2020e).

As a result of this pattern of infestation, herbicides to control invasive plants may be applied in the understory of these dry conifer cover types, particularly along roads and trails or in logged or burned areas. Seedlings and saplings are most likely to be exposed to herbicides through ground-based broadcast application.

Herbicide application in conifer stands typically involves the use of the same herbicides and application rates as those used in grasslands and shrublands. Weed managers reduce the potential for adverse effects on conifers through herbicide selection and application techniques. For example, clopyralid may be selected over picloram when applying in an understory with numerous seedlings and saplings. Applying at lower pressure and using directional application techniques reduces herbicide contact with conifer foliage. Herbicide labels provide instructions to prevent nontarget damage to trees. Adherence to herbicide label direction and avoidance of direct application to trees reduces adverse effects on individual conifers.

The season of application can also mitigate damage (Gratkowski 1977 and 1978, Radosevich et al. 1980). Likewise, Radosevich et al. (1980) found that seedlings from a number of pine and fir species and Douglas-fir were tolerant of herbicide applications when not in active growth stages.

Indirectly, the application of herbicides to invasive plants can harm conifers (primarily the youngest age classes) through movement in the soil and root uptake, especially for herbicides that are quite mobile in the soil. This risk can be avoided by herbicide selection (e.g., selecting an herbicide such as clopyralid, which conifers tolerate easily), selecting the lowest effective use rates, following herbicide label directions, and minimizing herbicide application within the foliage zone of trees.

Direct and indirect effects are limited to individual trees (usually seedlings) or very small site-specific locations (typically <0.01 acre) and have no landscape-level effects because only small acreages in conifer cover types are sprayed and, with the exception of roadsides, spot spraying techniques are used under conifer overstory.

Deciduous Trees and Shrubs

Within the project area, these cover types are usually located in riparian areas and have abundant access to water. They are capable of high site productivity and can support an array of vegetation groups. These habitats are highly preferred by many species of wildlife and are often heavily occupied. Many invasive plant species are able to establish and spread quickly in the riparian environment. Common noxious weed species infesting deciduous plant communities include Canada thistle, leafy spurge, and gypsyflower (hound's tongue), while newer invaders such as oxeye daisy and saltcedar have been found in more recent years (USDA Forest Service 2020e).

Many native deciduous shrub and tree species are not highly susceptible to herbicide damage, but may be variably affected based on species and age as well as the herbicide applied, the application rate, and the application techniques used. Some species, however, may be quite susceptible to the effects of herbicides on foliage and roots. Eliasson (1972) found that aspen was sensitive to the effects of 2,4-D, dicamba, and (especially) picloram. His study found that aspen was up to 10 times as sensitive to picloram as it was to the other two herbicides. Bowes (1976) found that aspen, cottonwood, rose, and western snowberry could all be killed by applications of 2,4-D and picloram. The herbicide label for metsulfuron methyl lists aspen, cottonwood, hawthorn, wild roses, and willows as all susceptible to lethal effects at moderate to high use rates. In addition, because glyphosate is a nonselective herbicide that can kill or injure living plant foliage, injury is possible when applied directly to deciduous species.

Nontarget deciduous trees and shrubs most likely to be adversely affected by herbicide treatments are seedlings/saplings. Mature plants with actively growing foliage that is over-sprayed with herbicide may also be injured. Direct effects to deciduous species can be mitigated through herbicide selection, use of the lowest effective rate, and application technique.

Indirectly, the unintentional exposure of nontarget vegetation such as deciduous shrubs and trees could result from some herbicides moving through the soil profile or water profile (Anderson 2007). Lethal or nonlethal injuries could result from the movement of herbicide away from the application site. This risk of exposure is reduced by adherence to label directions. For example, the label for metsulfuron methyl advises that off-target movement in soil or water is possible and provides recommendations to reduce the likelihood of movement.

Direct and indirect effects are limited to individual plants or very small site-specific locations (typically <0.01 acre) and have no landscape-level effects.

Evergreen Shrubs

Evergreen shrubs include sagebrush species, rabbit brush, bitterbrush, ceanothus, mountain mahogany, and other shrub species that retain their foliage year-round (similar to conifers). Landscapes with an evergreen shrub overstory are referred to as shrublands. Shrublands receive less annual precipitation than conifer cover types and often occur on sites with rocky or gravelly soils. The water table is often located deep underground, so water can be a limited resource. Topography also plays an important role in the distribution of evergreen shrubs (Burke et al. 1989).

Evergreen shrub species are variably susceptible to herbicide damage. Susceptibility depends on species, age, and growth stage as well as on the herbicide, the application rate, and the application techniques used. Researchers and land managers have long known that some species are resistant to the effects of certain herbicides or particular use rates (Evans et al. 1981). Some species, such as mountain mahogany, are highly susceptible to herbicide injury, while many sagebrush species exhibit minor effects to many of the herbicides and use rates commonly applied for invasive plant control. Younger-age classes are more susceptible to the effects of herbicide; mature plants are usually less affected. Species that grow close to the ground are more likely than taller species to experience direct contact with herbicide.

Some of the herbicides in use for invasive plant control have the potential to damage evergreen shrubs. Direct effects range from plant mortality to various kinds of nonlethal stem and foliage damage.

Of the herbicides in use, glyphosate and 2,4-D are most likely to impact evergreen shrubs. As a nonselective herbicide, glyphosate can be expected to kill living plant foliage on which it is deposited when applied at rates toxic to evergreen brush species (i.e., at or above 1.5 pints per acre). Likewise, 2,4-D amine applied at rates at or above 4 pints per acre can kill the evergreen foliage on which it is deposited.

The seedling/sapling-age class of evergreen shrubs may be most adversely affected by herbicide treatments; however, mature plants with actively growing foliage that are over-sprayed with herbicide may also be injured. Gratkowski (1977) found that stands of two *Ceanothus* species were susceptible to applications of 2,4-D. Evans and Young (1975) killed green rabbitbrush and big sagebrush stands with an aerially applied tank mix of 2,4-D and picloram.

Direct effects to evergreen shrub species can be managed through the selection of the appropriate herbicide, use rate, and application technique (e.g., minimizing herbicide application over the top of evergreen shrub canopies), along with the timing of herbicide application. Spot herbicide applications are preferred wherever possible to reduce adverse effects to nontarget vegetation.

Indirectly, the application of herbicides to invasive plants can affect evergreen shrubs through movement in the soil and root uptake, especially for herbicides that are quite mobile in the soil (Tu et al. 2001). This risk can be reduced by selecting the lowest effective use rates and following herbicide label directions.

Forbs

Forbs are a diverse group of broadleaf plants that are important components of most cover types. In some cover types, forbs can comprise a major component of the plant community (Pokorny et al. 2004, Ortega and Pearson 2011) and play a major role in plant community function (Pearson and Ortega 2009). Forbs can be broadly divided into groups based on their reproductive strategies and root systems. Many early spring forbs are annual plants or corm/bulb species that reproduce by dry seed, often in capsules of various kinds. Other forbs reproduce by means of fleshy fruits or spread via rhizomes or stoloniferous root systems (e.g., strawberries). Yet other forbs are taprooted, often with very large roots that grow deep underground (e.g., lupine or balsamroot species).

Forbs are typically the most impacted group of nontarget vegetation in any herbicide application. Because most invasive plant species in the project area are forbs, broadleaf-selective herbicides are used, inevitably resulting in some degree of damage or mortality to nontarget forbs as well.

All herbicides used have the potential to kill or damage native or desirable forb species. Once an invasive plant infestation has been established long enough to out-compete native forbs and become a monoculture, nontarget damage to forbs is no longer a concern. In the earlier stages of invasion, however, invasive plants and native or desirable forb plants are intermixed, and nontarget damage to forbs occurs.

Herbicides with short periods of toxicity and little residual activity, such as glyphosate and 2,4-D, generally have few direct or indirect effects on spring- and early summer-flowering species when applied during the species' dormant periods, such as in mid to late summer and fall (Rice et al. 1997a). These species often include corm and bulb species, such as death camas, or rhizomatous species with fleshy roots, such as wild iris. Annual forbs that have completed their life cycle by the time herbicides like glyphosate and 2,4-D are applied are also unlikely to be affected. Jacobs and Sheley (1999) found forb density unaffected after 2,4-D applications in early June and early July on a study site in the early stages of invasive plant invasion.

Forb species are most likely to be adversely affected when exposed to herbicides while in an active growth stage (e.g., young plants or plants that are initiating growth in the spring), since plants are most susceptible to herbicide effects when they are rapidly developing (Rice et al. 1997a). Many native broadleaf plants flower and set seeds in spring and summer and are dormant in fall. When plants are dormant, they are not as susceptible to herbicides (Rice and Toney 1996). Application of herbicides during the summer and fall when annual forbs have completed their life cycles and many perennial native forbs are dormant or at low levels of physiological activity can substantially reduce adverse effects of herbicide application (Rice et al. 1997a).

Herbicide applications must be made to invasive plant infestations, however, when the invasive plants are most susceptible to the herbicide's active ingredient. Many noxious weeds, for instance, have vigorous periods of growth in spring and again in the fall when temperatures begin to cool and precipitation increases.

Spring and early-to-mid summer herbicide applications typically result in some degree of adverse effects to non-target forbs, particularly when using herbicides with residual activity (Rice et al. 1997a, Rice and Toney 1998, Rice 2000). Adverse effects have also been noted with some fall applications (Crone et al. 2009, Ortega and Pearson 2011).

A number of researchers working in Montana on the effects of herbicides to target and nontarget plants have investigated the effects of picloram. Pokorny et al. (2004), Crone et al. (2009), and Ortega and Pearson (2011) have all conducted multiple-year studies of picloram. Picloram is a very effective herbicide commonly used to control highly aggressive noxious weed species like leafy spurge and spotted knapweed, and it can remain active in the soil for one or more years (Tu et al. 2001).

Other herbicides used, such as clopyralid, have lesser degrees of soil residual activity (Dow AgroSciences 1997), but are also capable of producing adverse effects on nontarget vegetation while the herbicide remains active in the soil.

The effects to forbs from herbicides with residual activity are often reported by researchers to be short term with regard to cover or leaf area, although demographic effects (fecundity) of longer but unknown durations may be present. In multiple-year studies from adjacent Montana, Rice and colleagues (Rice et al. 1997a, Rice and Toney 1998, Rice 2000) found short-term effects on

native forb species with applications of picloram, clopyralid, or a mixture of clopyralid and 2,4-D. Picloram had the greatest impacts on forbs, while clopyralid alone had the fewest. These studies showed that initial decreases in native forb cover recovered to pre-spraying levels within 3 years. Without continued control, however, spotted knapweed recovered to pre-treatment levels. Follow-up treatments showed that spotted knapweed control could be maintained without permanent adverse impacts to the forb component.

Arrowleaf balsamroot, a common dominant forb species in bunchgrass and sagebrush plant communities, has been used in a number of studies as a good representative of a native perennial forb. A recent study by Crone et al. (2009) investigated the effects to flowering, seed production, and seedling recruitment in western Montana. Crone et al. (2009) found that a single application of picloram did not reduce the leaf area of arrowleaf balsamroot in the short term; however, it did reduce flowering and seed set, an effect that lasted for a period of 4 years. The application also greatly reduced the recruitment of new arrowleaf balsamroot plants. The picloram application in this study was broadcast via all-terrain vehicle (ATV) in the fall, while arrowleaf balsamroot was dormant.

Ortega and Pearson (2010, 2011) had much the same results while also studying the effects of picloram on spotted knapweed and arrowleaf balsamroot in the Lolo National Forest over a 6-year period. Ortega and Pearson (2010, 2011), however, also looked specifically at the initial levels of spotted knapweed infestation, finding (at moderate and high levels of spotted knapweed invasion) that arrowleaf balsamroot cover was already depressed by spotted knapweed prior to treatment with the herbicide. Ortega and Pearson (2010, 2011) also noted impacts to arrowleaf balsamroot from broadcast applications made in the fall.

Research from an ongoing study in the Great Basin south of the project area (Davis 2013, 2014) has found that imazapic applications suppress native annual forb species in terms of percent cover in the short term. Similar to the results by researchers studying the effects of picloram and clopyralid, by year 3 to year 4 post-application, forb species recovered in the study areas.

Graminoids

Graminoids (grasses and grass-like plants such as sedges) are a component of all cover types and constitute an important plant life form in some cover types (Mueggler and Stewart 1981). The vigor, density, and seed production of graminoids play an important role in the ability of plant communities to recover from weed invasion (Sheley and Petroff 1999).

Some of the most common perennial native graminoids on rangeland are bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), and needle and thread grass (*Hesperostipa comata*). In forest cover types, pinegrass (*Calamagrostis rubescens*) and elk sedge (*Carex geyeri*) are often common components of the plant community.

The effects of herbicides used on perennial graminoids are much less variable than the effects on nontarget forbs. Most herbicides used are selective herbicides that target broadleaf invasive plants and do not affect graminoids. At the application rates used, chlorsulfuron, clopyralid, metsulfuron methyl, dicamba, imazapyr, picloram, and 2,4-D have little or no adverse effects on perennial graminoids. For example, Jacobs and Sheley (1999) found that perennial graminoids were unaffected by 2,4-D and that, on their study site, bluebunch wheatgrass and Idaho fescue increased in density with 2,4-D control of spotted knapweed.

The major exception to this lack of negative effects is glyphosate (NuFarm 2011b). Glyphosate is a nonselective herbicide that can kill or damage graminoids, sometimes even at low use rates.

Other herbicides used that affect graminoids are imazapic and sulfometuron methyl. Imazapic is an herbicide often used in restoration efforts where the establishment of graminoids is an important component of restoration and can often be applied to control broadleaf invasive plants simultaneously with the seeding of many native grasses. However, imazapic also provides control of some annual grasses, such as cheatgrass, and some cool season, perennial grasses, such as Kentucky bluegrass (BASF 2011). Both of these grasses are nonnative invasive species, control of which may be a management objective in some settings.

There have been reports that imazapic may injure some native grasses. One species, Sandberg bluegrass (a perennial, shallow-rooted grass), is native to the Rocky Mountain Ecoregion. This is a highly desirable grass for niche occupation, and weed managers consider it important to retain Sandberg bluegrass where it occurs when considering herbicide applications. Davis (2014) reports that recent research in the Great Basin has found that although imazapic applications may cause a slight initial suppression of Sandberg bluegrass, plants recover within 3 to 4 years post-treatment.

In contrast to imazapic, sulfometuron methyl controls many annual and perennial grasses. Cheatgrass and Kentucky bluegrass are common examples of nonnative invasive graminoids susceptible to sulfometuron methyl. Fescues and bromes, both of which occur as native grasses, are also susceptible to this herbicide. Due to the use of imazapic, however, sulfometuron methyl has not been applied in recent years.

Persistent herbicides are more likely to affect graminoids in the seedling stage than when mature. Sheley et al. (2000) found that effects to the establishment of grass seedlings from clopyralid and picloram applications depended on the application rate and the timing of the application relative to the time since the grass had germinated. Herbicide applications implemented two or more weeks after the grass was seeded, even at higher use rates, allowed successful grass establishment.

Spring applications are more likely to cause short-term damage to mature graminoids than fall applications, by temporarily reducing vigor and seed production of some grass species (Rice et al. 1997a, Rice and Toney 1998). In addition, mature grasses may be atypically affected by herbicides when physiologically stressed, such as during a drought period or insect outbreak. The effects of herbicides on nonsusceptible graminoids is generally short term (often no more than one or two growing seasons) and does not alter long-term species diversity or overall biomass (Rice and Toney 1998).

With the exceptions noted above, herbicide applications in general are beneficial to nonsusceptible graminoids (Rice and Toney 1998, Ortega and Pearson 2011). As an example, native grasses such as bluebunch wheatgrass are vulnerable to the impacts of weed invasion (Ortega and Pearson 2011) and usually respond very positively to herbicide treatments that reduce weed density and cover. There are a number of reasons why graminoids respond so positively. They are not physiologically impacted by broadleaf herbicides, so they can respond rapidly to re-allocations of site resources (Rice and Toney 1998, Ortega and Pearson 2011). Soil and water resources are more available without competition from weeds. All elopathic effects decline as weed density decreases. In addition, more growing spaces are made available for graminoid recruitment as weed density decreases (Rice and Toney 1998, Ortega and Pearson

2011). In this example, because bluebunch wheatgrass is a community dominant in grassland and shrubland cover types, grass recovery in response to weed control measures assists in plant community recovery.

Grasslands are often impacted by a high degree of human uses (Parks et al. 2005). Historically, these sites were often settled early during westward expansion and continued on into the homesteading era. Land clearing for raising crops and livestock introduced early and widespread soil and vegetation disturbance. Many nonnative plant species were introduced deliberately or accidentally, setting the stage for weed establishment and spread more than a century ago (Rice 1999, Parks et al. 2005).

Areas denoted as "grasslands" usually host a wide variety of native forb species, some of which codominate with grasses (Pokorny et al. 2005). In these plant communities, the effects of herbicide vary between vegetation groups, some of which are beneficial and some adverse, depending on the vegetation group. Researchers have found that herbicide applications can cause depressions in forb species richness, cover, and fecundity (Rice and Toney 1996, Ortega and Pearson 2011). Conversely, herbicide applications that control broadleaf invasive plants allow graminoid species to increase in terms of cover and biomass, as a result of decreased competition. In long-term studies, Rice and his colleagues have found that this effect tends to balance out over time. Nonetheless, it is important to recognize and ameliorate the effect.

3.5.3.2.1.4 Mechanical Control

Mechanical control is a very labor intensive and expensive method of treating invasive plants and is best suited to small sites. Various methods of mechanical control have been shown to be quite effective in controlling or partially controlling some invasive plant species (Sheley 1994). Mechanical control methods are generally more effective in controlling taprooted species or those with shallow root systems. Mechanical control is seldom an effective means of controlling species with rhizomatous or stoloniferous root systems or those that can sprout from deep underground roots.

The effects of mechanical control may be variably beneficial or detrimental. For example, a benefit of mechanical control is the reduction in the number of seeds produced and shed in a given year, if the mechanical control takes places before seed production. Other beneficial effects of removal of weeds include an increased availability of water and nutrients that were claimed by the more competitive invasive plants (Bussan and Dyer 1999). Canopy cover of invasive plants is reduced as well, allowing desirable plants greater access to sunlight for photosynthesis.

Mechanical invasive plant control may disturb soils and increase the amount of bare ground. This can be detrimental, beneficial, or a combination of both. Commonly, the dead plant material from plants that were mechanically removed breaks down and covers the soil surface, providing a protective litter layer; however, increased amounts of bare ground could result in a temporary increase in soil erosion, for example, during a high-intensity rain event. The bare ground also provides a bed for the deposition of freshly produced seeds, along with reduced competition for seeds already present in the soil, whether these are from desirable species or from invasive species. These effects are usually confined to very small areas, since mechanical control is practiced on only a small scale.

Detrimental effects of mechanical control include soil disturbance, churning of the seed bed (turns up viable seeds that have been buried in the soil and can create a germination event from soil-banked seed) and, potentially, very minor amounts of erosion due to soil disturbance, particularly on steeper slopes. The scale of such effects occurs only at a localized level because the mechanical control is confined to small areas, however.

Especially at the seedling stage, a minor amount of incidental mortality of nontarget plants due to proximity to target invasive plants or to occasional misidentifications could occur.

The extent of use for all methods of mechanical control is limited and most often used in conjunction with other invasive plant control techniques. However, mechanical treatment is considered an important invasive plant control tool, especially for controlling invasive plant species that exhibit long-distance seed dispersal, such as gypsyflower (hound's tongue), puncturevine, or rush skeletonweed.

3.5.3.2.1.5 Type of Mechanical Control

Hand-pulling, Grubbing, Hoeing

Hand-pulling target invasive plants has very little direct effect on native vegetation, for several reasons: (1) only extremely limited areas can be effectively treated by this method, (2) there is limited soil disturbance with hand-pulling, and (3) only target invasive plants are removed.

Hand-pulling, grubbing, and hoeing do create small areas of bare soil that, without additional control measures, will be promptly recolonized if residual viable seeds exist in the soil.

A minimal amount of soil disturbance may result from hand-pulling, grubbing, and hoeing. The impacts of soil disturbance are limited to the immediate area around the plants being removed by hand-pulling, grubbing, or hoeing.

Grubbing and hoeing target invasive plants may also affect adjacent nontarget plants, due to the increased soil disturbance and the fact that some nontarget plants are injured or killed, since these methods are less selective than hand-pulling.

Cutting and Mowing

Cutting, mowing, and other similar methods using hand or power tools have minimal potential to disturb the soil. The goal of cutting and mowing methods is to reduce the vigor and reproductive ability of targeted plants. Depending on the target species, intermixed nontarget plants could also be affected by these treatments. Timing the treatments when possible to avoid interfering with seed production phases on nontarget vegetation can be used to reduce the impacts to desirable species.

Cutting of some invasive plant species, such as saltcedar, which grows in a large shrub to small tree form, is a treatment that removes only stems of the target species. Unless mistakes are made in correctly identifying the target species, cutting generally has no direct nontarget effects.

Torching

Torching is only used in focused circumstances, due to the possibility of fire escaping and burning areas not intended for treatment. An example of torching would be using a propane torch at dispersed, undeveloped campsites to destroy viable puncturevine seeds. Soil at these sites is compacted and hardened, due to frequent use, and little vegetation is present. Due to the site setting, effects are generally limited to changes in soil morphology from the application of fire.

3.5.3.2.1.6 Native Vegetation Communities

Mechanical control methods include hand-pulling, grubbing, hoeing, cutting and mowing, burning, and torching. The CTNF and CNG do not currently use or propose to use mechanical methods such as chaining and disking as methods for controlling invasive plants.

Various methods of mechanical control have been shown to be quite effective in controlling or partially controlling some invasive plant species (Sheley 1994). Mechanical control methods are generally more effective in controlling taprooted species or those with shallow root systems. Mechanical control is seldom an effective means of controlling species with rhizomatous or stoloniferous root systems or those that can sprout from deep underground roots.

Mechanical control methods are very expensive and labor intensive (Duncan et al. 2004, Beck 2013) and are generally implemented only under these circumstances: (1) on small, high-priority sites, such as campgrounds or picnic areas, where reducing the threat of spread justifies the expense, (2) on invasive plant species prioritized for high levels of control, such as new invaders identified for early detection efforts, (3) only during seed production stages of plant growth, or (4) in conjunction with other control methods. For example, mechanical removal of seed heads is commonly practiced on small infestations of gypsyflower (hound's tongue) from mid-summer through fall, when viable seeds are present on mature plants.

Mechanical control is expensive for two reasons: (1) treatments are physically very demanding and time consuming, so daily output is very low; hard rocky soils and high invasive plant densities further slow the work, and (2) treatments must be repeated frequently to be effective, sometimes as often as every 2 to 3 weeks, depending on the target species. This means that although mechanical control can be effective at a very small scale, it is not effective at the landscape level.

Mechanical control as the sole method of eradicating an invasive plant infestation is often ineffective because of the long-term viability of invasive plant seeds in the soil. In addition, mechanical treatments are often less effective than herbicide applications. There is only a narrow seasonal window for implementation. Pulling, grubbing, and hoeing are usually effective only in the spring and early summer when the soil is moist enough to effectively remove the entire root crown or root masses of target plants. Pulling leaves and stems but not removing the root crown does not kill the plant and usually results in prompt regrowth.

Additionally, once plants have dropped seed for the year, mechanical treatment can become ineffectual because of seeds remaining in the soil, which ensures a fresh crop of invasive plants the following year. Most invasive plant species are prolific seed producers and have the ability to regenerate and produce seed following removal of top growth, so mechanical methods can even prompt rebloom.

Mechanical treatments can kill many, but not all, taprooted species (some invaders, such as rush skeletonweed, are able to resprout from segments of taproot left in the ground). Mechanical treatments of invasive plants with rhizomatous or stoloniferous root systems (such as leafy spurge or invasive hawkweeds) do not kill plants, but reduce seed production only for the season in which they are treated.

Removal of seed heads can improve treatment efficacy by reducing the potential for viable seeds to be spread by people, domestic livestock, or wildlife. Very small infestations are often pulled or grubbed to remove viable seeds on existing plants, then treated with herbicide. If the

infestation consists of many mature plants in seed set, however, mechanical removal is too time consuming and expensive to be a practical control method. For that reason, mechanical control methods are often combined with herbicide applications, especially for Dalmatian toadflax, gypsyflower (hound's tongue), leafy spurge, rush skeletonweed, and saltcedar. Once herbicide application has reduced the size and density of the infestation, integration of mechanical control helps to reduce the risk of further spread. Mechanical treatments are also effective when combined with reseeding or other restoration efforts.

3.5.3.2.1.7 Special-status Plant Species

The effects of mechanical control may be variably beneficial or detrimental to special-status plants. Mechanical control can be an effective choice for some sensitive plant populations when used as part of IWM. For example, invasive plants can be mechanically removed within the sensitive plant population and then herbicides can be sprayed outside the population to provide a buffer against re-invasion.

Removal of seed heads from invasive plants in and around a sensitive plant population can prevent the input of fresh seeds to the seedbank, helping to reduce the density of invasive plants within a sensitive plant population and allowing more growing space for sensitive plants.

However, mistakes can be made in plant identification when performing mechanical control and some individual sensitive plants could be killed. This incidental mortality could be due to proximity to target invasive plants or to occasional misidentifications, especially at the seedling stage, which can be more difficult to see than adult plants. Incidental mortality is more likely to occur when working with hand tools or power tools, as compared to hand-pulling.

One of the effects of mechanical control includes soil disturbance. Churning of the seed bed turns up viable seeds that have been buried in the soil and can create a germination event from soil-banked seed. Soil disturbance can also potentially increase the risk of erosion. The scale of soil disturbance effects occurs only at a localized level, since mechanical control is confined to small areas.

Mechanical invasive plant control may also increase the amount of bare ground. This can be detrimental, beneficial, or a combination of both. Increased amounts of bare ground could result in a temporary increase in soil erosion, for example, during a high-intensity rain event. The bare ground also provides a seed bed for the deposition of freshly produced seeds, whether from desirable species or from invasive species. This bare ground effect is usually confined to very small areas, since mechanical control is practiced on only a small scale.

3.5.3.2.1.8 Rehabilitation and Restoration Practices

FSM and FSH direction provide guidance on rehabilitation and restoration. *Rehabilitation* is defined as repairing ecosystem processes, productivity, and services, while *restoration* is defined as more actively assisting the recovery of an ecosystem that has been degraded to the point it no longer has biotic integrity in terms of species composition and community structure (FSM 2070). Rehabilitation may require little more than invasive plant control measures and removal of disturbances (e.g., foot or vehicle traffic) for a time to allow a site to recover naturally on its own. Some sites that have been highly degraded by invasive plants may require more intervention in addition to invasive plant control, such as seedbed preparation, seeding, planting plugs, or mulching.

Invasive plant control is a rehabilitative and restorative practice in itself, aimed at reducing or removing invasive plants and corresponding banks of viable seeds stored in the soil, in order to promote the establishment and maintenance of desirable plant species (USDA Forest Service 2011). An upward vegetative trend of desired plant species helps meet the desired conditions of plant communities. Healthy, functional plant communities containing desirable species are resilient to disturbances such as fire and are more resistant to invasive plant invasion.

Some degraded sites require additional intervention to achieve a desired plant community that is stable, self-sustaining, resilient to disturbances, and resistant to weed invasion (Masters and Sheley 2001). Sites may be so impacted by invasive plants that rapid recovery of desired plant species is limited by one or more factors (Goodwin et al. 2006). There may not be enough native seed left in the soil. The soil may have been affected by allelopathic compounds from the invasive plants. There may have been changes in pollinator population levels or species diversity. In these cases, when desirable plant species—whether native graminoids and forbs or as part of a mix of nonnative plants suited to the site (e.g., a pasture grass mix at an administrative site)—are no longer present at the site, then revegetation must be considered. From a natural resource management perspective, post-treatment plant communities are considerably more desirable than untreated, invasive-plant-dominated communities.

For recovery to proceed, whether natural recovery or human-assisted restoration, invasive plants must be controlled (Kardol and Wardle 2010), sources of disturbance and vector pathways must be managed, and microsite niches must be available to receive and shelter desirable vegetation, whether seeds, plugs, or transplants (Goodwin et al. 2006, Sheley and Half 2006, Brown et al. 2008).

The USDA Forest Service prefers to rely on natural regeneration as part of rehabilitative measures to restore ecosystem structure, function, and productivity on sites degraded by invasive plants. Passive or natural regeneration is preferred during and after control treatments for sites that still contain sufficient cover and density of desirable plant species. There are a number of advantages to natural site recovery. Sufficient native or desirable vegetation or seed sources may still be available onsite or nearby, making assisted recovery unnecessary. Where some or many components of a native plant community are still present, unassisted natural recovery may readily occur, although some vegetation groups may take longer to recover than others (Goodwin et al. 2006). In addition, a few researchers have suggested that relict vegetation on a heavily invaded site may possess some adaptions to cope with the invading plant species (Callaway and Ridenour 2004). If so, allowing this relict vegetation to re-establish could confer some degree of resistance to re-invasion.

Typically, site restoration involves supporting the re-establishment or return of desirable vegetation to a degraded site because necessary components of the plant community are no longer present or are too few in number. When assisted restoration must be used, native species are preferred in most situations. If possible (where and when available), locally sourced seed or plants are also preferred. When locally sourced plant materials are not available, the USDA Forest Service uses seed and plants produced commercially from nurseries whose parent stock comes from locations on which site conditions are similar to the area requiring restoration.

Assisted restoration is used at very high priority sites (e.g., where no native seed sources are available or in areas with high human uses). Often, the best assistance is simply to reduce human

disturbance and allow an area time to slowly recover. As an example, fencing to prevent human or animal access is often a very useful strategy, although it is not effective over large areas.

Natural regeneration may be slower, but it is the more desirable outcome. However, there are also drawbacks to natural regeneration. Although natural regeneration reduces the risk of introducing a new invasive plant, it could occur so slowly that invasive plants could re-establish in the area before desirable vegetation, negating the benefits of control. Natural regeneration may not compete well against invasive plants. For example, most invasive plant species have persistent seed banks that can make it harder for desirable plants to re-establish. Following treatment of a monoculture or near-monoculture of invasive plants, desirable species may need to be seeded to re-establish desirable native or nonnative vegetation and prevent re-invasion. As another example, areas with active soil erosion may recover too slowly to protect the soil, resulting in yet more soil erosion and increased site instability.

Site environmental properties are important to consider when developing an implementation plan for assisted restoration (Goodwin et al. 2006). Topographical features such as elevation, aspect, and slope must be assessed, as do soil attributes and local climatic conditions.

Soil-related factors such as compacted or shallow topsoil, poor soil fertility, lack of soil microorganisms, or insufficient microsites to harbor seeds can strongly influence the outcome of assisted restoration actions (Goodwin et al. 2006).

Weather also plays a large role in the success or failure of assisted restoration actions. Lack of adequate moisture when seeds are germinating and developing root systems may yield poor establishment or even complete failure to establish (Goodwin et al. 2006). Conversely, too much precipitation can wash soil away from germinating plants before their root systems develop sufficiently to hold soil in place. The two most common reasons a restoration activity fails are lack of moisture during the seedling phase, and intense competition with nonnative invasive plants for growing spaces and site resources (Sheley and Petroff 1999).

Although natural regeneration is usually considered the best method of re-establishing desirable species, if invasive plant invasion and site disturbance has caused local extinctions of native or desirable plant species and left behind few, if any, relict plants, and if no seed bank is present, then assisted recovery becomes necessary. The decision to implement rehabilitation or restoration includes factors such as low native species diversity, low plant cover, lack of seed sources from nearby areas, the need to establish desirable vegetation to compete with invasive species, and stabilization of eroding soil. When desirable plant cover or density is too low for a site to recover on its own in a timely manner, then assistance in the form of interseeding may be needed to achieve management objectives for the site. When assisted recovery actions are determined to be the best choice, the USDA Forest Service has established practices to guide managers in site recovery. Based on the cost of implementation and site limitations, such as access or topography, weed managers may have to rely on natural regeneration at some sites because they cannot otherwise effectively regenerate all the sites.

Invasive plant control is a rehabilitative/restorative practice in itself, aimed at reducing or removing invasive plants and the banks of viable invasive plant seeds stored in the soil, to promote the establishment and maintenance of native plants (USDA Forest Service 2011b). An upward vegetative trend of native plants, including sensitive plant species, helps meet the desired condition of plant communities.

After invasive plant control, the USDA Forest Service prefers to rely on natural recovery to restore ecosystem structure, function, and productivity on sites degraded by invasive plants. In the case of sensitive plant species, which often have adaptions to highly specific habitat conditions, allowing site recovery to proceed naturally is preferred. Therefore, there would be no direct or indirect effects to sensitive plants since there would be no active restoration implemented in sensitive plant populations.

3.5.3.2.2 Cumulative Effects of Alternative 1

City, state, and county governments have ongoing weed spraying programs, some with less-stringent measures to prevent water contamination. Unknown amounts of herbicides are sprayed annually along road right-of-ways by state and county transportation departments, sometimes several times a year. Private landholders also spray unknown chemicals in unknown amounts. Any private herbicide use could potentially combine with contaminants from other federal and nonfederal activities and could contribute to formation of chemical mixtures or concentrations that could kill or harm ESA-listed steelhead. In addition, fish stressed by degraded habitat conditions are more susceptible to toxic effects of herbicides. Although the mechanisms for cumulative effects are clear, the actual effects cannot be quantified due to not knowing what chemicals, how much, and what application methods might be used.

Habitat quality for sensitive plant species addressed in this document has likely declined since pre-settlement conditions. Past, ongoing, and foreseeable Forest management activities have resulted in changes to forested, nonforested, dry meadow, wet meadow, and riparian habitats associated with these species (Appendix H). These activities include road construction and maintenance and off-road vehicle use. Decades of domestic livestock grazing directly altered species compositions and cover densities in upland and riparian habitats' plant species. Fire suppression altered natural fire regimes, reducing the frequency of low-intensity fires in habitats that evolved with fire to high-intensity, infrequent fires, which directly alters species compositions and cover densities. Timber management activities have altered the landscape, along with associated actions such as slash pile burning, logging decks and landings, roads, and public firewood-gathering programs. Recreation activities occur associated with developed and dispersed uses such as OHV use, horseback riding and pack animal use, bicycling, hiking, backpacking, and utilization of developed camp areas). All these activities have the potential to displace native species, introduce and spread nonnative plant species, and shift plant community composition, altering resource availability and successional pathways.

The actions described in this document have and would contribute to cumulatively affecting sensitive plant species, as noted above. The introduction and spread of nonnative plant species in remote locations would likely continue, and the effects on sensitive plants would likely increase on remote sites. Ground-based herbicide application has helped the Forest control noxious plant species populations along roadways; however, nonnative plant species infestations in inaccessible areas such as remote burned areas, decommissioned roads, roadless areas, and backcountry areas are mainly untreated due to economic and physical infeasibility. The result has been that species such as rush skeletonweed and leafy spurge are expanding into inaccessible areas.

Every mile of road has an associated area of vulnerability to nonnative plant species invasion due to use and maintenances as well as to the associated herbicide treatments that occur in known areas of noxious plant species. These activities have created positive and negative impacts on

sensitive species that prefer disturbed habitats, such as species in the genus *Botrychium*. The potential negative impacts depend on the nonnative plant species and the type of herbicide applied.

Fire, both wildfire and prescribed fire of high and moderate severity, have contributed to a high risk for nonnative plant species invasion that could impact sensitive plant species. It is likely that the unchecked spread of nonnative plant species populations in the future would potentially add to the cumulative effects to sensitive plant species in inaccessible areas.

The definitive cumulative effects from nonnative plant species competition and the related treatments are unknown. Past, ongoing, and foreseeable Forest management activities mentioned above and public use of forest lands have contributed, and would continue to contribute, to the introduction and spread of nonnative plant species and resulting treatments.

3.5.3.2.2.1 Biological Control

Few cumulative effects to native vegetation and sensitive plant populations result from the use of biocontrol agents. However, in an IWM program, multiple invasive plant control techniques are used in combination. One potentially beneficial cumulative effect of biocontrol agents, used in conjunction with other invasive plant control measures, could be a more rapid reduction of invasive plant density and distribution in sensitive plant populations. This would result in a reduced need for other invasive plant control treatments, such as mechanical or herbicide treatments.

There is little likelihood of adverse cumulative effects arising from the use of biocontrol agents. One potential adverse effect could be the natural movement of biocontrol agents dispersing naturally across national boundaries from countries where requirements regarding host specificity are less stringent. There is one such case from Canada, where a biocontrol agent intended to control gypsyflower (hound's tongue; *Cynoglossum officinale*) was found to cross over from the gypsyflower and feed on native members of the borage plant family. There is usually no way to remove biocontrol agents from natural settings once they have been released, have established, and are naturally dispersing. In this case, however, no sensitive plant species in the borage family exist within the project area.

3.5.3.2.2.2 Herbicide Control

Much private land is under agricultural production and no longer supports native plant communities. Sensitive plant species are not federally protected and, while private landowners may be encouraged to conserve native plants, they are not required to do so nor to alter land-use practices that support their businesses.

The same is largely true of county lands. County land is often dedicated to supporting county uses and infrastructure. It has often been converted from native vegetation to serve county needs. For example, county material sources are managed to provide materials needed for county road maintenance. Another example involves the airports that serve each county.

Other federal land management agencies, such as the BLM, may apply herbicides within or near populations of sensitive plant species that occur on BLM lands. The BLM follows much the same standards for protecting rare plants and maintaining or restoring rare plant habitat as does the USDA Forest Service. Likewise, BLM operational practices for invasive plant control are similar to those practiced by the USDA Forest Service. Given this, it is unlikely that federal

invasive plant management activity within or near sensitive plant populations would contribute to downward trends in population numbers.

Within the project area, the CTNF and CNG invasive plant management programs carry responsibility for herbicide applications, with the one exception of herbicide application along state highway rights-of-way. Herbicide applications, including those made by contractors and partners, are conducted using standard operating practices that provide protection to native vegetation and sensitive plants while accomplishing invasive plant management objectives.

3.5.3.2.2.3 Mechanical Control

There is little likelihood of cumulative effects arising from mechanical invasive plant control in native vegetation and sensitive plant populations. Sensitive plant populations are mapped and made known to invasive plant management crews, who plan invasive plant control treatments, including mechanical control, to protect sensitive plants. Likewise, when other ground-disturbing land-use activities are planned (for example, mineral exploration), program managers check the NRIS database for the presence of known populations of sensitive plant species.

3.5.3.2.2.4 Rehabilitation and Restoration Practices

Cumulatively, any projects, especially those at the landscape level, could contribute to improved habitat conditions for native vegetation and sensitive plants.

3.5.3.2.3 Alternative 1 Summary

No irreversible or irretrievable uses of resources are associated with the Current Action Alternative, which is a continuation of the present invasive plant management program. To date, success in prevention, early detection, and control and management elements of invasive plant management has been achieved. Overall, however, the presence and influence of invasive plant species throughout the project area is increasing due to lack of appropriate tools and technology. In time, this could impact sensitive plants in terms of plant vigor, productivity, and habitat suitability.

Native vegetation and special-status plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed, especially young plants that are difficult to detect. Continued implementation of the Current Action would not contribute to a downward trend in populations or habitat quality for any sensitive plant species, nor would it lead to listing under the ESA. Table 3-35 displays the determination of effects to habitat and sensitive plant populations as a result of implementing the Current Action Alternative.

3.5.3.3 Alternative 2—Proposed Action

Alternative 2 (Proposed Action) brings forward all the treatment actions presently available under the Alternative 1-Current Action, as well as providing for the use of one additional herbicide. Most notably, the Proposed Action would implement IWM, which emphasizes prevention and restoration components, in addition to treatment of new and existing weed populations. The main tenets of the IWM approach under the Proposed Action include the following:

- Prevention—prevent the introduction and establishment of new invasive plant species.

- EDRR—as new invasive plant infestations are detected, a quick and coordinated inventory and eradication response.
- Control and Management—IWM would facilitate the use of a variety of treatment options and combinations intended to minimize the effect of invasive plants and limit their spread.
- Rehabilitation and Restoration—restore and maintain healthy native or desired plant communities that are resistant to invasive plant establishment, recover quickly from disturbances, and provide ecosystem functionality.
- Monitoring—Monitoring provides the data for IWM. Information collected from monitoring may be used by managers to evaluate the efficacy of prevention, EDRR, treatment, and rehabilitation and restoration actions.
- Control techniques include manual/mechanical, chemical (including aerial spray application), and biological methods for areas infested by invasive plants.

Table 3-35. Determination of effects special status plant habitat and plants resulting from Alternatives 1 and 2.

SENSITIVE PLANT SPECIES	EFFECTS TO HABITAT	EFFECTS TO PLANTS	EFFECTS DETERMINATION
Endangered Species Act List			
Ute-ladies'-tresses	Short-term adverse impacts Long-term beneficial impacts (SAI-LBI)	Short-term adverse impacts Long-term beneficial impacts (SAI-LBI)	May impact individuals and habitat (MIIH), but not likely to cause a trend toward federal listing or loss of viability
Whitebark Pine (candidate)	SAI-LBI	SAI-LBI	MIIH
Forest Service Region 4 Sensitive List			
Pink agoseris	SAI-LBI	SAI-LBI	MIIH
Sweet-flowered rock jasmine	SAI-LBI	SAI-LBI	MIIH
Meadow milkvetch	SAI-LBI	SAI-LBI	MIIH
Starvling milkvetch	SAI-LBI	SAI-LBI	MIIH
Payson's milkvetch	SAI-LBI	SAI-LBI	MIIH
Dainty moonwort	SAI-LBI	SAI-LBI	MIIH
Centennial rabbitbrush	SAI-LBI	SAI-LBI	MIIH
Welsh rockcress draba	SAI-LBI	SAI-LBI	MIIH
Payson bladderpod	SAI-LBI	SAI-LBI	MIIH
Cache beardtongue	SAI-LBI	SAI-LBI	MIIH
Marsh's Bluegrass	SAI-LBI	SAI-LBI	MIIH
Salmon twin bladderpod	SAI-LBI	SAI-LBI	MIIH
Alkali primrose	SAI-LBI	SAI-LBI	MIIH

While these components are present in Alternative 1, prevention, EDRR, monitoring, and rehabilitation and restoration, would be emphasized in Alternative 2 to reduce the program's dependence on control and management. The proposed adaptive, IWM program would utilize a variety of tools, alone or in combination, to treat invasive plants. Proposed treatment methods include the following:

- Biological control through the use of predators, parasites, pathogens, and targeted grazing.

- Herbicide control using ground-based application methods.
- Herbicide control using aerial application methods.
- Herbicide control using aquatic application methods.
- Manual and mechanical methods, such as hand-pulling, mowing, cutting, or torching.

Table 2-3 show herbicides and application settings proposed for use under Alternative 2.

3.5.3.3.1 Direct and Indirect Effects

3.5.3.3.1.1 Biological Control

The direct, indirect, and cumulative effects of biological control under Alternative 2 would be similar to those described under Alternative 1.

3.5.3.3.1.2 Herbicide Control

Alternative 2 would implement design criteria to help minimize the impacts of herbicide application to native vegetation and special-status plants while still achieving invasive plant control objectives.

The direct and indirect effects of herbicide application as implemented by Alternative 2 would be similar to those disclosed under Alternative 1, with considerations:

- the removal of two herbicides as approved herbicides,
- the addition of three herbicides as approved herbicides,
- the use of aerial-application of herbicides,
- the use of aquatic-application of herbicides.
- the components of IWM, specifically the emphasis on prevention, EDRR, and restoration and rehabitilitation, which would reduce the need to actively treat weed populations with measures that can have adverse effects to the natural vegetation, including special-status plant species.

Additional Herbicides

Alternative 2 proposes the use of three herbicides in addition to those currently in use: Imazapyr, Imazamox, and Rimsulfuron.

Aerial Application

The ability to use aerial application would help improve invasive plant control efforts in the project area for infestations that are currently uncontrolled or poorly controlled. Treatment limitations (e.g., topography, slope, lack of water, remote sites, and associated high treatment costs) would be easier to manage with aerial application as an approved tool. Aerial application would provide IWM on sites where no or few invasive plant control options currently exist due to these treatment limitations. This is a particularly important consideration for invasive plant species for which there are no biocontrol agents available or for which available agents have not been effective in providing weed control. Aerial application would greatly reduce treatment costs on areas that are currently prohibitively expensive due to site location, topography, and long distances to water.

Aircraft have been widely used as a land management tool for decades. Aerial application of herbicides started primarily in agriculture, but as aircraft and application equipment improved, its use expanded into natural resource management. The use of aircraft in natural resource management includes many activities, such as the control of detrimental insects, weeds, and diseases or in restoration projects requiring fertilization and seeding. The need to reach large expanses of remote, inaccessible terrain and the high cost of manual, ground-based labor dictate that many of these activities be conducted from the air (Kilroy et al. 2003).

Currently, ground-based application of herbicides is performed utilizing both spot and broadcast application techniques, with design criteria incorporated to manage the risks associated with the application of herbicides. The aerial application of herbicides is no different. It is proposed to utilize aircraft to perform broadcast applications of herbicides. The design criteria were developed to minimize the risks associated with the application of herbicides by air, in addition to those for general herbicide application.

Although aviation is an inherently dangerous activity, risks can be minimized by following operating and safety guidelines. In addition to safety concerns, the other aspects of herbicide application, such as volatilization, drift, and movement of herbicide through soil or water are considered. Herbicides can move with eroding or windblown soil or with surface or subsurface water. Herbicides can also move through the air as spray drift, which occurs during herbicide application, and via volatilization, which could occur after application. Spray drift is dependent on spray equipment parameters such as nozzle orifice size, boom height and pressure, and wind speed (Branham and Hanson 1987). Volatility is dependent on the physical properties of the herbicide, primarily vapor pressure.

Volatilization is the conversion of a liquid or solid chemical to a gas. In the case of an herbicide that volatilizes, the vapor can then move with air currents away from the treatment site and affect nontarget plants. The amount of volatilization that occurs is dependent upon climactic and microclimatic conditions. Soil moisture is the primary environmental condition influencing the rate at which herbicides volatilize; in general, herbicides volatilize more rapidly from moist soils than from dry soils (Menalled and Dyer 2005). Volatilization also increases with higher air and soil temperatures and increasing wind speed. Ester formulations of herbicides have higher vapor pressures and volatilize more than amine formulations (Nice 2004). No ester formulations are proposed for use. Table 3-36 displays the volatilization potential of herbicides being considered for aerial application under the Proposed Action.

The potential for volatilization can be minimized in a number of ways, some of which are operational and some environmental. Using water as a carrier and the use of specific adjuvants further reduces the likelihood of volatilization.

The climatic regime for the project area is one of low annual precipitation and the soils are naturally dry, which reduces the potential for volatilization from soil. Aerial applications would be made primarily during morning hours when air and soil temperatures are lower and winds are calm or light. These conditions further reduce the likelihood of volatilization.

Table 3-36. Herbicide volatilization potential of herbicides considered for aerial application.

HERBICIDE	VOLATILIZATION POTENTIAL
2,4-D amine	Much less volatile than ester formulations. [a]
Aminopyralid	Extremely low. [b]
Chlorsulfuron	Volatilization plays minor role in disappearance. [c]
Clopyralid	Does not volatize readily in the field. [a]
Dicamba	Volatilization not significant from soil surfaces, some may occur from plant surfaces. [d] Can be volatile. [e]
Glyphosate	Does not volatize readily in the field. [a]
Imazamox	Volitization not significant. [f]
Imazapic	Not volatile. [a]
Imazapyr	Does not volatize readily in the field. [a]
Metsulfuron methyl	Does not volatize readily in the field. [g]
Picloram	Does not volatize readily in the field. [a]
Rimsulfuron	Unlikely to volatilize in wet soils or from aquatic systems. [h]
Sulfometuron methyl	Not volatile. [i]
Triclopyr TEA (triethylamine salt)	Ester formulations are highly volatile (Forest Service uses amine). [a]

[a] Tu et al. 2001, [b] Dow Agro 2010, [c] PMEP 1985, [d] EXTOXNET 1993, [e] Branham and Hanson 1987, [f] EPA 1997, [g] Information Ventures 2003, [h] USDI BLM 2014, [i] USDOE Bonneville Power Administration 2000.

Spray drift is the movement of herbicide, generally via spray droplets, away from the target area. Spray drift can be reduced by increasing droplet size. This can be done by reducing spray pressure, increasing nozzle orifice size, using drift reduction nozzles, rearward nozzle orientation during aerial applications, and the addition of drift reduction adjuvants to the spray mix. Other factors influencing spray drift are the method of application (drift is generally greater from mist blower and aerial applications than ground application); the distance between the nozzle and target (less distance will reduce drift); wind direction and wind speed; air stability; and temperature and humidity (low humidity and high temperatures cause rapid evaporation, which reduces the size of droplets). The influence of humidity and temperature is not always predictable (Dexter 1993). Spray drift cannot be completely eliminated; however, with proper management, drift levels can be minimized to levels that do not cause harm (Felsot 2001). General methods to reduce drift potential of herbicides considered for aerial application are discussed below.

The broadcast nature of aerial application would, in the short term, affect nontarget vegetation across larger areas, as compared to ground-based broadcast or spot applications. For this reason, the CTNF and CNG would apply design criteria to reduce the effects of aerial application to nontarget vegetation. These include measures such as herbicide selection, applying more selective and less toxic herbicides such as aminopyralid and clopyralid, and using the lowest effective use rate. For example, since glyphosate is a nonselective herbicide, it would not be used for aerial application. Only upland sites would be treated with aerial application, to reduce effects to nontarget deciduous trees and shrubs. Conifer cover types with more than 30 percent overstory canopy cover would not be treated using aerial application. Aerial application of herbicides would be limited to lands greater than 300 feet from special-status plant populations and 300 feet from live water; therefore, the potential impacts to nontarget riparian vegetation would remain the same as those for ground-based applications.

The direct and indirect effects of these herbicides on nontarget vegetation are the same regardless of the application method—whether the herbicide is applied using a ground-based broadcast application system, like a spray truck, or applied using an aerial application method with strict

adherence to design criteria and herbicide label direction. The potential for drift during aerial application is slightly higher than for ground-based applications, but standard operational practices successfully manage drift concerns, drift control agents, appropriate type and size of nozzle, appropriate boom length and application pressure, application at the lowest safe elevation, and application in optimal weather conditions (Wolf 2000). The number of acres treated annually would increase in years in which herbicides were applied aerially. Necessarily, this would also increase the amount of broadcast acreage, creating a concurrent increase in the adverse effects of herbicide application to nontarget vegetation in the areas treated aerially.

The potential effects at the site level would be the same as for a ground-based broadcast application. The difference is one of scale, in that more acreage would be treated aerially than could be treated using ground-based equipment. However, from a project area perspective, even though aerial application has the potential to apply herbicides over larger areas, implementation of the Proposed Action would only aerially treat 10,000 acres per forest annually. At a landscape scale, the potential short-term impacts to nontarget vegetation in the project area would be minor; however, the long-term benefit of reduced invasive plant cover in these infestations could contribute to increased density of desirable vegetation with improved productivity and vigor.

Beneficially, areas that are presently not infested but "at risk" to invasive plant invasion would be more protected by aerially applying herbicides to infestations that are currently uncontrolled, thus establishing containment boundaries. Additionally, aerial application would provide for landscape-level restoration efforts to manage invasive plants and maintain or improve ecosystem resilience.

Special-status plant species would potentially be impacted by aerial herbicide applications, but design criteria have been put in place to greatly minimize the risk. Aerial application would not be done within 300 feet of known special-status plant populations. There remains a risk of impact to unknown special-status plant individuals and populations. Another design criteria is that no aerial applications of herbicides would be made in whitebark pine stands. There would be no direct or indirect adverse effects to any known populations of special-status species resulting from aerial application of herbicides.

Aquatic Applications

There are two known species of littoral weeds (i.e., weeds that grow with their roots in or very near the water and with their foliage well above the surface of the water) that infest lands within the project area. These are Japanese knotweed and saltcedar; both species occur in riparian areas or grow adjacent to water, but do not grow beneath the surface of the water. Both of these species have the ability to grow beyond the immediate vicinity of water, but at this time they are only found growing immediately adjacent to water. To date, they have been managed for eradication as riparian weeds and utilizing treatment techniques, herbicides, and design criteria associated with terrestrial plants. A hybrid Eurasian watermilfoil (*Myriophyllum spicatum*) is known to occur within the project area at one location. It is a submerged invasive that grows in the water and would require aquatic application of herbicides to treat. Implementation of the Proposed Action Alternative would allow quick response to aquatic invasive plants. Early detection and treatment would minimize the impacts of treatment and would reduce the impacts of invasion to native aquatic vegetation.

The State of Idaho has two invasive species management plans that provide direction toward the management of aquatic invasive plants within the project area. The first of these plans is the

Idaho Invasive Species Strategic Plan 2012–2016 (IDA 2012); the second of these plans is the Idaho Aquatic Nuisance Species Plan of 2007 (ID ISCTC 2007). In particular, the Idaho Aquatic Nuisance Species Plan of 2007 outlines a rapid response strategy that the CTNF and CNG propose to implement if an aquatic invasive species is found to occupy waters within the CTNF and CNG.

In many ways, aquatic invasive plants are similar to terrestrial invasive plants. There are annuals and perennials. Many flower and produce seed, others propagate only asexually. Some produce tubers or winter buds, some are more shade-tolerant than others, and nearly all respond to fertilization. Therefore, the management and control of these pests is similar, in many respects, to that of terrestrial invasive plants (Morgan and Patten 2012).

Herbicide treatment options are generally associated with three broad categories of aquatic invasive plants: emergent, submersed, and floating. Emergent plants (sometimes called bank or marginal plants) are those rooted or anchored in the substratum, with most of the leaf stem tissue above the water surface. They do not rise and fall with the water level. Examples include purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), and saltcedar (*Tamarix ramosissima*). Submersed plants are adapted to grow with all or most of their vegetative tissue below the water surface. Examples of submersed plants include pondweeds (*Potamogeton* spp.), Eurasian watermilfoil, and Brazilian waterweed (*Egeria densa*). Floating plants are those that are either free-floating or anchored to the substratum. They produce most of their leaf stem tissue, or thalli, at or above the water surface. Leaves or thalli of floating plants rise and fall with the water level. An example of a floating plant is the water hyacinth (*Eichhornia* spp.), although other aquatic invasive plants on the Idaho noxious weed list can survive in a free-floating form; an example of this is Carolina fanwort (*Cabomba* spp.).

Alternative 2 proposes to use four herbicides for the treatment of aquatic invasive plants. Of these, two herbicides (glyphosate and triclopyr TEA) are already authorized for use in the treatment of terrestrial invasive plants. The two herbicides that are proposed to be added to the toolbox are imazamox and imazapyr. Table 3-37 displays these four herbicides as proposed for use by plant growth form.

Table 3-37. Herbicide treatment options, by growth form.

GROWTH FORM	AQUATIC USE HERBICIDES			
	Glyphosate	Imazamox	Imazapyr	Triclopyr TEA
Submersed Invasive Plants		X		X
Emergent Invasive Plants	X	X	X	X
Broadleaf; Floating and Emergent	X	X	X	X
Floating Invasive Plants	X			

Application techniques for the treatment of aquatic invasive plants fall into two basic types, foliar application and submersed aquatic. In a foliar application, the herbicide is mixed with water and sprayed on the foliage of floating or emergent plants in a given area. The goal during foliar application of an aquatic herbicide is to obtain good coverage and ensure that the maximum amount of herbicide is taken up by the target weed. The foliar application of herbicides to emergent and floating-leaved plants is generally well understood by homeowners because this is common practice on ornamental lawn and garden plants.

The application of herbicides for submersed weed control, however, is often more complicated and thus more difficult to understand. In an application for submersed aquatic invasive plants, herbicide is applied into the water and the target plant uptakes the active ingredient through the water. The control of submersed aquatic weeds is much more difficult than the control of emergent aquatic plants, for the following reasons:

- Fewer herbicides are registered for submersed treatments.
- The dilution effect of water depends on the depth of the water.
- Wind, waves, and currents dilute herbicides.
- It takes more time to treat and cover submersed plants.
- Submersed weeds are generally much more expensive to treat.
- The growth stage and area covered by the plants are important.
- Use of treated water for irrigation and drinking may be restricted.

These general factors, along with additional site-specific factors, would be used to determine which herbicides and application techniques should be used to control submersed aquatic invasive plants. When making aquatic herbicide applications, all the design criteria for general herbicide applications apply, as well as design criteria specific to aquatic herbicide applications.

There are no special-status plant species that grow in aquatic settings. Aquatic applications would have no effects, direct, indirect, or cumulative to special-status plants.

3.5.3.3.1.3 Mechanical Control

The direct and indirect effects of mechanical control under Alternative 2 would be the same as those described under Alternative 1.

3.5.3.3.1.4 Integrated Weed Management

Integrated weed management would increase the effectiveness of the invasive species management program by ensuring better information is used in the decision-making process and would guide the development of the best treatment approach (Figure 2-1). Inventory and monitoring data would to be used to determine the intial treatment option, and to adjust the treatment strategy based on the results of treatments. Integrated weed management would also increase the effectiveness of biological, herbicide, and mechanical control practices and efforts by providing a path to incorporate new treatment tools as they become available.

3.5.3.3.1.5 Rehabilitation and Restoration Practices

The direct and indirect effects of rehabilitation and restoration measures under Alternative 2 would be similar to Alternative 1. Increased emphasis of rehabilitation and practices under Alternative 2 would result in potentially increased short-term adverse effects due to site preparation or vegetation manipulation. Likewise, there would be anticipated long-term beneficial effects from the increased emphasis on rehabilitation and restoration under Alternative 2 relative to Alternative 1, including natural plant communities that are more resistant to invasive species in the future.

3.5.3.3.2 Cumulative Effects of Alternative 2

3.5.3.3.2.1 Biological Control

The cumulative effects of biological control as implemented by Alternative 2 would be the similar as those disclosed under Alternative 1 (No Action).

3.5.3.3.2.2 Herbicide Control

The cumulative effects of herbicide application to native vegetation communities and special-status plant species are the same as those described under Alternative 1, with the exception of including aerial application and aquatic application as approved application methods. Note that there would be no cumulative effects to special-status plant species resulting from aquatic applications.

Beneficial effects of weed control accrue at both the site level and at the plant community and landscape level. These include improved plant community composition and ecosystem resilience. The potential increase in acres treated could result in short-term impacts to nontarget vegetation, but could provide for long-term benefits in terms of plant community composition and ecosystem resilience. These beneficial effects would not only be realized within the project area, but would also benefit lands beyond the project area by reducing the movement of invasive plant reproductive propagules or seeds from NFS lands.

The CWMAs are all making use of herbicides. Integrated weed management programs on adjacent non-NFS lands could be more effective since both the CTNF and CNG work cooperatively with these entities. Integrated weed management in the project area would continue to identify infestations as high priorities for treatment. Herbicide application at these sites would continue to be very low, although the products used would shift to new, less toxic herbicides with lesser effects on nontarget vegetation. There would be no increase in cumulative effects from the shift to newer herbicides.

3.5.3.3.2.3 Mechanical Control

The direct, indirect, and cumulative effects of mechanical control under Alternative 2 would be the same as those described under Alternative 1.

3.5.3.3.2.4 Rehabilitation and Restoration Practices

The direct, indirect, and cumulative effects of rehabilitation/restoration measures under Alternative 2 would be similar to those described under Alternative 1.

3.5.3.3.3 Alternative 2 Summary

No irreversible or irretrievable uses of resources are associated with the Proposed Action. Implementation of Alternative 2 would contribute to restoration of native or desirable vegetation in areas where nonnative, invasive plant species have established. Invasive plant treatments as described in accordance with Alternative 2 would have relatively short-lived detrimental effects and long-term beneficial effects. Detrimental effects to sensitive plants would be minimized through the implementation of the design criteria.

Implementation of Alternative 2 would be beneficial overall since it uses a coordinated approach to (a) prevent the introduction and establishment of weeds in to the project area; (b) use EDRR to detect and respond to weeds that do become introduced into the project area; (c) use the most appropriate combination of ground or aerial herbicide, biological, and mechanical treatment to

treat weeds; and (d) implement reclamation and restoration efforts to make plant communities more resistant to establishment of weed species. The coordinated approach and the addition of aerial spraying and a new herbicide would allow the Proposed Action to be more effective at weed management. In the long term, preventing invasive plants from spreading into currently uninfested areas, slowing the rate of spread of existing infestations, and reducing the density of invasive plants in existing infestations would prove beneficial to native vegetation communities and sensitive plants.

Native vegetation communities and sensitive plant species may be impacted by herbicide and mechanical invasive plant control measures; individual plants or small groups could be damaged or killed, especially young plants that are difficult to detect. However, adverse effects on communities and populations would be negligible, even with the addition of aerial application. Implementation of Alternative 2 would not contribute to a downward trend in populations, habitat quality, or native vegetation communities nor would it lead to listing under the ESA. Table 3-37 (above) displays the determination of effects to habitat and sensitive plant populations (by sensitive plant species) as a result of implementing the Proposed Action Alternative.

3.6 Issue 5: Human Health

The human health report was developed for this analysis and is included by reference (USDA Forest Service 2020f).

3.6.1 Methodology for Analysis

3.6.1.1 Analysis Scale

The analysis area for direct and indirect effects is the entire CTNF and CNG. Cumulative effects will be addressed at a District-wide level in order to include CWMA activities.

3.6.1.2 Data Sources

The USDA Forest Service contracted with SERA to evaluate human health and ecological effects of herbicides using EPA studies and other peer-reviewed articles from the open scientific literature. Laboratory and field studies surrounding herbicide toxicity, exposure, and environmental fate were used to estimate the risk of adverse effects to nontarget terrestrial and aquatic organisms, human, water, and soil. Risk Assessments compiled by the BLM was also used in our analysis.

3.6.1.2.1 Methodology

The effects of herbicide use depend on the toxicity of the herbicide, the level of exposure to that herbicide, and the duration of that exposure. Risk assessments evaluate the potential effects to nontarget plants, wildlife, human health, soils, and aquatic organisms from the herbicides considered for use in a project area.

Table 3-1 identifies the risk assessments available by active ingredient.

In addition to the analysis of potential hazards to human health from the active ingredients in the herbicides, the SERA risk assessments evaluated available scientific studies on the potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert

ingredients, and adjuvants. Compared to herbicide active ingredients, however, less toxicity data are available for these substances because they are not subject to the extensive testing required for the herbicide active ingredients under FIFRA.

Risk assessments are a qualitative evaluation of the probability that the use of an herbicide may pose a risk to human health or the environment (FSM 2150.5). The risk assessments contain:

- Hazard Characterization—What are the dangers inherent with the active ingredient?
- Exposure Assessment—Who could come into contact and how much?
- Dose Response Assessment—How much is too much?
- Risk Characterization—Indicates whether or not there is a plausible basis for concern.

The risk assessments considered worst-case scenarios, including accidental exposures and applications at maximum label rates. Although these risk assessments have limitations (see discussion below), they represent the best science available. The risk assessment methodologies and detailed analyses are incorporated into conclusions about herbicide toxicity in this document.

For this analysis, a limitation of the risk assessments is the method used to estimate exposure from aerial spraying. SERA's exposure estimates for aerial application are higher than those found in field conditions because of the calculations used. Another limitation is SERA's modeling of the aerial application of imazapic using only helicopters. Under the proposed action, other aerial application methods may also be used to aerially apply imazapic. For the purposes of this analysis, we assume the risk to herbicide mixers/loaders and pilots is the same for all types of aircraft. The operator of the aircraft is not exposed because the spraying apparatus is mounted on a boom attached below the enclosed cockpit.

3.6.1.3 Exposure Scenarios

For each human health assessment in a risk assessment, researchers analyze a set of general exposure scenarios based on the low, typical, and maximum label rates of the herbicides. For workers, exposure analyses are based on application method, application rate, and acres treated. For the public, general exposure scenarios include coming into contact with sprayed vegetation and consumption of contaminated fruit, fish, or water.

Herbicide applicators are more likely than the general public to be exposed to herbicides. Worker exposure is influenced by the application rate selected for the herbicide, the number of hours worked per day, the acres treated per hour, and variability in human dermal absorption rates. In routine broadcast and spot applications, workers may contact and internalize herbicides mainly through exposed skin, but also through the mouth, nose, or lungs. Contact with herbicide formulations may irritate eyes or skin.

Accidental exposure scenarios were designed to be intentionally extreme. The worker exposure scenarios involved immersion of the hands for a 1-minute period and the wearing of contaminated gloves for an hour, at varying application rates; however, for all herbicides and surfactants, the amount of plausible worker exposure was below the LOC, for all application methods.

In 2015, the EPA released a list of 52 pesticides, based on the high potential for human exposure, to be tested for the potential to cause endocrine disruption. 2, 4 D is the only herbicide included

in the EPA list that is considered for use within the project area; it did not require further testing in the Tier 2. 2, 4 D was studied by SERA in 2006 (SERA 2006).

The quantitative risk characterization for human health and ecological effects is expressed as the HQ. For workers and members of the general public, the RfD of 2 mg a.e./kg body weight/day is used to characterize risks associated with acute and longer-term exposure levels. All exposure assessments are based on the unit application rate of 1 pound a.e./acre. Based on the HQ method, concern for workers is minimal. At the highest labeled application rate for terrestrial applications (about 8 pounds a.e./acre), the highest HQ is 0.6, which is the upper bound of the HQ for workers involved in ground broadcast applications.

For the general public, accidental exposures are evaluated in three scenarios: a naked child is sprayed directly with an herbicide as it is applied and no steps are taken to remove the pesticide from the child for 1 hour; a woman of childbearing age is accidentally sprayed on her feet and legs and no attempt is made to remove the pesticide for 1 hour; and an accidental spill into a small pond occurs, where a young child consumes 1 L of contaminated water soon after. The plausibility of these scenarios is very low; ideally, trained applicators practice proper hygiene and would never spray a person (e.g., the naked child and woman's legs) and, in the event of a pond spill, precautions would be taken to prevent public access following the spill, thus reducing the chances of, for example, water consumption and fishing.

The estimates of longer-term general exposure via consumption of contaminated water are based on estimated application rates and monitoring studies that can be used to relate levels in ambient water to treatment rates in a watershed. In most herbicide applications, however, substantial proportions of a watershed are not likely to be treated.

The exposure scenarios based on longer-term consumption of contaminated vegetation assume that an area of edible plants is inadvertently sprayed and these plants are consumed by an individual over a 90-day period. Wild foods commonly gathered by the public, such as huckleberries, occur incidentally on some portions of the Forest in areas that do not tend to have high densities of invasive plants. Several exposure scenarios for recreational and subsistence fish consumption were considered in the SERA risk assessments; none are near any herbicide exposure LOC (SERA 2009b).

3.6.1.3.1 Consideration of Available Science

The techniques and methodologies used in this analysis consider pertinent available science. The analysis includes a summary of credible scientific evidence which is relevant to evaluating reasonably foreseeable impacts. The analysis also identifies methods used and references the scientific sources relied on. The conclusions are based on a scientific analysis that shows a thorough review of relevant scientific information.

The relevant science considered for this analysis consists of several key elements. For wildlife the elements of science used are:

- ***Scientific literature:*** Relevant literature was used for identifying potential impacts on human health. The complete list of references utilized is listed below.
- ***Methods:*** The methods used to determine effects were based upon exposure scenarios developed by the EPA.

The determinations reached in the specialist's report are based upon a review of literature that is cited in the specialist report. On the basis of the foregoing, it is my determination that I have considered science relevant to impacts of the Invasive Plant Treatment project on the CTNF and CNG on human health effects.

3.6.1.3.2 Irreversible and Irretrievable Commitments

No irreversible or irretrievable commitment of resources that would affect human health associated with the implementation of any alternatives would be anticipated. This project restores native vegetation in areas where nonnative plants have been introduced. Herbicide treatments implemented in accordance with the alternatives would have relatively short-lived impacts; effects on human health would be minimized through the implementation of design criteria.

3.6.2 Affected Environment

3.6.2.1 Potential Human Health Effects

3.6.2.1.1 Invasive Plants

Some invasive plants found in the project area contain compounds that can cause allergic reactions; others have spines, prickles, or sharp leaf margins that can cause scrapes, cuts, or skin irritation. Individuals who are allergic to plants may suffer symptoms ranging from mild congestion, rashes, and localized itching to severe breathing difficulty or even anaphylaxis.

Approximately 18 to 20 percent of the US population exhibits symptoms of allergic rhinitis or hay fever. Knapweed pollen is a common but powerful allergen that peaks in late July to early August. It can trigger severe reactions in sensitive individuals (Duncan and Clark 2005).

Leafy spurge contains a toxic compound in its milky latex which can cause primary chemical irritation, resulting in dermatitis and causing blisters and inflammation. If leafy spurge sap gets into the eye, it can cause inflammation of the cornea and result in sight-threatening complications (Eke 1997). The sap of spotted knapweed may also cause skin irritation. People coming into contact with weeds (generally from pulling them) are advised to wear gloves to protect against injury and reduce contact with compounds in the plants.

3.6.2.1.1.1 Biological Treatments

Biological treatments would result in no known risks to human health.

3.6.2.1.1.2 Chemical Treatments

Toxicity tests required by the EPA for pesticide registration include acute (short-term) or chronic (longer-term) exposures. Herbicides are subjected to long-term animal studies that test for effects and compliance with federal safety standards for human health. Table 3-38 displays EPA toxicity categories.

During the herbicide registration process, the EPA evaluates carcinogenicity, teratology (birth defects), endocrine-system disruption, and mutagenicity studies of herbicide effects to animals. The study data are used to make inferences relative to human health. Table 3-39 displays the categories under Human Hazards Based on Acute Toxicity for assessed herbicides, while Table 3-40 displays Human Hazards Based on Chronic Toxicity for assessed herbicides. Data are from

the respective SERA reports (as shown in Table 3-38), NPIC (2002), Gervais et al. (2008), Henderson et al. (2010), and Bunch et al. (2012).

Table 3-38. US Environmental Protection Agency (US EPA) toxicity categories (US EPA 2012a).

TOXICITY CATEGORY	SIGNAL WORD	TOXICITY CLASSIFICATION	ORAL (MG/KG)	DERMAL (MG/KG)	INHALATION (MG/L)	EYE IRRITATION	SKIN IRRITATION
I	DANGER POISON	High	0–50	0–200	0–0.2	Corrosive: corneal opacity not reversible within 7 days	Corrosive
II	WARNING	Moderate	>50–500	>200–2,000	>0.2–2.0	Corneal opacity reversible within 7 days; irritation persisting for 7 days	Severe irritation at 72 hours
III	CAUTION	Low	>500–5,000	>2,000–20,000	>2.0–20	No corneal opacity; irritation reversible within 7 days	Moderate irritation at 72 hours
IV	NONE	Very Low	>5,000	>20,000	>20	No irritation	Mild or slight irritation at 72 hours

Table 3-39. Human hazards based on acute toxicity categories.

HERBICIDE	ACUTE ORAL TOXICITY	ACUTE DERMAL TOXICITY	ACUTE INHALATION TOXICITY	PRIMARY EYE IRRITATION	PRIMARY SKIN IRRITATION
2,4-D amine	Moderate	Moderate	Low	High	Very Low
Aminopyralid	Very Low	Very Low	Very Low	Very Low	Very Low
Chlorsulfuron	Very Low	Low	Low	Low	Very Low
Clopyralid	Low[a]	Low	Low	Moderate	Very Low
Dicamba	Low	Low	Very Low	Moderate	Moderate
Glyphosate	Low	Low	Low	Low	Very Low
Imazamox	Very Low	Very Low	Very Low	Moderate/Very Low[b]	Very Low
Imazapic	Very Low	Very Low	Low	Low	Very Low
Imazapyr	Very Low	Very Low	Low	Low	Very Low
Metsulfuron methyl	Very Low	Low	Moderate	Low	Low
Picloram	Low	Low	High	Low	Very Low
Rimsulfuron	Low	Low	Low	low	low
Sulfometuron methyl	Very Low	Very Low	Low	Low	Low
Triclopyr TEA	Low	Low	Low	High	Low

[a] Low for technical grade, which is not used by the USDA Forest Service; very low for formulation used by the USDA Forest Service.
[b] Moderate for technical grade; very low for formulation used by the USDA Forest Service.

Table 3-40. Human hazards based on chronic toxicity categories.

HERBICIDE	CARCINOGEN	TERATOGEN	REPRODUCTIVE	MUTAGEN	ENDOCRINE DISRUPTOR
2,4-D amine	Not Classifiable	Unlikely	Unlikely	Unlikely	Little or no impact
Aminopyralid	Not Likely to Be Carcinogenic	No Effects	No Effects	No Effects	No Evidence
Chlorsulfuron	Evidence of Noncarcinogenicity	No Effects	No Evidence	No Effects	No Evidence
Clopyralid	Evidence of Noncarcinogenicity	No Effects	No Effects	No Effects	No Evidence
Dicamba	Not Classifiable	Unlikely	No Effects	No Effects	No Information
Glyphosate	Evidence of Noncarcinogenicity	Unlikely	Unlikely	No Effects	Unlikely
Imazamox	Not Likely	No Effects	No Effects	No Effects	No Effects
Imazapic	Evidence of Noncarcinogenenicity	No Effects	No Effects	No Effects	Unknown
Imazapyr	Evidence of Noncarcinogenicity	No Effects	No Effects	No Effects	No Evidence
Metsulfuron methyl	Not Likely to Be Carcinogenic	No Effects	No Effects	No Effects	No Evidence
Picloram	Evidence of Noncarcinogenicity	No Effects	No Effects	No Effects	No Effects
Rimsulfuron	Not likely to be carcinogenic	No Effects	No Effects	No Effects	No Effects
Sulfometuron methyl	No Evidence of Carcinogenic Activity	Unlikely	Unlikely	No Effects	No Evidence
Triclopyr TEA	Not Classifiable	No Effects	No Effects	No Effects	No Evidence

Note: Not Classifiable = Inadequate evidence of carcinogenicity or for which no data are available; Unlikely = Inconsistent or isolated effects have been shown in laboratory tests; not considered a hazard to humans at expected exposure levels; Unknown = Laboratory tests are inconclusive or further testing is required; No Effects = No effects have been shown in laboratory tests; not considered a hazard to humans.

Acute toxicity is a function of the amount of toxicant received, the route of administration, and/or the type of animal tested. Acute reactions tested include oral, dermal, and inhalation toxicity, along with eye and dermal irritation.

All herbicide applicators must follow the label directions for application rate and usage. The herbicide label is the primary communication for safe handling and use of the product. The label reflects the numerous scientific studies and regulatory reviews generated by the EPA registration process, which provides reasonable assurance that the potential benefits of use outweigh any potential risks—that, when used according to label directions, the herbicide will not cause unreasonably adverse effects on humans, fish, and wildlife, or on the environment. The law requires herbicide users to read and follow label specifications. FIFRA, as currently amended, allows use of an herbicide at rates up to those approved on the label.

In addition to following label directions, the USDA Forest Service requires an additional level of risk assessment. The inherent hazard (toxicity) of the herbicide, an estimate of exposure, and the response of the individual organism under consideration to that exposure (dose–response) are modeled to generate an estimate of risk (i.e., the HQ) for each scenario. The herbicides in this analysis are evaluated based on the HQ, which is the ratio between the estimated dose (the amount of herbicide received from a particular exposure scenario) and the RfD. When a predicted dose is less than the RfD, and the HQ (estimated dose/RfD) is less than 1.0, which is below the LOC, then significant toxic effects are unlikely for that specific herbicide application. Table 3-41 displays various scenarios (described below under Active Ingredients), some of which show where HQs were exceeded.

Table 3-41. Scenarios in which hazard quotients (HQs) were exceeded.

HERBICIDE	WORKERS (ACUTE)	WORKERS (CHRONIC)	PUBLIC (ACUTE)	PUBLIC (CHRONIC)
2,4-D amine	Yes	Yes	Yes	Yes
Aminopyralid	No	No	No	No
Chlorsulfuron	No	Yes	Yes	No
Clopyralid	No	No	Yes	No
Dicamba	No	No	Yes	No
Glyphosate	No	No	Yes	No
Imazapic	No	No	No	No
Imazapyr	No	No	No	No
Imazamox	No	No	No	No
Metsulfuron methyl	No	No	No	No
Picloram	No	Yes	No	Yes
Rimsulfuron	No	No	No	No
Sulfometuron methyl	No	Yes	No	Yes
Triclopyr TEA	Yes	Yes	No	Yes

In the instances where the worker exposure exceeded the HQ, it only occurred when exceeding the typical application rates. As previously described for the general public scenario, they are designed to be extreme and are implausible. In all cases, the HQ was exceeded under these scenarios: a naked child is sprayed directly with an herbicide as it is applied and no steps are taken to remove the pesticide from the child for 1 hour; a woman of childbearing age is accidentally sprayed on her feet and legs and no attempt is made to remove the pesticide for 1 hour; and an accidental spill into a small pond occurs, where a young child consumes 1 L of contaminated water soon after.

Potential techniques for minimizing human exposures to herbicides include selecting herbicides with low toxicity and using them at the lowest effective application rate to achieve the project's objective; using application methods that minimize off-target movement and nontarget exposures; for streams, using buffer areas for certain herbicides; providing personal protective equipment for applicators; and posting signs at treated areas to inform the public. Under all alternatives, treatments would be accomplished according to strict safety and health standards as

required by EPA pesticide regulations, which are rendered on herbicide labels through the instructions for appropriate use.

Chronic toxicity results from repeated exposures or prolonged or continuous exposure to a chemical, typically at levels lower than those causing acute toxicity. Chronic toxicity often demonstrates a delayed response. Public concerns toward herbicides generally focus on potential chronic toxicity. Sublethal poisoning or exposure may be expressed by any of the following: skin/eye irritations; nervous system disorders; reproduction system disorders; damage to other organ systems (e.g., liver, kidney, lungs); birth defects; mutations; and cancer.

3.6.2.1.1.3 Active Ingredients

2,4-D Amine

2,4-D, the common name for 2,4-dichlorophenoxyacetic acid, is a selective systemic herbicide used to control broadleaf weeds. In the risk assessment, two acute RfDs were used—one for reproductive-age females derived from the basis of maternal toxicity (0.025 mg/kg/day), and one for male workers (0.067 mg/kg/day). The chronic RfD was the same for female and male workers (0.005 mg/kg/day). For workers, HQs could be exceeded in both acute and chronic scenarios (Table 3-41) potentially resulting in adverse health outcomes. For chronic exposure, at the typical application rate of 1 pound a.e./acre, HQs for backpack and aerial spray methods would be 16 and ground broadcast would be 30. The acute accidental scenarios of wearing contaminated gloves for 1 hour at all application rates and wearing contaminated gloves for 1 minute at the highest application rate resulted in HQ exceedances of 15 to 94. The accidental spill on the lower legs at a high application rate (4 pounds a.e./acre) also exceeded the HQ, by 1.8 (i.e., the HQ was 2.8). The magnitude of the HQ is linearly related to the application rate.

For scenarios involving the public, HQs for both chronic and acute scenarios were exceeded (Table 3-41). For acute accidental exposures, researchers projected that the naked child scenario HQ would be exceeded by 3 at the lowest application rate (0.5 pound a.e./acre) to 28 at the highest application rate. For consumption of contaminated water by a child, HQs were exceeded by 41, 82, and 328 for the lowest, typical, and highest application rates. The other acute scenarios that exceeded HQs were those of an adult female eating contaminated fruit (4, 7, and 30 at the lowest, typical, and highest application rates) and vegetation (27, 54, and 216, respectively). Regarding chronic exposure, the scenario for consumption of vegetation over the long term showed plausible adverse health effects: the HQ exceedances would be 19, 38, and 152 at the lowest, typical, and highest application rates (USDA Forest Service. 2006b).

Subgroups sensitive to 2,4-D amine exposure are children, especially those who are malnourished; women who are pregnant or who could become pregnant; immune-compromised individuals; and individuals with diseases affecting the integrity of the cell membrane. In addition, sunscreens can increase the absorption of 2,4-D into the skin (USDA Forest Service 2006b).

Aminopyralid

No exposure scenarios for workers, neither acute nor chronic, exceeded the RfD (Table 3-41). The HQs for all application methods were below the LOC, by factors of 33 to 200.

For chronic public exposure scenarios, HQs at the highest application rates were below the LOC, by factors of 100 to 125,000. Acute exposures for consumption of contaminated produce were

below the LOC by factors of 10 to 50, and nonaccidental exposures involving contaminated water were below the LOC by factors of 50 to 500. The accidental exposure scenario of a child consuming contaminated water resulted in an HQ of 0.6, which is below the LOC.

No information suggests any specific groups or individuals may be sensitive to the systemic effects of aminopyralid. Aminopyralid is a relatively new herbicide, and available information is limited to studies required for pesticide registration. However, nothing has raised substantial concern. Risks to the public or workers are not anticipated resulting from the application of aminopyralid (SERA 2007b).

Chlorsulfuron

Regarding chronic exposure for workers, the upper range of the HQs was below the LOC for all backpack and aerial applications, although it was somewhat above the LOC for ground broadcast at the maximum label application rate. No acute accidental scenarios resulted in an HQ exceeding the LOC (Table 3-41).

As for public exposure, the only scenario to slightly exceed the LOC was water consumption after an accidental spill of a large amount of chlorsulfuron into a small pond. This scenario assumes that an adult consumes contaminated ambient water from a contaminated pond for a lifetime which is not a plausible scenario. No other scenario, neither acute nor chronic, exceeded the HQs (Table 3-41). For both workers and members of the general public, typical exposures to chlorsulfuron do not lead to estimated doses that exceed a LOC. (SERA 2004a).

No information exists to suggest that specific subgroups or individuals may be sensitive to this chemical. In addition, no data exist to assess if chlorsulfuron would interact synergistically or antagonistically with any other herbicide. No additives in chlorsulfuron formulations are classified as toxic. There is no indication that repeated exposures would exceed a toxicity threshold (SERA 2004a).

Clopyralid

For workers, none of the acute or chronic exposure scenarios exceeded the HQ LOC at any application rate (Table 3-41).

Regarding public exposure, the only scenario to slightly exceed the LOC was the consumption of water by a small child after an accidental spill of a large amount of clopyralid into a small pond. No other scenario, acute or chronic, exceeded the HQs (Table 3-41). All of the anticipated exposures for workers are below the acute RfD for acute exposures and below the chronic RfD for chronic exposures. For members of the general public, none of the longer-term exposure scenarios approach a LOC and none of the acute/accidental scenarios exceed a LOC, based on central estimates of exposure (with the exception of the contaminated water consumption). The use of clopyralid does not appear to pose any risk of systemic toxic effects to workers (or to the general public) in USDA Forest Service programs.

No information suggests specific subgroups or individuals may be sensitive to this chemical. It is unclear as to whether individuals with preexisting diseases of the kidney, liver, or blood would be particularly sensitive to clopyralid exposure; however, individuals with any severe disease may be considered more sensitive to any chemical exposure. No data exist for assessing whether or not clopyralid would interact synergistically or antagonistically with any other herbicide. No

additives in clopyralid formulations are classified as toxic. There is no indication that repeated exposures would exceed a toxicity threshold (SERA 2004b).

Dicamba

At the typical application rate for ground-based broadcast applications (0.3 pound a.e./acre), the upper range of the HQ for chronic exposure was reached, but not exceeded. For backpack and aerial applications, the LOC was exceeded at application rates over 0.6 pound/acre. At typical application rates, no accidental acute exposure exceeded the LOC; however, at the maximum application rate (2 pounds/acre), workers would be exposed to levels of dicamba considered unacceptable, although it is uncertain as to whether noticeable effects would occur.

Regarding the acute accidental exposure scenarios for the public, at typical and above application rates, the naked child scenario and the consumption of contaminated water after a spill exceeded the LOC for the HQs (Table 3-41). At the highest application rate, the acute scenarios of the sprayed lower legs of the woman, the consumption of fruit, and the consumption of fish by subsistence populations all exceeded the LOC. None of the chronic exposure scenarios at the typical application rate exceeded the LOC (Table 3-41). At the highest application rate, the LOC was exceeded for the consumption of contaminated vegetation.

The only sensitive subgroup identified for dicamba was children. The scenarios analyzed included effects on children. No evidence exists that dicamba interacts with other compounds (SERA 2004c).

Glyphosate

For workers, the accidental acute exposure scenario was below the HQ LOC by a factor greater than 300; for chronic exposures, all HQs were below the LOC (Table 3-41). To reach the LOC (HQ = 1.0) for aquatic applications, a worker would have to treat more than 250 acres in a single day (nonaerial), which is not plausible.

For the public, the acute exposure scenario of eating contaminated produce applied at the rate of 8 pounds/acre would result in an HQ of 5.6 (Table 3-41). No basis exists for asserting the dose related to that exposure level would result in gross signs of toxicity or lethality, but the level may raise concerns for adverse health effects in pregnant women. This is not a plausible exposure scenario for the applications being analyzed, however, since food crops are not being treated. Aquatic applications all saw HQs below the LOC, by a factor of 100.

Glyphosate breaks down into a metabolite and impurities. The metabolite present in the formulations used by the USDA Forest Service is aminomethylphosphonic acid (AMPA). Existing glyphosate toxicity data encompass mammalian exposures to this metabolite. As far as concerns of AMPA as an environmental metabolite, it has been determined by the EPA that it is of no toxicological concern. Glyphosate contains N-nitrosoglyphosate (NGN) as an impurity. The EPA has concluded that the NGN present in glyphosate is not toxicologically significant (SERA 2011a).

Glyphosate inhibits some cytochrome P450 isozymes (aromatase). Inhibiting these enzymes could enhance or diminish the toxicity of other compounds, depending on whether metabolism increases or decreases toxicity of those compounds (SERA 2011a). The impact of an added surfactant for aquatic applications is directly proportional to the surfactant's toxicity and concentration. Using lower application rates while keeping the concentration of the surfactant

constant would decrease the impact of the surfactant relative to high application volumes (SERA 2011a).

The International Agency for Research on Cancer (IARC) determined glyphosate should be classified as "possibly carcinogenic to humans" based on reviews of existing studies rather than new research (Guyton et al. 2015). In 1991, the EPA concluded that glyphosate had "evidence of non-carcinogenicity" (Table 3-40), based on a lack of evidence to the contrary and on the criteria used by the EPA for classifying a carcinogen. The USDA Forest Service defers to the EPA in cases such as this. A new risk assessment is expected later this year; if the EPA adopts the IARC recommendation and reclassifies glyphosate, then the USDA Forest Service would consider updating their risk assessments, and the reclassification would be considered "new information" for the purposes of NEPA (Bakke 2015).

In 2017, EPA Glyphosate-Systematic Review of Open Literature detail two open literature searches conducted for glyphosate and the subsequent review of the studies gathered from these searches. The majority of the literature studies were found to be unacceptable for use in the EPA's glyphosate Registration Review draft human health risk assessment. Most studies used commercial formulations or dilutions, limited dosing, small sample sizes, and lack of test chemical purity. Global regulatory and research agencies determined when used as label prescribed little evidence of toxicity, not likely to be carcinogenic to human, and do not present risk to human (2019).

Imazamox

No exposure scenarios for workers or the public resulted in an HQ that exceeded or approached a LOC (Table 3-41). The use of imazamox is not likely to possess any identifiable risks to humans (SERA 2010).

In terms of the human health risk assessment imazamox does not appear to cause detectable signs of toxicity in mammals even at very high doses. No remarkable signs of toxicity are reported in standard toxicity studies involving dermal, ocular, or inhalation exposure. Most of the occupational exposure scenarios and many of the exposure scenarios for the general public involve the dermal route of exposure. For some compounds, acute dermal and oral LD50 values can be used to assess the plausibility of the estimated dermal absorption rates relative to oral absorption rates. This is not possible for imazamox due to its low toxicity which resulted in a lack of definitive LD50 values in the acute oral toxicity studies and acute dermal toxicity studies.

Imazapic

The worker exposure scenarios, both acute and chronic, did not result in HQs exceeding a LOC (Table 3-41). A LOC could, however, be reached by wearing contaminated gloves at the maximum application rate for a longer period of time than the scenarios called for. Imazapic is also mildly irritating to the eyes. These effects are mitigated by wearing proper personal protective equipment and following proper handling practices.

For the public, none of the long-term exposure scenarios resulted in an HQ exceeding the level of concern (Table 3-41). For acute accidental scenarios, the only one reaching a LOC was the drinking of contaminated water by a small child after a spill into a small pond. No information suggests that specific groups or individuals may be especially sensitive to systemic effects of imazapic (SERA 2004d).

Imazapyr

No exposure scenarios for workers or the public resulted in an HQ that exceeded or approached a LOC (Table 3-41). The use of imazapyr is not likely to possess any identifiable risks to humans (SERA 2011b).

Metsulfuron methyl

No exposure scenarios for workers or the public resulted in an HQ that exceeded or approached a LOC (Table 3-41). No information suggests that specific groups or individuals may be especially sensitive to systemic effects of metsulfuron methyl (SERA 2004e).

Picloram

For workers, none of the acute or chronic exposure scenarios exceeded the HQ LOC at any application rate (Table 3-41).

Regarding public exposure, the only scenario resulting in an HQ greater than 1.0 was the long-term consumption of contaminated vegetation at the maximum application rate of 1 pound a.e./acre (Table 3-41). This scenario is unlikely, especially since vegetation would exhibit visible damage after being sprayed with picloram.

No information suggests that specific subgroups or individuals may be sensitive to this chemical. One study implicated 2,4-D in combination with picloram; this combination may cause reproductive impairment in mice. Another study indicated a commercial mixture of picloram and 2,4-D might negatively affect immune function in rats; however, the study did not allow for an evaluation of any potential interactions between picloram and 2,4-D (SERA 2011c). It should be noted that a formulation of 2, 4-D in combination with picloram is not used in USDA Forest Service programs.

Rimsulfuron

Rimsulfuron is not acutely toxic via dermal or oral routes of exposure. It is not likely to pose a risk. The occupational risks associated with exposure to rimsulfuron are not expected to exceed EPA's LOC for any of the potential occupational receptors under routine use scenarios.

Sulfometuron methyl

At the typical application rate (0.045 pound/acre), no acute or chronic scenarios exceeded the LOC for workers (Table 3-41). At the maximum label application rate, backpack, ground broadcast, and aerial application methods all slightly exceeded the LOC for chronic exposure (Table 3-41). If the assumptions (i.e., highest application rate, highest number of acres treated per day, and hygiene practices utilized) had been changed, there still would be no indication of workers at risk of sustaining systemic toxic effects. No accidental acute scenarios exceeded the level of concern at the highest application rate.

None of the acute or chronic scenarios involving the public resulted in an exceedance of the LOC at any application rate (Table 3-41).

No sensitive subgroups have been identified; however, speculation exists that individuals with existing thyroid dysfunction could be at increased risk. No evidence indicates sulfometuron methyl would interact synergistically or antagonistically with any other herbicide (SERA 2004f).

Triclopyr TEA

For workers, none of the acute exposure scenarios exceeded the HQ LOC at the typical application rate (1 pound a.e./acre) (Table 3-41). At the application rate of 1 pound a.e./acre and typical conditions of application, no indication existed that workers would be subjected to hazardous levels of triclopyr TEA at central estimates of exposure. At the upper ranges of exposure, however, the LOC was exceeded. At the application rate of 6 pounds a.e./acre, the LOC for chronic exposure was exceeded for all terrestrial application methods (Table 3-41). None of the accidental exposure scenarios exceeded the LOC at the typical application (1 pound a.e./acre) or the high application (6 pounds a.e./acre) rates. At the maximum label application rate (9 pounds a.e./acre), a rate that is rarely (if ever) used by the USDA Forest Service, the accidental exposure scenario of wearing contaminated gloves for 1 hour would exceed the HQ LOC for female workers. No accidental exposure scenarios would exceed the LOC for male workers.

For the public exposure scenarios, the only acute scenario resulting in an exceedance (HQ = 27) of the LOC was a female of childbearing age eating contaminated vegetation after an application rate of 1 pound a.e./acre. Aquatic applications of triclopyr do not present identifiable risks to workers or the public. Identified sensitive subgroups are women of childbearing age; a risk of potential adverse reproductive outcomes exists in women exposed to amounts of triclopyr above the LOC. Individuals with kidney disease or those with multiple chemical sensitivity syndrome may be at higher risk; however, no literature supports this conclusion.

A major metabolite of triclopyr is 3,5,6-trichloro-2-pyridinol (TCP), which is toxic to mammals and other species. The HQs for TCP are similar to those for triclopyr: the exposure scenario of a female of childbearing age eating contaminated vegetation at the application rate of 1 pound a.e./acre would exceed the LOC, with the upper-bound acute HQs ranging from 2 to 15 (SERA 2011d).

Triclopyr is a relatively typical, weak-acid auxin herbicide. Aminopyralid, clopyralid, and picloram are similar in structure and in the way each chemical is absorbed, distributed, metabolized, and eliminated (as well as in toxicity); therefore, it is reasonably anticipated that exposure to triclopyr along with the aforementioned other weak-acid herbicides may result in additive risks (SERA 2011d).

3.6.2.1.1.4 Drift and Volatilization

Herbicides can move through the atmosphere via spray drift, which occurs during herbicide application, and by volatilization, which occurs after application. Volatility depends on the physical properties of the herbicide, primarily vapor pressure, while spray drift depends on the sprayer parameters, such as nozzle orifice size, boom height and pressure, and wind speed (Branham and Hanson 1987).

Volatilization is the conversion of a liquid or solid chemical to a gas. The amount of volatilization occurring depends on climactic and microclimatic conditions. Soil moisture is the primary environmental condition influencing the rate at which herbicides volatilize; in general, herbicides volatilize more rapidly from moist soils than from dry soils (Menalled and Dyer 2005). Volatilization also increases with higher air and soil temperatures and greater wind speed. Using surfactants can change the volatility of an herbicide (Lincoln County Weed Board unk.).

Ester formulations of herbicides possess higher vapor pressures and volatilize more than amine formulations (Nice 2004). No ester formulations are proposed for use in this analysis.

Studies examining the risk to the public from pesticide volatilization have been conducted in residential areas near agricultural areas (Table 3-36). The chemicals addressed in these studies do not include any that are reviewed in this analysis (Kegley et al. 2009).

Spray drift is the movement of the herbicide, generally via spray droplets, from the target area to an unintended area. Spray drift can be reduced by increasing droplet size. Droplet size can be reduced by reducing spray pressure, increasing nozzle orifice size, using drift reduction nozzles, utilizing rearward nozzle orientation during aerial applications, and adding adjuvants to the mixture. Other factors influencing spray drift are the method of application (drift is generally greater from mist blowers and aerial applications than from ground applications), the distance between the nozzle and the target (less distance reduces drift), wind direction and wind speed, air stability, and temperature and humidity (low humidity and high temperatures causes rapid evaporation, which reduces the size of droplets). The influence of humidity and temperature is not always predictable, however (Dexter 1993).

Spray drift cannot be completely eliminated; however, with proper management, drift levels can be minimized to levels that do not cause harm (Felsot 2001). The methods to reduce drift potentials of herbicides considered for aerial application are discussed below.

Aminopyralid

For aerial applications, liquid formulations of aminopyralid are applied using specially designed spray nozzles and booms designed to reduce turbulence and maintain large droplet size to reduce drift (SERA 2007b). Applications may only be performed under favorable weather conditions, which include wind speeds between 2 and 10 miles per hour (mph) and not during temperature inversions. Aminopyralid should be applied at rates of no less than 2 gallons (mixed) per acre; 5 gallons or greater are recommended. If electrostatic spray systems are used, then aminopyralid can be applied at a rate of 1 gallon per acre (Dow AgroSciences 2007).

No worker or public exposure scenarios in the risk assessment exceeded the RfD; all were below the LOC, by factors of 33 to 200 (SERA 2007b).

Chlorsulfuron

For chronic exposure for workers, the upper range of HQs is below the LOC for all backpack and aerial applications, but is somewhat above the LOC for ground broadcast at the highest application rate. No acute accidental scenarios resulted in a HQ that exceeded the LOC.

For public exposure, the only scenario to slightly exceed the LOC is the consumption of water after an accidental spill of a large amount of chlorsulfuron into a small pond. This is not likely to be toxicologically significant or result in adverse effects. No other scenario, acute or chronic, would exceed the HQs.

There is no information to suggest that specific sub-groups or individuals may be sensitive to this chemical. There is no data to assess if chlorsulfuron will interact synergistically or antagonistically with any other herbicide. No additives in formulations are classified as toxic. There is no indication that repeated exposure would exceed a toxicity threshold (SERA 2004a).

Clopyralid

Clopyralid has been shown to have little potential for drift during aerial applications (DiTomaso et al. 2004). To reduce any possible drift, the label recommends using straight stream nozzles, spray booms no longer than three-fourths the length of the rotor, drift control systems, and drift control additives. Aerial applications should be conducted when wind velocity is low and not during temperature inversions (Dow AgroSciences 2011).

The only scenario found to slightly exceed the LOC was the consumption of water after an accidental spill of a large amount of clopyralid into a small pond. No other acute or chronic scenario, whether for workers or for the public, exceeded the HQs (SERA 2004b).

Imazapic

The risk assessment analyzed aerial applications for imazapic to be conducted by aircraft. Liquid formulations are applied through specially designed spray nozzles and booms designed to reduce turbulence and maintain large droplet size to reduce drift (SERA 2004d). To additionally reduce or prevent drift, applications should not be performed in windy or gusty conditions (applications should occur when wind speeds are between 3 and 10 mph), high temperatures, low humidity, or temperature inversions (BASF 2011).

No worker or public exposure scenarios in the risk assessment exceeded the RfD; all were below the LOC, by a factor of at least 25 (SERA 2004d).

Metsulfuron methyl

Risk assessment included aerial application method. It is applied under pressure through specially designed spray nozzles and booms. The nozzles are designed to minimize turbulence and maintain a large droplet size, both of which contribute to a reduction in spray drift. In aerial applications, approximately 40–100 acres may be treated per hour. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

Picloram

For USDA Forest Service purposes, risk assessment analyzed aerial applications for picloram a by aircraft. Approximately 40 to 100 acres per hour may be treated. Liquid formulations are applied through specially designed spray nozzles and booms designed to reduce turbulence and maintain large droplet size to reduce drift (SERA 2011c). One exposure scenario exceeded the HQ; that of a person eating contaminated vegetation over the long-term. Aerial applications have the same exposure potential as backpack applications.

Rimsulfuron

Aerial methods employ boom-mounted nozzles for liquid formulations or rotary broadcasters for granular formulations, carried by aircraft. The aircraft is equipped with cylindrical jet-producing nozzles no less than 1/8 inch in diameter. The nozzles are directed with the slipstream, at a maximum of 45 degrees downward for fixed-wing applications, or up to 75 degrees downward for helicopter. Label contain mandatory spray drift management that restrict spray height and nozzle size. The number of workers range from 6 to 20 depending on the size of operations.

Sulfometuron methyl

One exposure scenario exceeded the HQ—that of a person eating contaminated vegetation over the long term. Aerial applications have the same exposure potential as backpack applications.

A study was done in the Missoula Valley modeling the buffer zones necessary to ensure that potential exposure to the public (and specifically children) would be well below any harmful levels. The simulation assumed a 10-mph wind for ground applications and a 6-mph wind for aerial applications. Table 3-42 illustrates the modeling results, which indicate that buffer zones resulting in no potential harm to a child were not substantial (Felsot 2001).

Table 3-42. Ground and aerial applications of clopyralid, 2,4-D amine, and picloram—recommended minimum buffer zones (feet).

APPLICATION METHOD	1 SPRAY SWATH			20 SPRAY SWATHS		
	Clopyralid	2,4-D Amine	Picloram	Clopyralid	2,4-D Amine	Picloram
Ground spray, low boom	0	5	0	0	5	0
Ground spray, high boom	0	15	0	0	30	0
Aerial spray, 10-ft release	-	-	-	0	N/A	0
Aerial spray, 25-ft release	-	-	-	0	N/A	0

Source: Felsot (2001).

3.6.2.1.1.5 Other Ingredients and Adjuvants

Inert (or "other") ingredients and adjuvants comprise ingredients in an herbicide formulation other than the active ingredient. By law, the active ingredient must be identified on a product's label and the percentage by weight disclosed. Inert ingredients and adjuvants are substances that are intentionally added to an herbicide either in the commercial formulation or in the tank mixture. Their purpose is to influence the effectiveness of the active ingredient by, for instance, preventing caking or foaming, extending the shelf life, acting as surfactants, or assisting with the mixing and/or application of the herbicide. The law does not require disclosure of the name or percentage of the "other" ingredients on the label or Material Safety Data Sheet, because the identity is considered proprietary information of the manufacturer (US EPA 2012b).

Some formulations of glyphosate contain the surfactant polyethoxylated tallow amine (POEA). The toxicity of formulations containing this surfactant is greater than the toxicity of formulations that do not contain it. The CTNF and the CNG do not propose to use the formulations of glyphosate containing the POEA surfactant.

The EPA reviews inert ingredients prior to registration. The lack of disclosure on the label of "other" ingredients in a formulation indicates none of the inert ingredients that are present at a concentration of 0.1 percent or greater are classified as hazardous or toxic (US EPA 2012b, 2013). The inclusion of certain ingredients in adjuvant formulations is regulated by the EPA, but the testing, the oversight of manufacture, and the use of adjuvants is not regulated consistently.

During the SERA risk assessments, data on inert ingredients in the confidential business information (CBI) files or obtained under a Freedom of Information Act (FOIA) request were reviewed, with the exception of 2,4-D, whose study predates FOIA availability (USDA Forest Service 2006b). The herbicide formulations whose proprietary information was released included inert ingredients on the EPA Inert List 4A (minimal-risk ingredients, whether of low toxicity or nontoxic); List 4B, which comprises "other" ingredients for which the EPA has sufficient information to reasonably conclude that the current use will not adversely affect public health; or List 3, which delineates inert ingredients for which available toxicity data are insufficient to classify the compound as one of toxicologic concern (List 1), one of possible toxicologic concern (List 2), or one of minimal concern (List 4). For purposes of this study, no toxic substances were identified as being included in any herbicide formulations.

The list of adjuvants commonly used is identified in the project record.

3.6.2.1.2 Manual and Mechanical Treatments

Potential risks to human health can result from manual and mechanical invasive plant control methods. Adverse weather and terrain can cause unfavorable working conditions. Heat and cold-related illness can be hazardous. Steep and uneven terrain could increase the risk of tripping and falling, resulting in strains, sprains, breaks, cuts, abrasions, or loss of control of equipment. Tools and equipment possess inherent dangers such as sharp edges of blades, emissions from gasoline or diesel powered equipment, flying debris, and loud noises that could damage hearing.

Ergonomic hazards resulting in musculoskeletal injuries could occur from carrying equipment and pulling invasive plants.

Although some potential for adverse health effects is associated with mechanical treatment of invasive plants, required personal protective equipment such as gloves, long-sleeved shirts, boots, and safety glasses, along with good personal hygiene and appropriate and adequate training and supervision, could prevent injuries or decrease exposure risks. Such hazards are mitigated through worker compliance with occupational health and safety standards.

3.6.2.1.3 Rehabilitation and Restoration Treatments

Potential human health risks associated with cultural control methods include exposure to dust and chaff during seeding operations. Allergic reactions can result from the exposure of seed chaff when handling seeds; however, gloves, long-sleeved shirts, boots, and other personal protective equipment (as needed) would mitigate injuries or irritations.

3.6.3 Environmental Consequences

3.6.3.1 Effects Common to All Alternatives

3.6.3.1.1 Biological Treatments

No human health effects are anticipated from biological treatments of invasive plants.

3.6.3.1.2 Manual and Mechanical Treatments

Potential risks to human health from mechanical invasive plant control methods are very low and include emissions from gasoline or diesel powered equipment, burns, allergies, back injuries,

injuries from tools and equipment, and skin irritation from direct contact with plants by individuals performing the work.

In a few individuals, some invasive plant species can cause allergies and minor skin irritations. Some species of invasive plants, such as thistles, cause minor scrapes and irritations. Other, more serious, complications may result from hand pulling. For example, leafy spurge contains a latex-bearing sap that irritates human skin and, rarely, causes blindness in humans upon contact with the eye (Webster 1986, Eke 1997). Highly allergic individuals can have serious complications when exposed to allergens (weeds or pollen), including constriction of the airway and anaphylactic shock, which can be especially hazardous because forest workers generally work some distance from medical assistance.

Although some potential for adverse health effects is associated with mechanical treatment of invasive plants, required personal protective equipment such as gloves, long-sleeved shirts, boots, and safety glasses, along with good personal hygiene, would mitigate injuries or irritation. Therefore, no human health effects are anticipated by manual or mechanical removal of invasive plants.

3.6.3.1.3 Rehabilitation and Restoration Treatments

Potential human health risks associated with cultural control methods include exposure to dust and chaff during seeding operations. Allergic reactions can result from exposure of seed and chaff when handling seeds; however, gloves, long-sleeved shirts, boots, and other personal protective equipment (as needed) would mitigate injuries or irritations. Therefore, no human health effects are anticipated by cultural control methods.

3.6.3.1.4 Direct and Indirect Effects

3.6.3.1.4.1 Effects Common to Alternatives 1, and 2

Herbicides would be used in Alternatives 1 and 2. All alternatives include the use of backpack- and vehicle-mounted sprayers. Health risks from herbicide use depend on the toxic properties of the herbicide and the level and duration of exposure.

There is potential for exposure from spray drift with either ground-based or aerial application methods. Aerial herbicide application has a greater potential because the herbicide is released from a greater height. Herbicide labels describe conditions in which spraying—ground or aerial—should not be done. Label instructions for herbicides also include provisions for managing drift, including controlling droplet size and not spraying in the following conditions—high or gusty winds, high temperatures, low humidity, and temperature inversions.

Spray drift is largely a function of droplet particle size. The largest particles, being the heaviest, will fall to the ground quickly upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but virtually all of the particles fall within a short distance of the release point. A small percentage of the spray droplets are small enough to be carried in wind currents to varying distances beyond the point of release. Since these smallest droplets are a minor proportion of the total spray volume, their toxicological significance beyond the project area boundary rapidly declines as they are diluted in increasing volumes of air (Felsot 2001).

Protection measures designed into the two alternatives would reduce the potential for exposure, including exposure from spray drift and the potential for doses in excess of the EPA's RfDs. All

herbicides would be applied according to label instructions to minimize exposure and adverse health effects. Label instructions include cautions about breathing and skin or eye contact with the herbicide, requirements for personal protective equipment (this is also a USDA Forest Service requirement) and recommendations for washing hands and contaminated clothing. PPE generally means gloves, waterproof boots, long sleeved shirts and pants, though the herbicide labels list the PPE requirements for each herbicide. Following label instructions and using PPE would reduce exposure on sensitive areas of the body and protect worker health.

Any time herbicide use is proposed, there is a risk of indirect effects from accidental spills and concerns with storage, transport and disposal. The SERA risk assessments account for these indirect effects in their potential exposure scenarios. Alternatives 1 and 2 all have the potential for these indirect effects; however, the risk is slightly higher under Alternative 2 because addition of aerial and aquatic treatment acres so more herbicide would be used. Risk would be outset with Integrated Weed Management measures in Alternative 2 because the best available method, herbicide, and treatment option would be implemented. Direction outlined in USDA Forest Service Handbook 2109.12 Pesticide Storage, Transportation, Spills and Disposal would be followed for both alternatives.

3.6.3.1.4.2 Alterative 1—No Action/Current Management

Alternative 1 includes the use of herbicides but does not allow the use of newly formulated herbicides within the Targhee portion and is limited. Potential exposure and potential for doses exceeding RfDs would be limited to the herbicides listed in 1987 EA. Effects to human health from the herbicides listed in this alternative are discussed below in the section titled Effects Common to both alternative. A more comprehensive risk discussion for each herbicide is available in the SERA risk assessments which can be found in the project file.

3.6.3.1.4.3 Alternatives 2—Proposed Action

The condition-based management strategies available under Alternatives 2 would result in fewer risks to human health than under Alternative 1. New technology, biological controls and herbicides are likely to be developed within the life of this project. Alternative 2, these new treatments would be considered if they would be more species-specific than methods currently used (Alternative 1), less toxic to non-target vegetation, capable of reducing human health risks, less persistent and less mobile in the soil, or more effective.

Under Alternative 2, aerial spraying would be used initially to treat cheatgrass with imazapic. In the future, aerial spraying may be used to treat cheatgrass with more effective and/or herbicides that pose less risk to health and safety, or to treat other invasive species with herbicides other than imazapic. The condition-based management strategy for selecting the most appropriate and effective control method is shown in Chapter 2 of the DEIS in Table 2.4 and in Figure 2-1.

Alternative 2 would pose less risk to workers than Alternatives 1 because it offers the option of aerial spraying which reduces exposure to the herbicide. The person who mixes and loads the herbicide has less contact time and the pilot who applies it is protected by the enclosed cockpit of the aircraft.

The aerial spraying option under Alternative 2 could expose the public to drift from spraying; however, this potential exposure would be reduced by following the herbicide label instructions. Herbicide labels describe conditions in which spraying—ground or aerial—should not be done.

Because aerial herbicide application is more efficient than backpack or vehicle spraying for control of cheatgrass (Hayward 2020), Alternative 2 could reduce the number of treatments and thus the likelihood of exposure over the long-term. It is estimated that aerial application can spray about 200 acres per day (50 acres/hour x 4 hours of flight time). A person can hand treat about 2 acres per day under optimal conditions. At this application rate, multiple treatments would be necessary.

3.6.3.2 Effects for Human Health Indicators

3.6.3.2.1 Effects Common to Alternatives 1, and 2

3.6.3.2.1.1 Indicator 1—Toxicity Potential

Worker Exposure

Worker exposure to herbicides is affected by the application rate of the herbicide, the number of hours per day the herbicide is applied, the number of acres treated per hour, hygiene used, and personal protective equipment worn. During broadcast and spot treatments, workers can come into contact with herbicides primarily through exposed skin, but also through the mouth, nose, and lungs. Contact with herbicides may result in irritation to the skin and eyes.

The worker exposure scenarios involve immersion of the hands for a one-minute period and wearing contaminated gloves for an hour at varying application rates. Of the herbicides analyzed, eight did not have any scenarios involving workers that exceeded the LOC. Five herbicides have scenarios that exceed the HQ LOC for workers at some rate of application. Four of those- chlosulfuron, dicamba, sulfometuron methyl, and triclopyr- do not exceed any LOC at typical application rates. One, 2,4-D, exceeded the chronic exposure LOC at typical application rates.

Design criteria minimize all worker exposure scenarios by following safe work practices and label advisories.

3.6.3.2.1.2 Indicator 2— Public Exposure

Public Exposure

Exposure scenarios assume that a person has contact with the herbicide from direct spray, from skin contact with sprayed vegetation, or from consumption of contaminated fruit, water or fish. Scenarios in risk assessments were modeled for both acute and chronic exposure.

Of the herbicides analyzed, six did not have any scenarios involving the public that exceeded the LOC. Seven herbicides have scenarios that exceed the HQ LOC at some rate of application. One herbicide, picloram, has no scenarios that exceed the LOC at the typical application rate. Two herbicides, chlorsulfuron and clopyralid, slightly exceed the LOC only under the scenario where a large amount of chemical is spilled in a pond and water from the pond is consumed soon after. Dicamba has two acute scenarios; consumption of water after a spill and the spraying of a child, that exceed levels of concern at a typical application rate. Triclopyr has a chronic scenario that exceeds the LOC of a female who eats vegetation that had been sprayed at a typical application rate. Glyphosate exceeded a LOC for an acute scenario of consuming contaminated produce applied at the maximum rate. One herbicide, 2,4-D, had acute and chronic exposure scenarios that had HQ level of concern exceeded at typical and lower application rates.

The public exposure scenarios evaluated in the risk assessments are purposefully extreme. There is virtually no chance of a child or a woman of child-bearing age to be directly sprayed during

herbicide applications. Three herbicides, 2,4-D , glyphosate, and triclopyr, had exposure scenarios that exceeded a LOC if fruit or vegetation containing herbicide residue were consumed shortly after application; 2,4-D also exceed the LOC for vegetation consumed over the long-term. There is some edible forest product collection within the CTNF, but is not extensive. People who harvest and consume edible forest products may be exposed through directly handling contaminated plant material, then chewing or eating it. Such doses are unlikely to exceed a threshold of concern. All herbicides applied within the CTNF also have a dye added to the tank mixture, so chemically treated plants are visually identifiable, which makes avoidance of those plants possible.

Design criteria will minimize public exposure by increasing notification of the public regarding areas that had herbicide applications. The general public would not be exposed to harmful levels of any herbicides used in the implementation of this project.

The risk assessment evaluated two hypothetical drinking water sources: (1) a stream, contaminated with herbicide residues by runoff or leaching from an adjacent herbicide application; and (2) a pond, into which a large amount of herbicide solution is spilled. The only herbicide scenarios of concern would involve a child drinking from a pond contaminated by a spill of a large tank of herbicide solution. The risk of a major accidental spill is not linked in a cause-and-effect relationship to how much treatment of invasive plants is projected for a particular herbicide; a spill is a random event. A spill could happen whenever a vehicle carrying herbicide passes a body of water. The potential risk of human health effects from large herbicide spills into drinking water are mitigated by design criteria that require all aspects of the Spill Plan to be implemented.

3.6.3.2.2 Cumulative Effects

Cumulative effects are “the incremental impacts of the proposed action and alternatives when added to effects of other actions both on NFS lands and other adjacent federal, state, or private lands” (40 CFR 1508.7).

The CEQ’s regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions. In regard to past actions, the agency must determine what information regarding past actions is useful and relevant to the required analysis of cumulative effects during the scoping process and the preparation of the analysis. Dependent upon the proposed action, the accounting for 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 comprehensively list and analyze all individual past actions. Just 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).

Human activities are known to have influenced the spread of invasive plants into North America, the Pacific Northwest, and specific sites within the project area. A complete list of past actions is not necessary to understand how land uses have contributed to the current distribution of invasive plants. The baseline for cumulative effects analysis is the current condition.

A list of ongoing activities and foreseeable future projects is available in the project record. Many of these activities have the potential to introduce or spread noxious invasive plants. Permitted activities have stipulations, such as prevention measures included in grazing allotment

annual operating instructions, timber sale contracts, and mineral material plans of operation. The travel management plans eliminated cross-country motorized travel, which eliminated a substantial potential for introducing or spreading noxious invasive plants. The potential for cumulative effects resulting from treatment activities is discussed below.

3.6.3.2.2.1 Biological Treatments

No direct or indirect human health effects are anticipated to occur as a result of biological treatments; therefore, no cumulative effects are anticipated to occur.

3.6.3.2.2.2 Manual and Mechanical Treatments

There is no data that identifies the level of manual and mechanical treatments that are conducted in the counties that encompass the proposed project area. No direct or indirect human health effects are anticipated to occur; therefore, no cumulative effects are anticipated to occur.

3.6.3.2.2.3 Chemical Treatments

Because of the manner in which the State of Idaho collects data regarding pesticide use, tracking which herbicides are used (or in what quantity) on private land is not possible; however, CWMA partners do track that information for their activities, to varying degrees. The County CWMAs treat private, State, County, and federally managed lands and provide herbicide to landowners. CWMA partners are licensed pesticide applicators; therefore, herbicides have been applied in compliance with label directions.

In addition, five nearby national forests (Bridger-Teton, Beaverhead-Deerlodge, Uinta-Wasatch-Cache, Sawtooth, and Salmon-Challis) treat weeds adjacent to the project area, as does multiple districts of the BLM. These invasive plant treatment programs are very similar to the Proposed Action Alternative.

The extent of herbicide applications for invasive plant management on lands adjacent to or near the Forests cannot be quantified in all instances; only some of these activities are known to the USDA Forest Service, and no reporting to State or other government agencies is required. Because other governmental invasive plant management entities do not collect usage data to the extent that the Forests do (nor in the same manner), comparison can, in some instances, be difficult. Moreover, the State of Idaho does not require private applicators to collect application data to the same degree as professional applicators.

Additionally, management of these areas may change over the 10 to 15-year timeframe of this project. County road rights-of-way (ROWs) and State highway ROWs are treated with herbicides. The BLM, the Idaho Department of Fish and Game, the Idaho Department of Transportation, and all project area Counties engage in invasive plant control measures, as do many private landowners, particularly ranchers and other agricultural producers. It is expected that invasive plant control efforts, including aerial and ground applications of herbicides, will continue on State-owned, privately owned, and public lands surrounding the Forests.

The SERA risk assessments identified connected actions and cumulative effects for each of the herbicides reviewed. In the risk assessments, connected actions include actions or the use of other chemicals that are both necessary and in close association with the use of the analyzed herbicide. Cumulative effects are analyzed within the context of the Food Quality Protection Act, which requires the assessment of chemicals with similar modes of action. It is beyond the scope

of the risk assessments to identify and consider all agents that might interact with, or cause cumulative effects in conjunction with, each analyzed herbicide.

2,4-D Amine

Some studies suggest that 2,4-D in combination with other herbicides may cause synergistic effects. One study implicated 2,4-D in combination with picloram; this combination may cause reproductive impairment in mice. No evidence exists that inert compounds or impurities found in 2,4-D formulations would constitute significant health risks (USDA Forest Service 2006b).

The herbicide 2,4-D is a member of the alkylphenoxy herbicide class of pesticides. Regarding human exposure, the EPA has not yet determined which compounds (if any) exhibit common modes of toxicity. Interactions are likely to occur between 2,4-D and other chemicals that affect cell membranes and cell metabolism. The risk assessment for long-term exposure (which addresses the potential impacts of cumulative effects) identified the potential for adverse health effects for workers and people consuming contaminated vegetation (USDA Forest Service 2006b).

Aminopyralid

No basis exists to assert that impurities in, or metabolites of, aminopyralid are likely to result in effects not already included in the HQs for human exposure scenarios.

The EPA has not made a common mechanism of toxicity finding for aminopyralid interacting with other substances. The risk assessment specifically considered the effects of repeated and long-term exposure, which addressed the potential impact of cumulative effects and concluded no basis existed for asserting that cumulative adverse effects were plausible (SERA 2007b).

Chlorsulfuron

No data exist to assess whether chlorsulfuron would interact, either synergistically or antagonistically, with 2,4-D or any other herbicide.

The risk assessment specifically considered the effects of repeated and long-term exposure, which addressed the potential impact of cumulative effects and concluded there was no indication that a threshold for toxicity would be exceeded or that cumulative adverse effects would occur (SERA 2004a).

Clopyralid

No data in the literature suggest that clopyralid would interact, either synergistically or antagonistically, with other compounds.

The risk assessment specifically considered the effects of repeated and long-term exposure. All long-term exposure scenarios were substantially below the LOC and should not be associated with cumulative adverse effects (SERA 2004b).

Dicamba

No substantial evidence exists that dicamba will interact with other compounds.

The risk assessment specifically considered the effects of repeated and long-term exposure. Long-term exposure scenarios were below the LOC and should not be associated with cumulative adverse effects (SERA 2004c).

Glyphosate

The most important connected action in the use of glyphosate is the use of surfactants. Formulas containing POEA are not considered in this analysis.

People could be exposed to multiple sources of glyphosate; however, the exposure scenarios indicate that multiple exposures do not exceed the LOC. The EPA possesses no data at this time to determine whether glyphosate has a common mechanism of toxicity with other substances or how to include glyphosate in a cumulative risk assessment (SERA 2011a).

Imazamox

Imazamox formulations contain inert components and the metabolism involves the formation of other compounds. Based on the low HQs derived from the exposure scenarios, there is not a plausible basis for suggesting that inerts, impurities, or metabolites will impact the risk characterization for human health effects.

Because imazamox and metabolic degradates have low toxicity, there is no concern regarding the potential for cumulative adverse effects with other substances with a common mode of action (SERA 2010).

Imazapic

The manufacturer recommends tank mixes with glyphosate and 2,4-D. No data are available for the combined toxicity with glyphosate and, although the combination with 2,4-D is more toxic than imazapic alone, that is likely due to the properties of 2,4-D.

The risk assessment specifically considered the effects of repeated and long-term exposure. Long-term exposure scenarios were below the LOC and should not be associated with cumulative adverse effects (SERA 2004d).

Imazapyr

Imazapyr formulations contain inert components, and its metabolism involves the formation of other compounds. Based on the low HQs derived from the exposure scenarios, no plausible basis exists for suggesting that inert ingredients, impurities, or metabolites will impact the risk characterization for human health effects.

Even though imazapyr is structurally similar to other imidazolinone herbicides (imazamox and imazapic), data do not support the conclusion that they share a common mechanism of toxicity and that the combined effect would result in cumulative adverse effects. Because imazapyr exhibits low toxicity, there is no basis for enhanced concern for the potential for cumulative adverse effects (SERA 2011b).

Metsulfuron methyl

No data in the literature suggest that metsulfuron methyl would interact, either synergistically or antagonistically, with other herbicides.

The risk assessment specifically considered the effects of repeated and long-term exposure, which addressed the potential impact of cumulative effects and concluded there was no indication that a threshold for toxicity would be exceeded or that cumulative adverse effects would occur (SERA 2004e).

Picloram

Although the technical grade formulation of picloram contains hexachlorobenzene, the exposure scenarios determined the potential carcinogenic risk was below the LOC. The use of technical grade picloram is not considered in this analysis.

Picloram does not appear to produce a toxic metabolite. For the purposes of this analysis, picloram is assumed to have no common mechanism of toxicity with other substances. The risk assessment specifically considered the effects of repeated and long-term exposure, which should not be associated with cumulative adverse effects (SERA 2011c).

Rimsulfuron

The occupational risks associated with exposure to rimsulfuron are not expected to exceed EPA's level of concern for any of the potential occupational receptors under routine use scenarios.

Sulfometuron methyl

No data in the literature suggest that sulfometuron methyl would interact, either synergistically or antagonistically, with other herbicides.

The risk assessment specifically considered the effects of repeated and long-term exposure, which addressed the potential impact of cumulative effects, and concluded there was no indication that a threshold for toxicity would be exceeded or that cumulative adverse effects would occur (SERA 2004f).

Triclopyr TEA

Triclopyr TEA may metabolize into 3,5,6-trichloro-2-pyridinol, or TCP, which is toxic to mammals and other species. The exposure scenario of a female of childbearing age eating contaminated vegetation at the application rate of 1 pound a.e./acre would exceed the LOC (SERA 2011d).

Triclopyr is a relatively typical, weak-acid auxin herbicide. Aminopyralid, clopyralid, and picloram are similar in structure and in the way each chemical is absorbed, distributed, metabolized, and eliminated (as well as in toxicity); therefore, it is reasonably anticipated that exposure to triclopyr along with the aforementioned other weak-acid herbicides may result in additive risks (SERA 2011d).

The exposure scenarios in the risk assessment specifically addressed and encompassed the potential impact of the cumulative effects of repeated exposures to triclopyr for workers at high application rates and for women of childbearing age who eat contaminated produce (SERA 2011d).

3.6.3.3 Conclusions about Cumulative Effects of Alternatives

The total land mass of the 17 counties in the project area is 23,559,969 acres. Private land comprises 7,489,672 acres, or 32 percent, of the counties (Table 3-43). Even without knowing how much herbicide is applied to private land, the proportion of private land in relation to the 17 countywide area is low. In addition, the applications of these herbicides are spatially distinct. None of the herbicides analyzed exhibit obvious cumulative adverse effects when used in combination with other herbicides. Effects from repeated exposures are discussed earlier in this

report and can be largely mitigated by proper use of personal protective equipment and good hygiene practices. Given the relatively small proportion of treatment across the landscape, the implementation of design criteria designed and utilized to protect workers and the public, and the use of label guidelines for proper application, cumulative adverse effects to human health are not expected from the implementation of any of the alternatives.

Table 3-43. Project area ownership (in acres) by county.

COUNTY AND STATE	OWNERSHIP							
	PRIVATE	STATE	BUREAU OF LAND MGMT.	US FOREST SERVICE	OTHER FEDERAL	TRIBAL	OTHER	TOTAL ACRES
Bannock Co., ID	375,176	47,852	75,432	118,932	613	116,264	478	734,746
Bear Lake Co., ID	350,703	18,883	55,409	227,544	19,213	0	0	671,753
Bonneville Co., ID	559,399	57,191	94,021	482,967	22,605	0	0	1,216,186
Butte Co., ID	171,806	13,265	512,936	271,660	462,988	0	0	1,432,660
Caribou Co., ID	535,366	107,161	76,712	376,465	17,119	38,306	0	1,151,130
Clark Co., ID	337,874	79,165	341,186	357,495	13,305	0	0	1,129,025
Franklin Co., ID	275,876	13,294	14,397	121,946	1,824	0	1	427,335
Fremont Co., ID	385166	114,166	150,616	523,577	40,028	0	0	1213553
Madison Co., ID	220895	22,050	17,501	41,459	1,021	0	0	302,926
Lemhi Co., ID	245440	37,878	575,180	2,065,788	0	0	0	2,924,286
Oneida Co., ID	350,608	12,974	266,327	138,407	0	0	0	768,316
Power Co., ID	452,554	26,915	203,279	36,017	1,916	166,336	0	922,963
Teton Co., ID	190,789	1,633	7,622	88,083	0	0	0	288,127
Teton Co., WY	109,352	6,493	2,385	1,367,702	140,1171	0	158	2,699,045
Lincoln Co., WY	591,687	107,970	984,609	902,450	33,593	0	251	2,620,558
Box Elder Co., UT	1,910,685	930,537	1,078,937	104,048	280,168	196	0	4,306,711
Cache Co., UT	426,296	37,916	131	286,306	0	0	0	750,649

3.7 Issue 6: Wilderness

The recreation resource specialist report was developed for this analysis and is included by reference (USDA Forest Service 2020g).

3.7.1 Methodology for Analysis

This analysis describes the affected environment and analyzes the effects of the proposed project and alternatives on wilderness located on the TNF. Effects on the wilderness character of the Jedediah Smith Wilderness and Winegar Hole Wilderness within the TNF are evaluated.

Federal law does not specifically require management action in wilderness to address invasive plants. However, action was determined necessary through the Minimum Requirements Decision Guide (MRDG) process to address the threat of invasive plants within the wilderness areas on the TNF (USDA Forest Service 2014). Effects from controlling invasive plants were determined

by utilizing the MRDG, which is derived from Section 4(c) of the Wilderness Act and involves two steps. The first step is to determine whether administrative action is necessary. The second step is to determine the minimum activity necessary to treat invasive plants in designated wilderness areas.

To determine if treatment was necessary, the analysis focused on the following: (1) total acres of invasive species in designated wilderness, (2) the effectiveness of current management strategies, (3) if action could be taken outside of designated wilderness, (4) if action was necessary to satisfy valid existing rights or a special provision in wilderness legislation or to meet the requirements of other federal laws, and to preserve one or more qualities of wilderness character.

Wilderness designation is intended to preserve and protect certain lands in their natural state. The Wilderness Act of 1964 identifies wilderness uses and prohibited activities. The Wilderness Act's Statement of Policy, Section 2(c), states that wilderness should be managed "…in such manner as will leave them unimpaired for future use as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character…" The statutory language of the Wilderness Act is used to identify five qualities of wilderness character (Landres et al. 2015):

- Untrammeled: Area is unhindered and free from intentional actions of modern human control or manipulation.
- Natural: Area appears to have been primarily affected by the forces of nature and is substantially free from the effects of modern civilization.
- Undeveloped: Area is essentially without permanent improvements or the sights and sounds of modern human occupation, and it retains its primeval character.
- Solitude or Primitive and Unconfined Recreation: Area provides outstanding opportunities for people to experience solitude or primitive and unconfined type of recreation including the values associated with physical and mental inspiration, challenge, self-reliance, self-discovery, and freedom.
- Other Features of Value: Area may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value. Though not required of any wilderness, where they are present, they are part of that area's wilderness character and must be protected as rigorously as any of the other four required qualities.

Invasive plants have spread aggressively in similar ecotypes; however, much of the inventoried infestations within the Jedediah Smith Wilderness and Winegar Hole Wilderness areas are currently relatively small and isolated. Within these wilderness areas, invasive weeds show patterns of infestation that indicate recreation may have been the initial vector (e.g., along trails). But now nonnative plants can be found throughout portions of the wilderness where recreation use is low to nonexistent. The number of infestations has been on the rise and the size of infestations is increasing. These infestations have the potential to spread to forest lands outside of the wilderness and to the adjacent Grand Teton National Park and Yellowstone National Park.

Invasive plants have the potential to irreversibly affect native plant communities, natural conditions, and scenic values in the wilderness. Because of spread vectors, such as wildlife and wind, limiting actions to outside wilderness areas to address infestations would not be effective

in minimizing the spread of invasive plants. The Wilderness Act of 1964 requires protection of natural conditions.

The second step in the MRDG process determines the minimum activity required to treat invasive plants in designated wilderness areas. This step requires analyzing other legislative direction, time constraints, various components of the treatment action, and a comparison of the action alternatives. The results of the MRDG process are provided in the Effects Analysis section below and in the project record.

3.7.2 Affected Environment

The analysis area—used to estimate direct, indirect, and cumulative effects—includes approximately 2.9 million acres of the CTNF and the approximately 47,600 acres of the CNG. The Jedediah Smith Wilderness and the Winegar Hole Wilderness were designated by Congress in 1984 with the passage of the Wyoming Wilderness Act. The Jedediah Smith Wilderness lies within both the Ashton-Island Park Ranger District and the Teton Basin Ranger District. The Winegar Hole Wilderness is located in the Ashton-Island Park Ranger District.

The Jedediah Smith Wilderness spans along the western slope of the Teton Mountain Range and stretches from Teton Pass north to Yellowstone National Park. The wilderness was designated because of the unique karst limestone geology. There are approximately 175 miles of trails accessed by twelve trailheads. Many of the trails cross into the bordering Grand Teton National Park. Outfitter and guide operations are permitted to provide day-hiking, backpacking, horse riding, hunting and backcountry skiing activities. Day use is high; the heaviest use occurs from June through September. Overnight use is prevalent in the areas with high-degree of connectivity with the adjacent national park. The Jedediah Smith Wilderness is intensively used year round.

The Winegar Hole Wilderness is located on the Wyoming side of the Idaho-Wyoming border and occupies the low area between Yellowstone National Park and Grand Teton National Park. This wilderness is managed as a trail-less area, but contains one trail that provides access to Yellowstone National Park. Recreation use of this area is mostly horse use into Yellowstone NP and some big game hunting.

According to the 2015 National Visitor Use Monitoring (NVUM) study, an estimated 68,000 people visited the wilderness areas located in the TNF (USDA Forest Service 2015). Perception of crowding was rated from 1 (very few visitors) to 10 (overcrowded). The average rating was 4.7, with the highest percentage (23.9%) of respondents responding with a rating of 2.0. Because of the Jedediah Smith Wilderness' close proximity to Grand Teton National Park, there is often backpacker overflow when the park is crowded.

There are approximately 43,679 total acres of inventoried invasive plants within the boundaries of the CTNF and CNG. Of this total, only 4.04 infested acres are located within the Jedediah Smith Wilderness (out of 123,896 acres) and only 11.63 infested acres are located in the Winegar Hole Wilderness (out of 10,715 acres). Table 3-44 shows invasive plants by species with acres of invasive plants per designated wilderness area.

The CTNF has been treating invasive plants in designated wilderness areas for many years. A treated acre is an area infested with invasive plants that has been treated or retreated by an acceptable method (herbicide, biological, mechanical, cultural, or manual) for the specific objective of controlling the invasive plant's spread or reducing its density. Table 3-45 displays

the total treated acres in designated wilderness areas for years 2012 to 2019, which totals approximately 180 acres for the Jedediah Smith Wilderness and approximately 10 acres in the Winegar Hole Wilderness.

Table 3-44. Designated wilderness with acreage of invasive plant infestations.

NAME OF INVASIVE PLANT		ACRES OF INVASIVE PLANTS	
Common Name	**Scientific Name**	**Jedediah Smith Wilderness**	**Winegar Hole Wilderness**
Butter and eggs	*Linaria vulgaris*	0.07	10.56
Canada thistle	*Cirsium arvense*	2.13	1.07
Nodding plumeless thistle	*Carduus nutans*	0.57	0.00
Scotch cottonthistle	*Onopordum acanthium*	1.24	0.00
Spotted knapweed	*Centaurea stoebe* ssp. *micranthos*	0.03	0.00
Grand Totals		**4.04**	**11.63**

Table 3-45. Designated wilderness with acres of treated invasive plant infestations.

YEAR	ACRES OF INVASIVE PLANT TREATMENT IN JEDEDIAH SMITH WILDERNESS	ACRES OF INVASIVE PLANT TREATMENT IN WINEGAR HOLE WILDERNESS
2012	34.29	0.00
2013	0.03	0.00
2014	2.41	10.09
2015	0.26	0.00
2016	41.51	0.00
2017	75.25	0.00
2018	18.79	0.00
2019	7.33	0.00
Grand Totals	**179.87**	**10.09**

The total acres treated was calculated using GIS. Many areas were treated multiple times, and the acres are counted for each treatment, so if a 10-acre area was treated five times, the total treated acres would be 50. For this reason, the number of treated acres is possibly higher than the total number of infested acres in the wilderness.

3.7.3 Environmental Consequences

3.7.3.1 Alternative 1: No Action/Current Management

It is anticipated that all future ground-disturbing activities would be developed with project-specific preventative control measures, which should allow the CNF, TNF, and CNG to minimize the impact of future management actions on the introduction or spread of invasive weeds. Overall, cumulative effects would not vary from the indirect effects described in Alternative 1: No Action/Current Management.

Direct effects from Alternative 1 would include adverse effects to the untrammeled and solitude qualities of wilderness character by consciously manipulating vegetation and by creating

encounters on and off trail with the public during treatment activities. Beneficial direct effects from Alternative 1 would occur to the natural and other features of value qualities of wilderness character by reducing nonnative plant infestations, thus preserving high quality habitat for the grizzly bear. Adverse indirect effects of Alternative 1 would include the potential that some invasive species that have not yet been identified within wilderness areas could become established and increase in frequency and cover because invasive species infestations would not be addressed at the landscape scale. Invasive plants that become established would be expected to opportunistically expand their range and compete with native plant populations. Both direct and indirect adverse effects from Alternative 1 would be short-term and minimal on the qualities of wilderness character mentioned, but the overall long-term effects to qualities of wilderness character would be positive.

Effects to designated wilderness areas were evaluated using the MRDG process and are summarized below based on the effects of implementing Alternative 1 on the following qualities of wilderness character:

- Untrammeled: Alternative 1 would negatively affect the untrammeled character of wilderness which is degraded by active manipulation of ecological processes, despite the fact that the plants are invasive (nonnative) and regardless of the method used to eradicate them.
- Undeveloped: Alternative 1 would have no effect on the "primeval character and influence" of the wilderness as no permanent development or installations would take place. Travel would occur largely on NFS trails. Travel off trail would be to such a small extent that no non-system trails would develop.
- Natural: Alternative 1 would affect the natural quality of wilderness character in a positive way because nonnative plants can change the character of the landscape. Treatment is necessary to protect the natural quality of wilderness character. If current infestations are left untreated, nonnative plants will reduce the amount of native species, thus altering the ecology at a landscape scale. Nonnative plants can displace or hybridize with native plants and may change important natural processes. However, because controlling invasive plants on a broad landscape-scale would not be addressed under Alternative 1, the relative success rate of the current management may not be enough to rapidly address any new or existing infestations of invasive plants within the wilderness to keep them from proliferating.
- Solitude or Primitive & Unconfined Recreation: Alternative 1 would negatively affect the solitude quality of wilderness character because the forest plan encounter standard allows for no contact between parties. USDA Forest Service staff will travel on foot and horseback into the wilderness both on and off designated trails to treat invasive plant infestations. As such, any encounter with the public may have a negative impact on a visitor's solitude expectations.
- Other Features of Value: Alternative 1 would have a positive effect on the other features of value quality. Reducing the amount and the number of species of nonnative plants will help to preserve natural and high quality habitat for the grizzly bear.

3.7.3.2 Alternative 2: Proposed Action

Treatment methods proposed under Alternative 2 include aerial application of herbicides outside of designated wilderness. Aerial herbicide application is not permitted within wilderness. As

such, direct and indirect effects from implementing Alternative 2 within wilderness would be the same as those described for Alternative 1 with the sole exception being the inclusion of the aquatic herbicide application option.

While neither of the alternatives considered would provide a permanent solution for controlling invasive plants, implementation of Alternative 2 would likely lead to more effective control and a greatly reduced rate of spread than Alternative 1. Alternative 2 would also lead to a reduced incidence of newly established populations. The variety of treatment options available, including aerial herbicide application (outside of designated wilderness areas), would allow some increased measure of controlling existing invasive plant populations in terms of density and potential spread to wilderness areas, which could eliminate new infestations if identified early enough through the use of early detection and rapid response. Rehabilitation and restoration following treatments would ensure native species, patterns, and ecological processes are protected within designated wilderness areas.

3.7.3.3 Cumulative Effects

Human activities are known to have influenced the spread of invasive plants into North America and into the project area. A complete list of past actions is not necessary to understand how land uses have contributed to the current distribution of invasive plants. The baseline for cumulative effects analysis is the current condition. Future actions are those within the bounds of the existing Forest Plans. Herbicide treatments occur on land ownerships adjacent to NFS lands. Because consistent and complete information about herbicides being used adjacent to the Forests is unavailable, certain assumptions were made for this analysis and are discussed in Appendix H.

3.7.3.3.1 Alternative 1: No Action/Current Management

It is anticipated that all future ground-disturbing activities would be developed with project-specific preventative control measures, which should allow the CNF, TNF, and CNG to minimize the impact of future management actions on the introduction or spread of invasive weeds. Overall, cumulative effects would not vary from the indirect effects described in Alternative 1: No Action/Current Management.

This alternative proposes no long-term control strategy to address treating newly discovered invasive plant populations or to arrest the spread of established invasive plant populations, which could have a lasting impact on wilderness character. The fundamental effects of not having a long-term control strategy would be the same as those addressed in the Effects Analysis above under Alternative 1. Differences may occur with respect to the rate at which the effects occur over time and would be a function of the number and span of ground-disturbing activities and the effectiveness of preventative control measures taken at the time of implementation. Reducing the introduction or spread of invasive plants in wilderness areas would help minimize the effect of future activities on designated wilderness areas.

3.7.3.3.2 Alternative 2: Proposed Action

It is anticipated that all future ground-disturbing activities would be developed with project-specific preventative control measures, which, when combined with IWM strategy and following the program components, should allow the CNF, TNF, and CNG to minimize the impact of future management actions on the introduction or spread of invasive plants. Reducing the introduction or spread of invasive plants would minimize the effect of future activities, including

effects to designated wilderness areas. Overall, cumulative effects would not vary from the direct and indirect effects described above for Alternative 2.

It is anticipated that all future ground disturbing activities would be developed with project-specific preventative control measures, which, when combined with EDRR and ground-based treatment options, should allow the TNF to minimize the impact of future management actions on the introduction or spread of invasive plants. Reducing the introduction or spread of invasive plants would minimize the effect of future activities, including effects to designated wilderness areas. Overall, cumulative effects would not vary from the direct and indirect effects described for Alternative 2, above.

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5 LITERATURE CITED

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