U.S. Fish & Wildlife Service

Malheur National Wildlife Refuge

Final Comprehensive Conservation Plan and Environmental Impact Statement

Volume 1

Malheur National Wildlife Refuge
Final Comprehensive Conservation Plan and Environmental Impact Statement
Harney County, Washington

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Abstract: We developed alternatives, including preferred and no action alternatives, as required by National Environmental Policy Act regulations for the Malheur National Wildlife Refuge (Refuge). We addressed issues, opportunities, and management options in the alternatives, summaries follow.

Alternative 1 (No Action). Under Alternative 1, management of carp and water levels in Malheur, Harney, and Mud Lakes would remain limited. Fish screens and ladders, water diversion dams, and carp barriers would remain, and riparian rehabilitation would continue. Habitat management in meadows, marshes, streams, and uplands would continue for waterbirds, shorebirds, and waterfowl. Flood irrigation would continue on meadows. Prescribed burning, haying, and rakebunch grazing would reduce plant litter, and some meadows would be hayed or grazed annually. Wildlife observation, photography, interpretation, environmental education, hunting, and fishing opportunities and facilities would continue. Cultural resources would be preserved, restored, and interpreted.

Alternative 2 (Preferred Alternative). Under Alternative 2, we would improve lakes and wetlands by removing invasive carp from Malheur, Harney, and Mud Lakes. We would develop a riverine/ wetland rehabilitation plan. Prescriptive grazing, mowing, farming, and dewatering would reduce invasive plants. Visitor facilities and wildlife-dependent recreation would be upgraded or developed. Accessibility for visitors with mobility-impairments would improve. Vehicle access would increase and visitors could drive to Krumbo Reservoir year-round. Current hunt areas would remain open, the upland game hunt would open earlier, areas of Malheur Lake would open to hunting, and a new boat launch would be developed. Fishing opportunities at Krumbo Reservoir, Blitzen River, East Canal, Mud Creek, and Bridge Creek would continue, with improved access. Rainbow trout stocking at Krumbo Reservoir would continue. We would pursue acquisition of adjacent lands. A cultural resources plan, and inventory and monitoring plans for focal species would be developed.

Alternative 3. Under Alternative 3, habitat management would be similar to Alternative 2 (Alt. 2); however, our emphasis on carp control and riverine/wetland rehabilitation would be equal. Riverine rehabilitation would enhance water quality and habitat for native fishes, connect floodplains, and improve riparian habitat. Other wetlands and habitat management would be the same as Alt. 2. Wildlife viewing and photography would be similar to Alt. 2, with fewer facilities and more self-guided and off-trail experiences. The Blitzen Valley auto tour would be closed to vehicles seasonally, and redesigned into shorter year-round routes. Free-roam, walk-in access along Center Patrol Road would be allowed seasonally, as would vehicle and walk-in access to Krumbo Reservoir. Vehicle access via Boat Landing Road to Malheur Lake's viewing platform would be open year-round. Temporary photography blinds would be permitted in free-roam areas. Waterfowl and game hunts would be similar to Alt. 2, except the Buena Vista waterfowl hunt would not occur. A youth hunt on the Double-O Unit would be explored. Fishing would be similar to Alt. 2 with less vehicle access. Other visitor and cultural resources management would be the same as Alt. 2.

Thirty days after the Final CCP/EIS is available to the public, we will select an alternative to implement on the Refuge in a Record of Decision, and share our decision with the public.

Malheur National Wildlife Refuge
Comprehensive Conservation Plan Foreword

Not many years ago it was hard to imagine that the process of developing a long-term management plan for Malheur National Wildlife Refuge (Refuge) would result in a broad spectrum of interests, including the local community, conservation organizations, and other government agencies, all working collaboratively together to craft the future direction of the Refuge. Today, after a collaborative effort engaging dozens of stakeholders working closely with each other and with Refuge staff and experts over three years, there is broad agreement on a comprehensive process that will restore the Refuge's aquatic health, enhance wildlife habitat, and revitalize relationships with stakeholders and the community. This process is laid out in the Comprehensive Conservation Plan (CCP) and the upcoming inventory and monitoring plan, which describe priorities for the Refuge and how decisions would be made over the next 15 years.

The Refuge is a cherished place, widely embraced by all kinds of people for its wildlife populations, recreation opportunities, and support of local communities. However, it has also been a flashpoint for conflict and controversy over the past few decades. This controversy created deep divisions and distrust between the Refuge and stakeholders, and between various stakeholder groups. At the same time, the ecological health of the Refuge's waterways and wetlands—long recognized as some of North America's most important habitat for migratory birds—were in steep decline as invasive carp came to dominate most wet areas, and other nonnative species spread throughout the Refuge.

The stakeholder consensus achieved in developing this CCP represents a significant achievement. Our nontraditional and innovative collaborative planning process has helped rebuild relationships and communication necessary to produce a remarkable consensus around core principles embedded in the proposed 15-year CCP, which include:

- An ongoing collaborative approach to implementation, built around partnerships and a shared commitment to the long-term sustainability of the Refuge and Harney Basin's wildlife, habitats, and human communities;
- Science-based active adaptive management driven by monitoring and results evaluation, with transparent Refuge decisionmaking that is informed by stakeholder involvement; and
- Restoration of the aquatic ecosystem health and subsequent benefits to waterways, wetlands, and upland habitats.

At many different levels the challenges moving forward will be great. We hope you will join us—the Refuge staff and many participating stakeholders, in turning our vision into reality.

Colby Marshall, Bruce Taylor, and Matt Little
On behalf of the Collaborative Group

Malheur National Wildlife Refuge
Final Comprehensive Conservation Plan and Environmental Impact Statement

Volume 1

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Volume 1
Table of Contents

Executive Summary **ES-1**

CHAPTER 1. INTRODUCTION AND BACKGROUND **1-1**
1.1 Introduction 1-1
1.2 The Significance of Malheur National Wildlife Refuge 1-1
1.3 Proposed Action 1-2
1.4 Purpose and Need for Action 1-3
1.5 Legal and Policy Guidance 1-4
1.5.1 The U.S. Fish and Wildlife Service 1-4
1.5.2 National Wildlife Refuge System 1-4
1.5.3 Other Laws and Mandates 1-6
1.5.4 Summary Hierarchy of Guidance 1-7
1.6 Refuge Establishment and Purposes 1-7
1.6.1 Legal Significance of the Refuge Purpose 1-7
1.6.2 Purpose and History of Refuge Establishment 1-8
1.6.3 Land Status and Ownership 1-13
1.7 Relationship to Other Plans and Assessments 1-14
1.7.1 Previous and Future Refuge Plans 1-14
1.7.2 Ecosystem Plans and Assessments 1-14
1.8 Special Designation Lands 1-17
1.8.1 Important Bird Areas 1-17
1.8.2 Wilderness Status 1-18
1.8.3 Research Natural Areas 1-19
1.9 Planning Process and Issue Identification 1-20
1.9.1 Planning Process 1-20
1.9.2 Key Issues Addressed in the CCP 1-21
1.9.3 Issues outside the Scope of the CCP 1-37
1.10 Refuge Vision and Goals 1-37
1.10.1 Refuge Vision 1-37
1.10.2 Refuge Goals 1-38
1.11 References 1-39

CHAPTER 2. ALTERNATIVES, GOALS, OBJECTIVES, AND STRATEGIES **2-1**
2.1 Considerations in Alternative Design 2-1
2.2 List of Goals 2-3
2.3 Alternative 1 2-4
2.4 Alternative 2 2-5
2.5 Alternative 3 2-10
2.6 Features Common to All Alternatives 2-12
2.7 Alternatives Considered but Not Developed 2-18
2.8 Comparison and Summary of Management Alternatives Considered 2-19
2.9 Goals, Objectives, and Strategies 2-34
Goal 1. Enhance aquatic health and habitat conditions. 2-34
Goal 2. Protect, maintain, and rehabilitate riverine habitats 2-37
Goal 3. Protect, maintain, and rehabilitate riparian habitats. 2-40
Goal 4. Enhance, protect, and maintain a diversity of aquatic and terrestrial wildlife species. 2-41
Goal 5. Enhance and maintain rare and unique habitats. 2-53
Goal 6. Welcome and orient visitors. 2-55
Goal 7. Provide wildlife observation and nature photography opportunities. 2-60
Goal 8. Provide hunting and fishing opportunities. 2-68
Goal 9. Provide wildlife observation and wildlife/nature photography opportunities 2-74
Goal 10. Manage prehistoric and historic cultural resources on the Refuge. 2-76

Goal 11. Identify and protect prehistoric and historic resources on the Refuge. 2-79
Goal 12. Manage the Refuge's paleontological resources 2-80
Goal 13. Gather scientific information to support adaptive management decisions. 2-81
Goal 14. Integrate conservation-based mission with the best available science. 2-86
2.10 References 2-87

CHAPTER 3. PHYSICAL ENVIRONMENT 3-1
3.1 Major Landforms 3-1
3.2 Climate 3-1
3.2.1 Current Climate 3-1
3.2.2 Climate Change 3-5
3.3 Hydrology 3-13
3.3.1 Hydrologic Units 3-13
3.3.2 Rivers and Streams 3-14
3.3.3 Malheur, Harney, and Mud Lakes 3-17
3.3.4 Groundwater 3-19
3.3.5 Water Rights and Use 3-19
3.4 Topography and Bathymetry 3-21
3.5 Geologic History and Features 3-21
3.6 Soils 3-23
3.7 Fire 3-25
3.7.1 Objectives of Prescribed Fire in Emergent Marsh 3-25
3.8 Environmental Contaminants (Point Source) 3-27
3.9 Air Quality 3-27
3.10 Water Quality 3-27
3.11 Visual Quality 3-28
3.12 Surrounding Land Use 3-29
3.13 References 3-29

CHAPTER 4. BIOLOGICAL ENVIRONMENT 4-1
4.1 Biological Integrity, Diversity, and Environmental Health 4-1
4.1.1 Overview 4-1
4.1.2 Wildlife and Habitat Conditions and Changes Since 1800 4-2
4.1.3 History of Refuge Management 4-5
4.1.4 Changes in Species Composition of Wildlife Populations after Refuge Establishment 4-8
4.2 Priority Resources of Concern 4-10
4.2.1 Selection Process 4-10
4.2.2 Relationship of Priority Resources of Concern to Habitat Goals and Objectives 4-11
4.3 Major Habitat Types on Malheur Refuge 4-12
4.3.1 Lacustrine (lakes) 4-12
4.3.2 Riverine 4-15
4.3.3 Woody Riparian 4-17
4.3.4 Palustrine Emergent (temporarily flooded wet meadows) 4-19
4.3.5 Palustrine Emergent (seasonally flooded marsh associated with wet meadows) 4-21
4.3.6 Palustrine Open Water/Emergent (semipermanently flooded wetland impoundments) 4-22
4.3.7 Dry Meadow 4-24
4.3.8 Salt Desert Scrub 4-25
4.3.9 Sagebrush Lowland 4-27
4.3.10 Sagebrush Steppe 4-28
4.3.11 Dune 4-30
4.3.12 Playa 4-31
4.3.13 Cropland 4-32
4.3.14 Cold and Hot Springs 4-33
4.3.15 Cliffs, Rimrock, and Outcroppings 4-34
4.4 Major Species Groups 4-34
4.4.1 Migratory and Resident Birds 4-34

4.4.2 Fisheries 4-37
4.4.3 Other Wildlife and Plants 4-38
4.5 Threatened, Endangered, and Sensitive Species 4-38
4.5.1 State or Federally Listed Species Known to Occur on the Refuge 4-38
4.5.2 Habitat Needs, Conditions, and Trends of Federally Listed, Proposed, or Candidate Species 4-39
4.6 Invasive and Nuisance Species 4-40
4.6.1 Exotic and Invasive Plant Species 4-40
4.6.2 Exotic Wildlife Species 4-42
4.7 Wildlife and Habitat Research, Inventory, and Monitoring 4-42
4.7.1 Monitoring 4-42
4.7.2 Refuge Research 4-43
4.8 Paleontological Resources 4-45
4.9 References 4-46

CHAPTER 5. HUMAN ENVIRONMENT 5-1
5.1 Cultural Resources 5-1
5.1.1 Native American Overview 5-1
5.1.2 Euro-American Overview 5-4
5.1.3 Current Knowledge of Local Cultural Resources 5-11
5.1.4 Investigations 5-12
5.1.5 Looting of Archaeological Resources 5-15
5.1.6 Historic Resources 5-15
5.1.7 Museum Property 5-17
5.2 Refuge Facilities 5-17
5.2.1 Boundary Fences and Markers 5-17
5.2.2 Entrances and Access Points 5-17
5.2.3 Roads and Parking Areas 5-18
5.2.4 Trails 5-18
5.2.5 Administrative Facilities 5-19
5.2.6 Easements and Rights-of-Way 5-19
5.2.7 Dikes, Irrigation, and Water Control Structures 5-19
5.3 Public Use Overview 5-20
5.3.1 Open and Closed Areas 5-20
5.3.2 Annual Recreation Visits 5-20
5.3.3 Accessibility of Recreation Sites and Programs for People with Disabilities 5-24
5.3.4 Law Enforcement 5-24
5.4 Wildlife-Dependent Public Uses 5-24
5.4.1 Wildlife Observation and Wildlife/Nature Photography 5-25
5.4.2 Interpretation 5-26
5.4.3 Environmental Education 5-28
5.4.4 Upland Game Hunting 5-29
5.4.5 Waterfowl Hunting 5-30
5.4.6 Other Hunting 5-31
5.4.7 Fishing Program 5-31
5.5 Other Refuge Uses 5-32
5.5.1 Hiking, Horseback Riding, Bicycling, and Cross-Country Skiing 5-32
5.5.2 Commercial Public Use 5-32
5.5.3 All-Terrain Vehicles 5-32
5.6 Illegal Uses 5-32
5.7 Area Outdoor Recreational Opportunities and Trends 5-33
5.7.1 Nearby Recreational Opportunities 5-33
5.7.2 Regional and State Recreation Factors and Trends 5-34
5.8 Social/Economic Environment 5-35
5.8.1 Environmental Justice 5-35
5.8.2 Regional Economic Setting 5-36
5.8.3 Population and Income 5-36

5.8.4 Employment and Business 5-38
5.8.5 Local Tax Revenues 5-43
5.8.6 Lifestyle and Social Values 5-44
5.8.7 Refuge Impact on the Local Economy 5-45
5.9 References 5-45

CHAPTER 6. ENVIRONMENTAL EFFECTS 6-1
6.1 Effects Common to All Alternatives 6-3
6.2 Effects to the Physical Environment 6-3
6.2.1 Effects to Hydrology 6-3
6.2.2 Effects to Water Quality 6-4
6.2.3 Effects to Air Quality 6-6
6.2.4 Effects to Visual Quality 6-6
6.3 Effects to Wildlife and Habitats 6-6
6.3.1 Effects to Lacustrine Habitat and Associated Species 6-6
6.3.2 Effects to Riverine Habitat and Associated Species 6-12
6.3.3 Effects to Woody Riparian Habitat and Associated Species 6-14
6.3.4 Effects to Palustrine Marsh, Meadow, and Open Water Wetland Habitats and Associated Species 6-16
6.3.5 Effects to Dry Meadow Habitat and Associated Species 6-20
6.3.6 Effects to Salt Desert Scrub Habitat and Associated Species 6-21
6.3.7 Effects to Sagebrush Lowland Habitat and Associated Species 6-22
6.3.8 Effects to Sagebrush Steppe Habitat and Associated Species 6-23
6.3.9 Effects to Dune Habitat and Associated Species 6-23
6.3.10 Effects to Playa Habitat and Associated Species 6-24
6.3.11 Effects to Cropland Habitat and Associated Species 6-25
6.3.12 Effects to Cold and Hot Springs and Associated Species 6-25
6.3.13 Effects to Cliffs, Rimrock, and Outcropping 6-26
6.3.14 Effects to Threatened, Endangered, or Candidate Species 6-26
6.4 Effects to Cultural, Historical, and Paleontological Resources 6-27
6.5 Social Effects 6-28
6.5.1 Effects to Opportunities for Quality Hunting 6-28
6.5.2 Effects to Opportunities for Quality Fishing 6-29
6.5.3 Effects to Opportunities for Quality Wildlife Observation and Photography 6-30
6.5.4 Effects to Opportunities for Quality Environmental Education 6-30
6.5.5 Effects to Opportunities for Quality Interpretation 6-31
6.5.6 Effects to Opportunities for Non-wildlife-dependent Recreation 6-31
6.5.7 Projected Refuge Visits in 15 Years, by Alternative 6-31
6.5.8 Amount of Illegal Use 6-33
6.5.9 Environmental Justice 6-33
6.6 Economic Effects 6-33
6.6.1 Approach to Estimating Economic Effects 6-33
6.6.2 Recreational Activities Effects on Local Economic Indicators 6-35
6.6.3 Refuge Expenditures Effects on Local Economic Indicators 6-42
6.6.4 Refuge Grazing and Haying 6-45
6.6.5 Summary 6-48
6.7 Other Effects 6-49
6.7.1 Potential Impacts on Adjacent Lands and their Associated Natural Resources 6-49
6.7.2 Potential Impacts to Nearby Residents 6-50
6.8 Cumulative Effects 6-50
6.8.1 Effects from Reasonably Foreseeable Future Refuge Activities 6-50
6.8.2 Potential Effects from Broader Environmental Trends 6-51
6.8.3 Other Reasonably Foreseeable Events and Activities from Others 6-51
6.9 References 6-52

Maps

(The Maps section follows Chapter 6)

Map 1: Location of Refuge and Regional Land Cover 1
Map 2: Land Status 3
Map 3a: Public Use Facilities, Alternative 1 5
Map 3b: Public Use Facilities (Insets), Alternative 1 7
Map 4a: Public Use Facilities, Alternative 2 9
Map 4b: Public Use Facilities (Insets), Alternative 2 11
Map 5a: Public Use Facilities, Alternative 3 13
Map 5b: Public Use Facilities (Insets), Alternative 3 15
Map 6: Habitat 17
Map 7: Watersheds 19
Map 8: Blitzen Hydrologic System 21
Map 9: Double-O Hydrologic System 23
Map 10: Malheur, Mud, and Harney Lakes 25
Map 11: Historic Sites 27
Map 12: Research Natural Area Boundaries 29
Map 13: Recommended Wilderness Study Area Boundary 31

Figures

Figure 1-1. Hierarchy of guidance within the National Wildlife Refuge System. 1-7
Figure 2-1. Adaptive Management Model 2-14
Figure 3-1. Mean and distribution of monthly temperature and precipitation for the area encompassed by Malheur Refuge for the period 1975 to 2009. 3-3
Figure 3-2. Mean and distribution of monthly temperature and precipitation in the Blitzen River watershed above Page Springs for the period 1975 to 2009. 3-4
Figure 3-3. Concentrations of important heat-trapping greenhouse gases over the last 2,000 years. 3-5
Figure 3-4. Global average temperature and CO_2 concentrations from 1880 to 2008. 3-6
Figure 3-5. Trends in April 1 snow water equivalent in the western United States from 1950 to 1997. 3-7
Figure 3-6. Trend in March monthly temperature for the Refuge and the Blitzen from 1950 to 2009. 3-8
Figure 3-7. Ratio of April 1 SWE to total October-March precipitation for the historical period (1916-2006), for the A1B scenario (left panel), and for the B1 scenario (right panel) at three future time periods (2020s, 2040s, 2080s). 3-10
Figure 3-8. Monthly mean discharge for the Blitzen River. 3-15
Figure 4-1. Total shorebird numbers from counts conducted at Malheur National Wildlife Refuge during the Pacific Flyway Project, 1990-1994 4-37
Figure 5-1. Monthly visits recorded in Refuge Headquarters visitor center with door counter, January to December 2010 5-21
Figure 5-2. Website statistics for monthly visits to the Refuge's website, January to December 2010 5-26
Figure 5-3. Number of student visits for environmental education, on- and off-Refuge, 2004 to 2010 5-29
Figure 5-4. Violation and incidents documented, 2005 to 2009 RAPP Station Report 5-33
Figure 5-5. Regional minority composition 5-37
Figure 5-6. State of Oregon non-farm employment 5-39
Figure 5-7. State of Oregon nonfarm employment 5-40
Figure 6-1. Duck production at Malheur National Wildlife Refuge 6-7
Figure 6-2. Sago pondweed acreage averages for Malheur Lake 2 years before and 2 years after rotenone treatments 6-9
Figure 6-3. Diving duck use day averages for Malheur Lake 2 years before and 2 years after rotenone treatments 6-9
Figure 6-4. Tundra swan use day averages for Malheur Lake 2 years before and 2 years after rotenone treatments 6-10
Figure 6-5. Malheur Refuge: grazing animal unit months and hay production, 2002-2010. 6-46

Tables

Table 1-1. Malheur Refuge Acreage by Type of Acquisition 1-13
Table 2-2. Comparison and Summary of Management Alternatives 2-20
Table 3-1. Barrier Diversion Capacity for Structures on the Blitzen River 3-16
Table 4-1. Selected Priority Resources of Concern Lacustrine Habitats 4-14
Table 4-2. Riverine Habitat Priority Resources of Concern Species 4-16
Table 4-3. Woody Riparian Priority Resources of Concern Species 4-18
Table 4-4. Palustrine Emergent (temporarily flooded wet meadow) Priority Resources of Concern Species 4-20
Table 4-5. Palustrine Emergent (seasonally flooded marsh associated with wet meadow) Priority Resources of Concern Species 4-22
Table 4-6. Palustrine Open Water/Emergent (semipermanently flooded wetland impoundments) Priority Resources of Concern Species 4-23
Table 4-7. Dry Meadow Priority Resources of Concern Species 4-25
Table 4-8. Salt Desert Shrub Priority Resources of Concern Species 4-26
Table 4-9. Sagebrush Lowland Priority Resources of Concern Species 4-28
Table 4-10. Sagebrush Steppe Priority Resources of Concern Species 4-29
Table 4-11. Dune Priority Resources of Concern Species 4-31
Table 4-12. Playa Priority Resources of Concern Species 4-32
Table 4-13. Federally Listed Species Known to Occur on or Adjacent to Malheur Refuge 4-39
Table 4-14. Oregon Department of Agriculture Noxious Weeds Found on or Adjacent to Malheur Refuge 4-41
Table 4-15. Biological Surveys Conducted at Malheur Refuge during the Peak of Biological Monitoring in the Late 1990s 4-42
Table 5-1. 2010-2011 Survey Data: Key Parameters Used in Calculating Refuge Visits 5-22
Table 5-2. Current Number of Refuge Visits Per Year, by Key Activity* 5-23
Table 5-3. Website Statistics for Most Popular Pages Viewed by Visitors, January to December 2010 5-27
Table 5-4. Typical Lesson for Students in Grade 1 5-28
Table 5-5. 2008-2012 Oregon SCORP Statewide Recommendations 5-34
Table 5-6. Local and Regional Population Estimates and Characteristics 5-36
Table 5-7. Per Capita Personal Income 5-37
Table 5-8. Poverty Rates at Local, County, and State Scales 5-38
Table 5-9. Nonfarm Employment Trends by Industry, 2001 to November 2009 5-40
Table 5-10. Employment and Earnings by Industry for Harney County and Oregon 5-42
Table 5-11. Regional Income and Income Tax Statistics 5-44
Table 5-12. In Lieu of Taxes Payments to Harney County, 2002 to 2010 5-44
Table 6-1. Estimated Refuge Visits at the End of 15 Years by Key Activities* 6-31
Table 6-2. Alternative 1: FY 2010 Visitation 6-36
Table 6-3. Alternative 1: Visitor Recreation Expenditures 6-37
Table 6-4. Alternative 1: Local Economic Effects Associated with Recreation Visits 6-37
Table 6-5. Alternative 2: Annual Refuge Visitation 6-38
Table 6-6. Alternative 2: Visitor Recreation Expenditures 6-39
Table 6-7. Alternative 2: Local Economic Effects Associated with Recreation Visits 6-40
Table 6-8. Alternative 3: Refuge Visitation 6-40
Table 6-9. Alternative 3: Visitor Recreation Expenditures 6-41
Table 6-10. Alternative 3: Local Economic Effects Associated with Recreation Visits 6-42
Table 6-11. Comparison of Annual Economic Effects Associated with Recreation Visits 6-42
Table 6-12. Change in Average Annual Recreation Visitors and Expenditures Compared to the Baseline 6-42
Table 6-13. Malheur Refuge One-time Expenditures 6-43
Table 6-14. Malheur Refuge Average Annual Expenditures 6-43
Table 6-15. Local Economic Effects Associated with One-time Expenditures 6-44
Table 6-16. Local Annual Economic Effects Associated with Average Annual Refuge Budget Distributed over 15 Years 6-44
Table 6-17. Change in One-time Expenditures Compared to the Baseline Distributed over 15 Years 6-44
Table 6-18. Change in Average Annual Expenditures Compared to the Baseline 6-45
Table 6-19. Malheur Refuge: AUMs and Revenue, 2002-2010 6-46

Table 6-20. Annual Cattle Sales 6-47
Table 6-21. Economic Effects of Cattle Sales—All Alternatives 6-47
Table 6-22. Annual Hay Sales 6-48
Table 6-23. Economic Effects of Hay Production—All Alternatives 6-48
Table 6-24. Summary of Annual Economic Impacts for Alternative 1 6-48
Table 6-25. Summary of Annual Economic Impacts for Alternative 2 6-49
Table 6-26. Summary of Annual Economic Impacts for Alternative 3 6-49

Volume 2
Appendices

APPENDIX A. APPROPRIATE USE FINDINGS A-1

APPENDIX B. COMPATIBILITY DETERMINATIONS
Introduction B-1
Uses Evaluated at This Time B-1
Compatibility: Legal and Historical Context B-2
References B-3
B.1 Wildlife Observation, Photography, and Interpretation Compatibility Determination B-4
B.2 Environmental Education Compatibility Determination B-20
B.3 Waterfowl Hunting Compatibility Determination B-29
B.4 Upland Game Hunting Compatibility Determination B-44
B.5 Fishing Compatibility Determination B-61
B.6 Commercial Tours and Photography Compatibility Determination B-72
B.7 Grazing and Haying Compatibility Determination B-80
B.8 Plant Gathering of Culturally Important Plants Compatibility Determination B-109
B.9 Research, Scientific Collecting, and Surveys Compatibility Determination B-114
B.10 Farming Compatibility Determination B-121

APPENDIX C. IMPLEMENTATION
C.1 Overview C-1
C.2 Costs to Implement the CCP C-2
C.2.1 One-time Costs C-2
C.2.2 Annual Operational (Recurring) Costs C-2
C.2.3 Partnership Opportunities C-6

APPENDIX D. WILDERNESS REVIEW INVENTORY PHASE
D.1 Introduction D-1
D.1.1 Refuge Overview D-1
D.1.2 The Wilderness Review Process D-2
D.1.3 Criteria for Evaluating Lands for Possible Inclusion in the National Wilderness Preservation System D-3
D.1.4 Relationship to Previous Wilderness Reviews D-3
D.2 Inventory Phase of Wilderness Review D-4
D.2.1 Lands and Waters Considered Under This Wilderness Review D-4
D.2.2 Inventory Units D-5
D.2.3 Evaluation of Unit Size D-5
D.2.4 Naturalness Evaluation D-6
D.2.5 Evaluation of Opportunities for Outstanding Solitude or Primitive/Unconfined Recreation D-11
D.2.6 Inventory Summary and Conclusion D-12
D.3 References D-13

APPENDIX E. BIOLOGICAL INTEGRITY, DIVERSITY, AND ENVIRONMENTAL HEALTH E-1

APPENDIX F. STATEMENT OF COMPLIANCE F-1

APPENDIX G. INTEGRATED PEST MANAGEMENT PLAN
G.1 Background G-1
G.2 Pest Management Laws and Policies G-2
G.3 Strategies G-3
G.4 Priorities for Treatments G-10
G.5 Best Management Practices G-10
G.5.1 Pesticide Handling and Mixing G-11
G.5.2 Applying Pesticides G-11
G.6 Safety G-12
G.6.1 Personal Protective Equipment G-12
G.6.2 Notification G-13
G.6.3 Medical Surveillance G-13
G.6.4 Certification and Supervision of Pesticide Applicators G-14
G.6.5 Record Keeping G-14
G.7 Evaluating Pesticide Use Proposals G-15
G.7.1 Overview of Ecological Risk Assessment G-16
G.7.2 Determining Ecological Risk to Fish and Wildlife G-16
G.7.3 Pesticide Mixtures and Degradates G-29
G.7.4 Determining Effects to Soil and Water Quality G-31
G.7.5 Determining Effects to Air Quality G-34
G.7.6 Preparing a Chemical Profile G-34
G.8 References G-49

APPENDIX H. GLOSSARY OF TERMS AND ACRONYMS
H.1 Glossary H-1
H.2 Acronyms H-10

APPENDIX I. CONTRIBUTORS I-1

APPENDIX J. PUBLIC INVOLVEMENT J-1

APPENDIX K. REFUGE MANAGEMENT TREATMENTS
K.1 Refuge Management Treatments K-1
K.2 Dormant Season Haying and Grazing in Wet Meadows K-1
K.3 References K-4

APPENDIX L. THE ECOLOGY WORK GROUP AND THE STATE AND TRANSITION MODEL
L.1 Adaptive Management and the State and Transition Model L-1
L.2 The Ecology Work Group L-1
L.3 References L-2

APPENDIX M. CLIMATE CHANGE
M.1 Introduction M-1
M.1.1 Global Greenhouse Gases M-1
M.1.2 Temperature and Precipitation M-2
M.1.3 Emissions Scenarios M-4
M.2 Pacific Northwest Climate Indicators and Observed Trends M-4
M.2.1 Observed Temperature and Precipitation Changes M-4
M.2.2 Observed Snowpack, Streamflow, and Glacial Changes M-5
M.3 Climate Change Indicators and Trends at Malheur Refuge M-8
M.3.1 Sources and References for Refuge Climate Data M-8
M.3.2 Observed Trends in Refuge Climate Data M-10
M.4 Projected Climate Changes for the Pacific Northwest and Malheur Refuge M-14
M.5 Observed and Predicted Ecological Response to Climate Change in the Region M-17

M.6 Climate Change Adaptation Strategies M-21
M.7 References M-22

APPENDIX N. LIST OF COMMON AND SCIENTIFIC NAMES USED IN THE MALHEUR NATIONAL WILDLIFE REFUGE CCP N-1

APPENDIX O. ADVANCING SUSTAINABILITY-BASED APPROACHES AND PRACTICES
O.1 Sustainability Philosophy O-1
O.2 Sustainability Actions Common to all Alternatives O-2
O.3 Sustainablity Assessments O-3
O.4 Sustainability Planning O-5
O.5 References O-7

APPENDIX P. HUNTING PLAN
P.1 Overview P-2
P.1.1 Species Covered by this Plan P-2
P.1.2 Game Species not Hunted P-2
P.2 Conformance with Statutory Authority P-3
P.2.1 Conformance with Statutory Objectives P-3
P.2.2 Conformance with Refuge Purposes P-3
P.3 Statement of Goals and Objectives P-3
P.3.1 Refuge Goals P-3
P.3.2 Refuge Objectives for Hunting P-4
P.4 Description of Hunting Program P-5
P.4.1 Upland Game Hunting: Proposed Program P-5
P.4.2 Waterfowl Hunting: Proposed Program P-7
P.4.3 Procedures for Consultation and Coordination with Oregon Department of Fish and Wildlife P-9
P.5 Measures Taken to Avoid Conflicts with Other Management Objectives P-10
P.5.1 Measures to Avoid Biological Conflicts P-10
P.5.2 Measures to Avoid Public Use Conflicts P-10
P.5.3 Measures to Avoid Administrative Conflicts P-11
P.6 Assessment P-11
P.6.1 Compatibility with Refuge Objectives P-11
P.6.2 Biological and Other Considerations P-11
P.6.3 Funding and Staffing Requirements for the Hunt P-14
P.7 Conduct of the Hunt P-14
P.7.1 Anticipated Public Reaction to the Hunt P-14
P.7.2 Hunter Application Process P-14
P.7.3 Media Selection for Publicizing the Hunt P-14
P.7.4 Hunter Requirements and regulations P-15

APPENDIX Q. EFFECTS OF PRESCRIBED FIRE ON MALHEUR NATIONAL WILDLIFE REFUGE LANDS
Q.1 Overview of Emergent Marsh at the Refuge Q-1
Q.1.1 Focal Flora Q-1
Q.1.2 Focal Fauna Q-2
Q.2 Fire Objectives and Complications in Emergent Marsh Q-3
Q.2.1 Objectives of Prescribed Fire in Emergent Marsh Q-4
Q.2.2 Complications Associated with Prescribed Fire in Wetlands Q-4
Q.3 Effects of Prescribed Fire to Emergent Marsh Flora Q-5
Q.3.1 General Effects on Flora Q-5
Q.3.2 Fire Effects on Invasive Native Wetland Vegetation Q-6
Q.3.3 Fire Effects on Invasive Weeds Found in Wetlands Q-6
Q.4 Effects of Prescribed Fire to Emergent Marsh Fauna Q-8
Q.4.1 First-order Fire Effects Q-8
Q.4.2 Short-term Fire Effects (The Next Growing Season) Q-9

Q.4.3 Mid-term Fire Effects (2 to 4 Years After the Fire) Q-9
Q.4.4 Long-term Fire Effects (5+ Years After the Fire) Q-10
Q.5 Management Implications for Prescribed Fire in Emergent Marsh and Wet Meadow Q-10
Q.6 References Q-10
Common Prescribed Fire Effects to Habitat Types on US Fish and Wildlife Refuges in the Pacific Region Q-12
Table of Contents Q-13
List of Tables Q-14
List of Figures Q-15
Introduction Q-16
Methods Q-21
Sagebrush Steppe Q-24
Upland Grasslands Q-42
Western Juniper Woodlands Q-56
Effects on Air Quality Q-70
Effects on Cultural Resources Q-79
Effects on Fire Operations Q-87
Climate Change Q-92

APPENDIX R. NATIONAL WILDLIFE REFUGE VISITOR SURVEY 2010/2011: INDIVIDUAL REFUGE RESULTS FOR MALHEUR NATIONAL WIDLIFE REFUGE
Introduction 1
Organization of Results 1
Methods 2
Selecting Participating Refuges 2
Developing the Survey Instrument 2
Contacting Visitors 2
Interpreting the Results 4
Refuge Description 5
Sampling at This Refuge 7
Selected Survey Results 7
Visitor and Trip Characteristics. 7
Visitor Spending in Local Communities 14
Visitor Opinions about This Refuge 15
Visitor Opinions about National Wildlife Refuge System Topics 20
Conclusion 24
Acknowledgments. 24
References 24
Appendix A: Survey Frequencies for This Refuge A-1
Appendix B: Visitor Comments for This Refuge B-1

APPENDIX S. IMPROVING THE AQUATIC HEALTH OF MALHEUR NATIONAL WILDLIFE REFUGE
S.1 Executive Summary S-1
S.2 Introduction S-5
S.3 The Problem: Carp Impacts S-7
S.4 Plan Goals and Management Priorities S-10
S.5 Information Needs S-11
S.6 The Solution: A Scientific, Strategic Approach to Aquatic Health Improvement S-12
S.6.1 Overview of Approach S-13
S.6.2 Role of Adaptive Management and Integrated Pest Management S-13
S.6.3 Methods for Baseline Data Inventories and Ongoing Monitoring S-14
S.6.4 Carp Population Determination S-17
S.6.5 Carp Movement and Aggregation Determination S-18
S.6.6 Carp Dynamics Modeling S-18
S.7 Carp Control Strategies S-19
S.7.1 Techniques and Technologies in Use S-20

S.7.2 Techniques and Technologies That May Be Used to a Limited Extent S-22
S.7.3 Techniques and Technologies That Are Unlikely to Be Used Again S-23
S.7.4 Planned New Techniques and Technologies S-23
S.7.5 Potential New Techniques and Technologies S-24
S.8 Summary S-26
S.9 References S-26

APPENDIX T. RESPONSE TO COMMENTS T-1

Figures

Figure B-1. Pronghorn population trends for the State of Oregon, 1978-2009. ..... B-51
Figure B-2. Mule deer population trend, Steens Mountain Unit, 1980-2009. ..... B-53
Figure L-1. A conceptual diagram of the State and Transition Model as an adaptive management tool. L-2
Figure M-1. Concentrations of important heat-trapping greenhouse gases over the last 2,000 years. M-1
Figure M-2. Global average temperature and CO_2 concentrations from 1880 to 2008. ..... M-2
Figure M-3. Percent of land area in the lower 48 states that has experienced greater than normal precipitation for the period 1910 to 2008. ..... M-4
Figure M-4. Trends in annual temperature or precipitation from 1920 to 2000. ..... M-5
Figure M-5. Trends in April 1st snow water equivalent (SWE) in the western United States from 1950 to 1997. Red (blue) circles indicate decreasing (increasing) SWE, with the size of the symbol indicating the magnitude of the trend. M-6
Figure M-6. Observed spring pulse of snowmelt-generated streamflow for (a) and (b) two high and (c) and (d) two mid-elevation Pacific Northwest streams, illustrating the much greater advance in timing in the mid-elevation streams. M-7
Figure M-7. Grinnell Glacier, Glacier National Park, photographs from 1940 and 2006. ..... M-8
Figure M-8. Trend in March monthly temperature for the Refuge and the Blitzen watershed (PRISM data) from 1950 to 2009. ..... M-10
Figure M-9. April 1st SWE at Fish Creek SNOTEL (elevation 7,660 ft.) and Silvies SNOTEL (elevation 6,990 ft.) for the period 1950 to 2009. ..... M-11
Figure M-10. Trends in the annual streamflow centroid (the date on which approximately half of the annual streamflow occurs) and the annual minimum 7-day average flow for the Blitzen River near Frenchglen, 1939 to 2009. Both data sets show no statistically significant changes for the period. M-12
Figure M-11. Trends in the annual ratio of June/May monthly flows and the annual maximum daily flow for the Blitzen River near Frenchglen, 1939 to 2009. Both trends are only weakly significant. M-13
Figure M-12. Simulated temperature change (top panel) and percent precipitation change (bottom panel) in the Pacific Northwest using twentieth and twenty-first century global climate model simulations. M-14
Figure M-13. Ratio of April 1st SWE to total March to October precipitation for the historical period (1916–2006) for the A1B scenario (left panel), and for the B1 scenario (right panel) at three future time periods (2020s, 2040s, 2080s). M-16
Figure M-14. Mountain pine beetle damage in British Columbia. M-17
Figure M-15. Illustration of climate change impacts to sagebrush/grassland communities. M-18
Figure M-16. Average statewide bloom date of lilacs in Idaho, 1957 to 1993. ..... M-19
Figure M-17. Illustration of climate change impacts to aquatic communities. M-20
Figure O-1. Malheur NWR FY 2008 Greenhouse Gas Emission Inventory Results by Source O-3
Figure O-2. Gasoline Fleet Vehicle Fuel Economy and Miles Driven by Vehicle (Apr 2011 through Sep 2011) . O-4
Figure O-3. Sustainability Management Areas and Aspects O-5
Figure S-1. Refuge Manager herding carp to sample for fish health and population dynamics at Crane Pond in 2010. ..... S-1
Figure S-2. East Knox Pond flourishes with life due to water manipulations. S-5
Figure S-3. Examples of the 1992 drought year and 1984 high water levels at Malheur Refuge. S-6
Figure S-4. Carp research being conducted by Refuge staff and a University of Minnesota post-doctoral fellow in Malheur Lake. Notice no vegetation and very turbid water. S-7
Figure S-5. Explanation of common carp impacts on the aquatic environment. S-8
Figure S-6. An estimated 1.5 million mortalities caused by 1955 rotenone treatment. S-9

Figure S-7a. Trumpeter swan with cygnets swimming in a healthy, vegetated water body. Figure S-7b. A view of a healthy marsh with open water and islands of vegetation. S-10
Figure S-8. Common carp impact areas. S-11
Figure S-9. Refuge fish biologist in the process of implanting a telemetry tag in a fish caught and released in Boca Lake. S-12
Figure S-10. Refuge Manager and fish biologist removing fish netted in a trammel net on Boca Lake. S-13
Figure S-11. Submergent vegetation in Malheur Lake. S-15
Figure S-12a. Collaboration by USGS and USFWS collecting aquatic macroinvertebrates on the Refuge. S-15
Figure S-12b. Collaboration with retired ODFW biologist on native freshwater mussel monitoring. S-15
Figure S-13. Youth Conservation Corp students helping collect fish data. S-16
Figure S-14. Pied billed grebe with chicks getting a ride from mom. S-16
Figure S-15. Mark and recapture study being conducted by the University of Minnesota. Fish are netted below the ice, fins are clipped, and fish are measured prior to being rereleased S-18
Figure S-16. Summer interns collecting water chemistry and telemetry data. S-18
Figure S-17. A simplified visual representation of the carp modeling system. S-19
Figure S-18. A water control structure at Barn Yard Spring in the Double-O Unit. S-20
Figure S-19. Operating fish screen on the West Canal at Page Springs Dam. S-21
Figure S-20. Electro-shocking for carp below Sodhouse Dam. S-21
Figure S-21. In 1992 Refuge staff made a huge effort to drain Headquarters Pond with two Crissafulli pumps to remove carp. S-22
Figure S-22. Prototype of the robotic carp. S-24
Figure S-23. Native redband trout. S-24
Figure S-24. Computer simulated design of experimental carp wheel. S-25
Figure S-25. Blood sample of common carp submitted to Oregon State University for koi herpes virus genetic testing. S-26

Tables

Table B-1. Summary of Compatible Use Determinations B-1
Table B-2. Costs to Implement the Use B-6
Table B-3. Costs to Implement the Use B-22
Table B-4. Special Use Requirements for Environmental Education B-24
Table B-5. Costs to Implement the Use B-30
Table B-6. Harvest and Population at Flyway, State, and Survey Unit Scales: Ducks, Geese[1], and Coots B-35
Table B-7. Costs to Implement the Use B-46
Table B-8. Upland Game Bird Population Index and Estimated Harvest B-48
Table B-9. Reported 2010 Coyote Harvest on the Refuge, County, Region, and State B-50
Table B-10. Reported 2009 Pronghorn Harvest on the Refuge, State Hunting Unit, and State Scales B-51
Table B-11. Reported 2009 Deer Harvest on the Refuge, State Hunting Unit, and State Scales B-52
Table B-12. ODFW Regulations for Sport Fishing for 2011[1] B-62
Table B-13. Costs to Implement the Use B-63
Table B-14. Costs to Implement the Use B-74
Table B-15. Special Use Requirements for Commercial Recreational Uses B-75
Table B-16. Costs to Implement the Use B-86
Table B-17. Wildlife Species that Depend on Treated Meadows for Particular Life History Stages B-89
Table B-18. Cost to Implement the Use B-123
Table C-1. Current and Proposed Staffing per Alternative C-3
Table C-2. Budget Summary for Implementation and Inventory and Monitoring (I&M) Activities (Wildlife and Habitat, Sustainable Practices Programs) C-8
Table C-3 Budget Summary for Implementation and I&M Activities (Visitor Services and Cultural Resources) C-19
Table D-1. Results of Wilderness Inventory (Phase I) for Malheur NWR D-12
Table E-1. Biological Integrity, Diversity, and Environmental Health for Malheur National Wildlife Refuge E-1
Table G-1. Ecotoxicity Tests Used to Evaluate Potential Effects to Birds, Fish, and Mammals to Establish Toxicity Endpoints for Risk Quotient Calculations G-16
Table G-2. Presumption of Unacceptable Risk for Birds, Fish, and Mammals G-18

Table G-3. Average Body Weight of Selected Terrestrial Wildlife Species Frequently Used in Research to Establish Toxicological Endpoints G-19
Table G-4. Estimated Environmental Concentrations (ppb) of Pesticides in Aquatic Habitats (1 foot depth) Immediately after Direct Application G-21
Table CP.1 Pesticide Name G-48
Table I-1. Core Planning Team I-1
Table I-2. Collaborative Participants and Reviewers I-1
Table K-1. Management Treatment Acres per Treatment Year K-1
Table M-1. Top 10 Warmest Years in the Instrumental Record from 1880 to 2010[a] M-3
Table N-1. Birds N-1
Table N-2. Mammals N-2
Table N-3. Bats N-3
Table N-4. Fish N-3
Table N-5. Mollusks N-4
Table N-6. Reptiles and Amphibians N-4
Table N-7. Invertebrates N-5
Table N-8. Plants N-5
Table P-1. Northern Portion of Malheur Lake Hunt Unit P-6
Table P-2. Buena Vista Hunt P-6
Table P-3. Boundary Hunt Unit P-6
Table P-4. Northern Portion of Malheur Lake Hunt Unit P-7
Table P-5. Southern Portion of Malheur Lake Hunt Unit P-8
Table P-6. Buena Vista Hunt Unit P-8
Table P-7. Malheur Lake Youth Hunt P-8
Table Q-1. Birds Q-2
Table Q-2. Raptors Q-3
Table Q-3. Mammals Q-3
Table Q-4. Amphibians Q-3
Table Q-5. Reptiles Q-3

Executive Summary

The Malheur National Wildlife Refuge (Refuge) is located in southeastern Oregon's high desert, at the northern of end of the Great Basin. It is adjacent to the Steens Mountain Wilderness, from which the Wild and Scenic Donner and Blitzen River flows into the Refuge's southern boundary. The Refuge is famous for its spectacular concentrations of wildlife, attracted to the Refuge's habitats and abundant water resources in an otherwise arid landscape. With more than 320 bird species, and 58 mammal species, Malheur is a mecca for birdwatchers and wildlife enthusiasts.

The Refuge was established in 1908 to protect migratory waterfowl, with an emphasis on colonial nesting species. We, the U.S. Fish and Wildlife Service (Service), manage the Refuge as part of the National Wildlife Refuge System (Refuge System). We are required by the National Wildlife Refuge System Administration Act of 1966 as amended, to manage each unit of the Refuge System in accordance with a comprehensive conservation plan that is developed in a public process with public input considered at key points in the process. This is a summary of the Malheur National Wildlife Refuge Final Comprehensive Conservation Plan and Environmental Impact Statement (CCP/EIS), more background information is provided in Chapter 1.

We evaluate and compare three alternatives for conserving the Refuge's fish, wildlife, and plant resources through population monitoring, habitat management and restoration, and invasive species control, in Chapter 2. Providing the Refuge System's priority public uses—wildlife observation and photography, hunting, fishing, environmental education, and interpretation, in a manner that is compatible with the Refuge's conservation purpose, is also evaluated. The alternatives are the result of our collaborative public planning process initiated in 2008. Hundreds of individuals, nonprofit organizations, State and local agencies, and tribal governments shared ideas, concerns, and information during our process. Alternative 1, our no action alternative, describes our current Refuge management activities. In alternatives 2 and 3 we describe management actions that would further improve Refuge conditions. We have identified Alternative 2 as our preferred alternative.

The Refuge's physical, biological, and human environments are described in detail in chapters 3, 4, and 5, and the predicted environmental effects from our proposed management activities and public uses on the Refuge's resources are identified and evaluated in Chapter 6, highlighting potentially significant effects. Chapter 6 is the basis for determining the compatibility of the Refuge's public uses and the administrative actions necessary for managing a wilderness study area. A collection of maps follows Chapter 6, and a number of appendices follow the maps, including appropriateness findings and compatibility determinations for proposed public uses in appendices A and B.

After the Final CCP/EIS is available to the public for 30 days, a Record of Decision will be signed by the Service's Regional Director in Portland, Oregon, selecting an alternative for implementation on the Refuge. The Final CCP will guide management of Malheur Refuge for 15 years.

Refuge Information and Background

In the late 1880s, plume hunters were decimating North American bird populations in pursuit of breeding birds' feathers highly valued by the hat industry. Hunters targeted colonial nesting birds and shorebirds, killing birds indiscriminately and orphaning chicks. When plume hunters discovered the large flocks of colonial nesting birds on Malheur Lake in 1898, the area's white heron (egret) population was nearly wiped out. Ten years later, wildlife photographers William L. Finley and

Herman T. Bohlman toured Malheur Lake and determined that nearly all of the egrets had been killed and the egret population had not recovered.

With backing from the Oregon Audubon Society, Finley and Bohlman proposed establishment of a bird reservation to protect birds using Malheur, Mud, and Harney lakes. Government lands identified as the Lake Malheur Reservation were set aside on August 18, 1908, by President Theodore Roosevelt, through Executive Order No. 929 "*as a preserve and breeding ground for native birds*." A letter from the Secretary of the Interior dated August 12, 1908, to the President stated that the purpose and intent was "to preserve the habitat values of the three lakes (Malheur, Mud and Harney Lakes) for migratory waterfowl, and especially, the colonial nesting species."

The Refuge now encompasses 187,757 acres that are a small part of the northern Great Basin. The Refuge is disproportionately important as a stop along the Pacific Flyway, and as a resting, breeding and nesting area for hundreds of thousands of migratory birds and other wildlife. Many of the species migrating through or breeding here are highlighted as priority species in national bird conservation plans. Historical bird counts show that Malheur Refuge and the adjoining Silvies River floodplain to the north may support between 50 percent and 66 percent of the Pacific Flyway's migrating bird populations for various priority waterfowl.

The Refuge's breeding habitat is also significant for waterbirds; it currently supports more than 20 percent of Oregon's population of breeding greater sandhill cranes. Most colonial waterbird numbers have easily exceeded 10 percent of the regional population at its peak, and numbers for certain species have reached up to 77 percent of the populations located with the Great Basin. Numbers of migrating shorebirds have been documented at levels high enough to qualify the Refuge as a Regional Western Hemispheric Shorebird Reserve. The Refuge also supports high densities of certain nesting riparian passerines and the largest local population of bobolinks in the western U.S.

The Refuge is well-loved by its visitors, many return year after year, compelled by the excellent birding, opportunities for solitude, intriguing historic remnants and geologic sites, and its proximity to Steens Mountain, an Oregon landmark. The Refuge has strong historic ties to local residents as an important contributor to local economies. Far-flung birding communities also feel a strong connection to the Refuge and the Audubon Society's role in its initial establishment. Both local and distant communities will continue to play a large role in the Refuge's future.

Refuge Purposes, Vision, and Management Goals

The primary purposes for Malheur Refuge follow.

- "a refuge and breeding ground for migratory birds and other wild life…" Executive Order 7106, dated July 19, 1935, as modified by Public Land Order 1511, dated Sept. 24, 1957
- "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)
- "for the development, advancement, management, conservation, and protection of fish and wildlife resources..." 16 U.S.C. § 742f(a)(4)
- "for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

- "conservation, management, and...restoration of the fish, wildlife, and plant resources and their habitats...for the benefit of present and future generations of Americans..." 16 U.S.C. § 668dd(a)(2) (National Wildlife Refuge System Administration Act)

The Service's vision for Malheur Refuge is stated as follows in the CCP/EIS.

> *Together with our surrounding community, partners, friends, staff, and all those who cherish this unique place where desert and water meet...*
>
> *Malheur National Wildlife Refuge commits to care for, conserve, and enhance the health of the Malheur Lake, Blitzen Valley, and Double-O units, including the playas, dunes, marshes, rivers, meadows, and ponds that are all part of this landscape.*
>
> *We will observe nature and manage in harmony with ecological forces, while recognizing and maintaining the Refuge as a key anchor for migratory and breeding waterfowl, waterbirds, shorebirds, songbirds, and raptors.*
>
> *We will work diligently to improve the health of the land and water, reducing the destructive impact of carp and other invasive species, addressing imbalances in floodplain function, and restoring the original abundance of fish and wildlife for which Malheur is famous.*
>
> *We will celebrate and welcome our visitors, noting and protecting the features that draw people again and again—the expansive landscape, the plenitude and diversity of wildlife, and the signs of a timeless history.*
>
> *We will allow and enhance opportunities to experience abundance, solitude, and renewal, for people birding, fishing, hunting, and learning on the Refuge. In respect to our ancestors and their fortitude, we will carefully preserve the legacies they left behind on this land.*
>
> *Collaboration with our neighbors, partners, and friends will be a critical cornerstone in our day to day work; we recognize that nature crosses our boundaries and we can be successful only in partnership. We recognize that our activities are inextricably linked to the health of the local economy. We commit to environmental stewardship and sustainable management. We commit to learn from our efforts, successes, and failures; to be humble about what we know; and to continuously strive for greater understanding in our stewardship of this remarkable place*

The vision for the Refuge would be achieved by managing the Refuge to accomplish the following goals, as stated in the CCP/EIS.

Goal 1. Enhance aquatic health and habitat conditions essential to the conservation of the flora and fauna that depend on Malheur Lake and associated water bodies.

Goal 2. Protect, maintain, and rehabilitate riverine and riparian habitats to conditions essential for the conservation of native fish and wildlife species.

Goal 3. Protect, maintain, and rehabilitate riparian habitats to conditions essential for the conservation of wildlife species.

Goal 4. Enhance, protect, and/or maintain primary habitats essential to the conservation of a diversity of aquatic and terrestrial wildlife species.

Goal 5. Enhance and maintain rare and unique habitats.

Goal 6. Visitors will be welcomed and can safely experience the Refuge's outstanding features – diversity of wildlife, signs of earlier inhabitants, scenic landscapes, and solitude. As a result, visitors will leave the Refuge with a memorable experience that fosters a connection between themselves and nature, and an appreciation of Malheur's unique resources.

Goal 7. Connect the hearts and minds of visitors with places and resources the Refuge protects, and enlighten visitors' experiences with an understanding, appreciation, and knowledge about the historic and natural resources, and the importance of conservation and stewardship.

Goal 8. Provide reasonable challenges and opportunities, and provide uncrowded conditions for the hunting and fishing public.

Goal 9. Initiate and nurture relationships to build support of the Refuge, and fortify Refuge programs and activities to achieve the Refuge's purpose and goals.

Goal 10. Manage prehistoric and historic cultural resources for their educational, scientific, and cultural values for the benefit of present and future generations of Refuge users and for the communities that are connected to these resources.

Goal 11. Identify and protect prehistoric and historic resources on the Refuge that are eligible for or listed on the National Register of Historic Places.

Goal 12. Manage the Refuge's paleontological resources for their educational and scientific values for the benefit of present and future generations of Refuge users.

Goal 13. Gather scientific information (surveys, research, and assessments) to support adaptive management decisions.

Goal 14. Integrating our conservation-based mission with the best available science, the Refuge will become a leader in advancing best design and management practices for innovative, sustainable Refuge and community development opportunities.

Management Issues

Through the collaborative development of the CCP/EIS we addressed several important Refuge management issues with input from State and tribal governments, other Federal agencies, and the public. The following major issues are analyzed and addressed in the CCP/EIS.

- The importance of the Refuge and Silvies River floodplain to migratory and breeding birds.
- Invasive species, including common carp and perennial pepperweed.
- Habitat and vegetation management.
- Riverine conditions: geomorphology, hydrology, fisheries, and riparian habitat.
- Water system infrastructure and water delivery.
- Preserving the legacy of human and paleontological history at Malheur.

- Visitor access, facilities, and information.
- Providing quality wildlife observation, photography, interpretation, and environmental education.
- Providing quality fishing and hunting opportunities.
- Wilderness preservation.
- Collaboration with all stakeholders.

Management Alternatives

The CCP/EIS includes three alternatives. Alternative 1 reflects the current management of the Refuge; under it we would continue to implement applicable management direction from other existing Refuge management plans. Alternative 1 is the baseline for evaluating the other alternatives. Alternative 2 is the Service's preferred alternative and is generally a more intensive approach to managing Refuge resources, compared to Alternative 1. The primary emphasis of Alternative 2 is the restoration of native habitats throughout the Refuge for the benefit of fish, wildlife, and plants. Alternative 3 is generally a less intensive management approach, compared to Alternatives 1 or 2.

Alternative 2 is our preferred alternative because it would restore the Refuge's degraded aquatic habitats that are being adversely impacted by invasive common carp and the spread of invasive nonnative weeds, and improve services, infrastructure, and access for visitors. Alternative 2 would best implement Service policies by removing invasive common carp from the Refuge; managing self-sustaining high-quality sport fishing opportunities; and designating roads and motorized vehicle routes for wildlife-dependent recreation that minimize adverse impacts to Refuge resources.

Alternative 1 (no action alternative)

Alternative 1 represents the "no change" alternative as required by the National Environmental Policy Act (NEPA) as amended (42 U.S.C. 4321-4347). The Refuge staff would continue programs at current levels, as described in Chapters 3, 4 and 5.

Lake and Wetland Habitat. Aquatic health management would continue, specifically, controlling common carp which requires a multi-faceted program. Water drawdowns and rotenone treatments would continue to be the dominant carp control tools. Refuge staff would continue to utilize water rotations and dewatering in strategic wetland units in the Blitzen Valley and Double-O Units, to augment habitat conditions and to decrease carp populations. Strategic water rotations or dewatering would continue within all units on a regular basis, to control carp populations and to decrease spawning habitat. Due to the state of Oregon's listing of the redband trout as a sensitive species, fish screens, ladders, and other diversions constructed on the main stem of the Blitzen River would continue to be developed and maintained to decrease entrapment of native redband trout in wetland units, and to control carp movement upstream.

Refuge staff would continue to gather scientific information related to habitat assessments, such as water quality (e.g. dissolved oxygen, turbidity, temperature, macroinvertebrate diversity, and pH) and carp population dynamics and control strategies. Grant funding would be pursued to conduct research for long term solutions to improving aquatic health and controlling carp. The Aquatic Health Coalition is developing a Harney Basin carp control plan that will provide more details.

Riverine Habitat. Our riverine rehabilitation efforts would continue to be focused on placing rock weirs in designated reaches of the Blitzen River, and Bridge and Mud Creeks. These projects would provide habitat improvement and bank stabilization by increasing stream complexity through the addition of rock structures (e.g., inverted weirs, rock veins, boulder clusters) and large woody debris (e.g., root wads). The success of river bank stabilization projects such as raising the grade of the stream bottom water level with rock structures, resloping incised banks, and reestablishing riparian vegetation (sedges, willow, rose, etc.), would continue to be assessed. Current fish passage structures on the Blitzen River and relevant tributaries and fisheries (e.g. East Canal) would be maintained. Riparian shrub propagation would continue on several reaches of Mud and Bridge Creeks and the Blitzen River. Native fish passage, placement and maintenance of carp barriers, and vegetative rehabilitation efforts would continue. Comprehensive water quality studies would continue contingent upon available funding. Additional riverine enhancement would consist of isolated, small-scale, in-stream improvements, as resources are available.

Terrestrial and Wetland Habitats. Management of terrestrial and wetland habitat would continue to address the needs of various waterbirds, shorebirds, and waterfowl by providing conditions necessary for nesting, pairing, and migration. Management for current focal species, including the greater Sandhill crane, willow flycatcher, redhead, mallard, gadwall, cinnamon teal, and an assortment of shorebirds, would continue as specified in the Blitzen Valley Management Plan (Rule et al., 1990) and Double-O Unit Habitat Management Plan (David and Ivey 1995). Management targets would include four major habitat types—upland, riparian, marsh, and meadow habitats. A specified irrigation schedule (March 1 through July 25) would continue to be utilized throughout most of the Refuge, with targeted areas receiving winter irrigation (prior to March 1). Plant litter, which becomes detrimental to wildlife over time, would be reduced through the use of prescribed burning, haying on or after August 10, and rake-bunch grazing on or after September 1.

Approximately 60 percent of meadows would continue to be left untreated annually, with the exception of irrigation and infrequent prescribed burns. The application of herbicides, the only other vegetation treatment strategy used prior to August 10 to control invasive plant species, would continue in wetland and meadow habitats. Minimal habitat restoration would occur. Emergent vegetation encroachment into wet meadows would continue, due to the favorable conditions that extended flood irrigation creates for common and hybrid cattails.

Public uses. Wildlife observation, wildlife/nature photography, interpretation, environmental education, hunting, and fishing, would continue, using current facilities and programs. No new public use facilities would be developed. Areas currently closed to public access would remain closed to provide wildlife sanctuary during the winter waterfowl season. The Refuge would not pursue any additional land protection measures under Alternative 1.

Cultural Resources. Archaeological resources would continue to be considered during project planning for all Refuge programs. Historic resources would continue to be stabilized and restored as funding becomes available through partnerships. Paleontological resources would continue to be protected. Interpretation of archaeological and historic resources would remain the same.

Alternative 2 (Preferred alternative)

The Refuge is legally mandated to conserve and protect migratory birds to achieve its establishing purposes. Addressing aquatic health is key to meeting this obligation, and full attention would be given to its improvement under Alternative 2. The greatest obstacle to this effort is common carp, an

introduced fish that negatively impacts water quality, and in turn impacts native fish, wildlife, and plants that depend on the Refuge's aquatic resources. Primary management emphasis would be placed on improving aquatic health, with staff time and budget largely directed to carp control. Partnerships and staff resources would also address visitor services and habitat management programs. We would develop a comprehensive riverine/wetland rehabilitation plan that would progress as staffing, funding, partnerships, and other resources become available.

Lake and Wetland Habitats. The management emphasis of Alternative 2 would be to improve the aquatic health of the Refuge's lake and wetland habitats, to enhance the feeding, resting and nesting components necessary for a variety of shore/wading birds, waterfowl, and other wildlife species. This would be achieved largely through carp population control. As turbidity decreases and submergent vegetation and invertebrate species become more abundant, the productivity of Malheur Lake and other water bodies within the Refuge (e.g. Boca Lake and Warbler Pond) would improve.

Because of the sheer size and complexity of the Refuge's aquatic health problem, a variety of assessment and control tools would be implemented to effectively address it. Existing partners, such as the Aquatic Health Coalition (comprised of federal, state, NGO, and Tribal participants), would assist in identifying strategies and implementing effective methods of control, inventory, funding, and monitoring. We would customize and incorporate methods successfully implemented worldwide, to suit the Refuge.

Strategic assessments of aquatic habitats and carp population dynamics would guide control activities and provide enhanced understanding of the system's innate ability to recover from carp impacts. Control strategies would include, but not be limited to, the application of piscicide, chemo-attractants, chemo-repellants, barriers, commercial harvest, angling, and water manipulation. The need for continued amendments to and construction of additional strategically placed instream structures (i.e. traps, screens, and fish wheels) that allow native fish passage and impede/prohibit carp movement through the system, would also be considered.

Riverine Habitat. The Blitzen River and its tributaries provide habitat that fish and wildlife depend on. Because a vast majority of Refuge-managed habitats are reliant on irrigation via a network of dams, canals, and ditches associated with the river, the connectivity between Malheur, Mud, and Harney Lakes, systems, and associated wetlands adds a level of complexity to carp control. Under Alternative 2, we would develop a comprehensive riverine/wetland rehabilitation plan to improve lake and wetland aquatic health through carp control. We may also pursue water management efforts to reduce the river's water temperatures in the summer, by increasing the cold water barrier that keeps carp out of wetlands in the upper Blitzen Valley.

Refuge management under Alternative 2 would emphasize carp control primarily, and strategic riverine assessment and rehabilitation. Alternative 2 allows for flexibility in our progress, which would be dependent on available resources, partnerships, and carp control success on the Refuge. We would gain a greater understanding of the impacts on adjacent floodplain habitats over a longer study period, which would enable us to gain site specific knowledge of how riverine, wet meadow, and marsh communities respond to hydrologic system changes. We would also use a science-based process to determine existing biological conditions, site capability, and management decisions. We would work with the ecology working group and other stakeholders to prioritize and refine objectives for creating a comprehensive riverine strategy. Our priority inventory and monitoring efforts would focus on building baseline data that could be used as part of our riverine rehabilitation activities and improve our understanding of adjacent habitats.

Wetlands and Terrestrial Habitats. We would continue to manage wetland and terrestrial habitats for the life history needs of focal resources (see Appendix E), with greater flexibility in identifying strategies to meet establishing objectives. Flexibility is critical for maintaining a variety of plant communities within emergent marsh, wet meadow, and dry meadow habitats, to meet foraging, breeding, brood rearing, and other life cycle needs of migratory birds and other native wildlife. For example, bobolinks and sandhill cranes both depend on wet meadows during the breeding season; however, their use of it and the conditions they require differ. To address the wide assortment of needs found within each habitat type, vegetation management tools to address litter accumulation and plant community succession would include traditional late summer haying and autumn/winter rake-bunch grazing to meet the foraging needs of early-arriving wildlife species, and highly prescriptive warm-season grazing, mowing, farming, burning, and extended dewatering, to reclaim acres lost to invasive plants such as common cattail and reed canarygrass, or to rehabilitate communities that have transitioned beyond desired conditions.

Wildlife Viewing, Photography, and Interpretation. The cornerstone of our public use program would be quality wildlife observation and photography opportunities. Management under this alternative would be focused on expanding facilities and programs for visitors and birders. Both spur and loop trails a mile or longer would be added to allow visitors to explore and learn about the wildlife and Refuge, and several trails would be upgraded or developed to meet accessibility compliance standards. Viewing overlooks and elevated viewing platforms would be upgraded and/or developed. The historic Audubon photography blind would be restored at the Refuge Headquarters Display Pond, two permanent screened photography blinds would be built to comply with accessibility standards, and an elevated viewing platform would be developed at Malheur Lake. For advanced birders, the Refuge would maintain and replant cottonwood and other non-endemic trees and shrubs at six historic landscapes to continue to provide habitat for rare and incidental passerines.

Docent-led tours would be conducted seasonally at various Refuge locations, and would include opportunities for guided kayak and canoe tours on Malheur Lake. Expanded vehicle access would be available, with year-round vehicle access to Krumbo Reservoir provided along Boat Landing Road near Refuge Headquarters, and from the southern portion of East Canal Road to the confluence of Bridge Creek. In addition, boating that is not directly supporting the fishing program would be available at Krumbo Reservoir to enhance wildlife viewing.

Interpretive features and programs are another high priority and key interpretive themes would include the significance of the Refuge to breeding and migratory birds, pre- and post-contact historic events, wilderness, geology, aquatic health, water importance, resource challenges, and the National Wildlife Refuge System. A stronger emphasis would be placed on developing and utilizing modern media. The George Benson Memorial Museum at Refuge Headquarters would be enhanced with interpretive panels, to connect visitors with the places and resources that the Refuge protects. Additional outdoor interpretive panels would be placed at key field sites and would focus on improving aquatic health and associated management activities, and the connection between historic events and the ecology of the Refuge. Special events and public presentations by Refuge staff and volunteers would be expanded and promoted to enlighten visitors' experiences.

Welcome and Orientation. Welcome and orientation features would improve under Alternative 2, with an emphasis on the use of modern and traditional media to reach and orient visitors. Up to eight outdoor panels would be located near Refuge entrances, and at other congregation areas to direct and guide visitors during their visit. To welcome visitors, developed sites with visitor amenities, such as picnic tables, shelters, and vault toilets would be upgraded, and at least five new sites would be

developed. An enlarged visitor contact station and gift shop at Refuge Headquarters and a seasonal contact station at P Ranch would be built to provide visitors contact with Refuge staff and volunteers.

Environmental Education. We would provide environmental education (EE) using Refuge staff time and resources strategically, by coordinating efforts with other EE initiatives. Existing modules from national and regional programs, such as the Junior Duck Stamp competition and International Migratory Bird Day, would be utilized as Refuge staff and volunteers become available. We would develop an outdoor shelter and learning area at Refuge Headquarters to support EE programs.

Hunting. Opportunities for upland game hunting would be enhanced, by improving the Saddle Butte access on Malheur Lake's north side, and opening the program three weeks early, from the fourth Saturday of October to the end of the State's pheasant season in the Buena Vista Hunt Unit. The north part of Malheur Lake and the Boundary Hunt Unit would remain open under existing regulations.

Waterfowl hunting would be enhanced, by promoting a youth hunt and improving the Saddle Butte access. In addition, new waterfowl hunt areas would be provided, doubling the existing waterfowl hunt area by opening a portion of the south-central area of Malheur Lake, and allowing waterfowl hunting within the existing Buena Vista Hunt Unit. The season would be open from the fourth Saturday of October to the end of the State waterfowl season. One new access point with an expanded parking area and an enhanced boat launch would be provided at the airboat launch site near Refuge Headquarters, to access the new Malheur Lake hunt unit. In partnership with potential users, the Refuge would support adding barrier-free facilities for waterfowl hunters with mobility impairments in the Buena Vista Hunt Unit.

An exchange of portions of Refuge lands west of State Highway 205 and southeast of Krumbo Reservoir (the Boundary Hunt Unit) to the Bureau of Land Management (BLM) in exchange for other lands would be explored, and the hunt would likely be managed under existing regulations. The exchange would facilitate the Refuge's focus on key aquatic areas and reduce the administrative problem of managing lands with an unmarked boundary.

Fishing. Fishing opportunities along the upper Blitzen River, the southern portion of East Canal, and Mud and Bridge Creeks, would continue. Vehicle access would be allowed on East Canal Road to the confluence of Bridge Creek, which would enable access to BLM's Granddad Reservoir. In addition, a new pedestrian crossing at Bridge Creek would enhance fishing access to seven miles of Bridge Creek located between the East Canal and Blitzen River. We would open a new bank fishing season from August 1 to September 15 on the Blitzen River, with a parking area on Boat Landing Road, from Sodhouse Lane to the bridge. Orientation panels with maps, brochures, and regulations, would be added to fishing areas, to provide information to visitors about fishing opportunities.

At Krumbo Reservoir, year-round access would be provided for wildlife viewing, boating, and fishing, in coordination with State seasons, which would increase public fishing opportunities. The triploid rainbow trout stocking program would continue in coordination with the Oregon Department of Fish and Wildlife (ODFW), and a redband trout genetic introgression study would be conducted.

Volunteer Program. To help enhance the Refuge's volunteer, public use, and other programs, a full-time volunteer coordinator would be added to the staff to increase recruitment, retention, and the return rate of volunteers, to better utilize Refuge facilities and staff, and to assist with building partnerships and increasing public outreach.

Cultural Resource and Paleontological Protection. We would strengthen protection of the Refuge's cultural and paleontological resources by developing step-down management plans with partners for administrative sites where historic, prehistoric, archaeological, and paleontological resources occur. Interpretation of historic sites would be expanded through the development and implementation of site specific interpretive plans. Opportunities for American Indians to collect plant materials for traditional uses would be expanded. Monitoring and inventory of archaeological resources would increase as part of step-down management plan implementation.

Energy Independent. Refuge staff would pursue energy independence and carbon negative Refuge operations, and would continue to emphasize partnerships to maximize adaptive management.

Inventory and Monitoring. The Refuge would develop inventory and monitoring plans to guide annual management actions. The plans would emphasize focal species and national monitoring efforts, and a geodatabase would be created to record and track the data collected under these plans.

Alternative 3

Under Alternative 3, our primary management emphasis would be on natural processes, and both aquatic health (carp control) and comprehensive riverine/wetland rehabilitation planning. We would also address the needs of the visitor services and habitat management programs through partnerships and staff resources.

Lakes and Wetland Habitats. Under Alternative 3, primary management emphasis would continue to be on improving aquatic health through carp control. Actions and outcomes discussed under Alternative 2 relevant to Malheur Lake and Refuge wetlands and carp control are essentially the same under Alternative 3.

Riverine Habitats. Developing a comprehensive riverine/wetland strategy would be a priority under Alternative 3, to enhance habitat for native fishes and improve water quality, floodplain connectivity, and riparian habitat. An assessment of the geomorphology, ecology, and hydrology of the Blitzen River and our use of riverine resources for visitor services, cultural and historic resources, and water rights programs would be conducted. By gathering data, engaging riverine experts in pilot projects, and evaluating our results and options, the Service would be able to identify the best strategies for rehabilitating riverine habitats.

Other Habitats. Because the river enhancement effort would proceed slowly, over a 15-year timeframe, no discernible difference exists between Alternatives 2 and 3 with regard to the management of wetland and terrestrial habitats within the Blitzen Valley.

Wildlife Viewing, Photography, and Interpretation. As in Alternative 2, the cornerstone of the public use program would be providing quality wildlife observation and photography opportunities. Management under Alternative 3 for wildlife viewing, photography, and interpretation would be similar to Alternative 2, but there would be less emphasis on developed facilities and more emphasis on self-guided and off-trail experiences. The 42-mile Blitzen Valley auto tour route on Center Patrol Road would be seasonally closed to vehicle access, August 15 to the fourth Friday of October in the Buena Vista Unit, and August 15 to March 1 in the P Ranch Unit, and would be redesigned into two or three shorter, year-round routes. Walk-in, free roam access along the closed portions of the Center Patrol Road and dike tops in both units would be allowed during the seasonal closure to provide

opportunities for self-guided and off-trail experiences. This would provide 11 weeks of free roam opportunity in the Buena Vista Unit and 27 weeks in the P Ranch unit.

Docent-led tours would be included under Alternative 3, and year-round vehicle access would be allowed on Boat Landing Road near Refuge Headquarters, to the Malheur Lake elevated viewing platform. Seasonal boating at Krumbo Reservoir would remain available. Vehicle access to Krumbo Reservoir would be seasonal as well, with walk-in access provided from November 1 to the fourth Friday of April, to provide visitors with improved opportunities for solitude. The southern portion of East Canal Road to the confluence of Bridge Creek and the East Canal would be open to year-round, walk-in access. Spur and loop trails of one mile or longer and a number of specific viewing facilities such as overlooks and platforms would be added with limited investment. Existing trails would be upgraded or built to meet accessibility compliance. The historic Audubon photography blind at the Refuge Headquarters Display Pond would be restored. Photography opportunities would be restructured with temporary photography blinds erected on a day-to-day basis, when free roam areas are open to the public. The Refuge would maintain and replant trees and shrubs at four historic sites to provide habitat used by rare and incidental passerines. Interpretive and environmental education features and programs would be the same as Alternative 2.

Welcome and Orientation. Fewer investments would be made to developed welcome and orientation sites under Alternative 3. Some existing developed sites would be upgraded, and picnic tables and shelters would be built at two developed locations, such as Refuge Headquarters and P Ranch.

Hunting. Upland game and waterfowl hunting would be managed similar to Alternative 2, except a Buena Vista waterfowl hunt would not be permitted, and accessible facilities would not be developed. However, a youth hunt opportunity on the State-designated weekend would be explored for the Double-O Unit.

Land Exchange. The Refuge would continue to explore opportunities to exchange portions of Refuge lands west of State Highway 205 and southeast of Krumbo Reservoir (the Boundary Hunt Unit) with BLM.

Fishing. Fishing opportunities would be similar to Alternative 2, but vehicle access along the East Canal to the confluence of Bridge Creek would not be permitted, and a pedestrian crossing at Bridge Creek would not be built. At Krumbo Reservoir, fishing would be managed similar to Alternative 2; however, only walk-in access would be available from November 1 through the fourth Friday of April to provide opportunities for solitude.

Volunteer Program. The volunteer program would be the same as Alternative 2's program.

Cultural and Paleontological Resources. Our protection of the Refuge's cultural and paleontological resources would be strengthened, by developing step-down management plans for historic, prehistoric, archaeological, and paleontological resources and sites. Interpretation of historic sites would be expanded through the development and implementation of site specific interpretive plans. Opportunities for American Indians to collect plant materials for traditional uses would be expanded. Monitoring and inventory of archaeological resources would increase as part of step-down management plan implementation and in conjunction with river rehabilitation plans. Monitoring and inventory will be implemented for paleontological resources as part of the management plan developed for this resource.

Energy Independendence. Efforts to achieve energy independence would be the same as Alternative 2.

Inventory and Monitoring. Efforts to inventory and monitor habitats and species would be the same as Alternative 2.

Actions Common to all Alternatives

All alternatives contain some common features. These are presented below to reduce the length and redundancy of the individual alternative descriptions.

Adaptive Management. The Refuge would be using adaptive management (AM) to implement strategies identified in the CCP. Adaptive management is a science-based public participation process for evaluating and adjusting a conservation effort relative to goal achievement as experience and knowledge are gained through implementation, study, and discussion. The Refuge and its collaborative partners support flexible decision making as outcomes from management actions and other events become better understood. As the CCP is implemented, the Refuge would achieve diverse goals through AM while enhancing wildlife benefits, advancing scientific knowledge, and improving working relationships among stakeholders.

Implementation Subject to Funding Availability. Under each alternative, actions would be implemented over a period of 15 years as funding becomes available. Project priorities are described in Appendix E. The Refuge would continue to work with partners to implement the CCP by sharing science, providing updates on successes and challenges, initiating discussions, encouraging participation, and hosting working groups.

Tribal Coordination. Regular communication and coordination with the Burns Paiute Tribe would continue regarding issues of shared interest. Currently, we coordinate with the Tribe on Native American Graves Protection and Repatriation Act and National Historic Preservation Act issues.

Harney County Court Coordination. We would continue to maintain regular discussions with the Harney County Court as CCP actions are implemented over 15 years.

State Coordination. The Service would continue to maintain regular discussions with the Oregon Department of Fish and Wildlife. Key topics for discussion would include wildlife monitoring, fisheries management, including fish passage and barriers, hunting and fishing seasons and regulations, and the management of species of concern (i.e. sage grouse).

Infrastructure Maintenance to Support Management of Wetlands and Meadows. Efforts to enhance the water management system would be made throughout the life of the CCP, to reflect aquatic health (e.g. carp control) and other habitat management needs and constraints. Actions would be directed by existing water rights, funding opportunities, and Refuge maintenance priorities.

Refuge Fire Management. Fire Management Plans, and accompanying NEPA documents and Endangered Species Act consultations were finalized for the Refuge in 2010. Fire management actions would continue to be guided by the direction set forth in these plans. Prescribed fire would be used in areas where it is the most appropriate tool to achieve habitat goals (e.g. emergent wetlands). Prescribed burns would generally be conducted in late winter to meet litter management objectives, but may be done at other times depending on desired outcomes.

Climate Change. The Refuge staff would participate in and contribute to climate change assessment efforts, including those underway at a landscape scale, such as the Great Basin Landscape Conservation Cooperative (LCC). As needed, objectives and strategies would be adjusted to enhance Refuge resources' resiliency to climate change.

Partnerships. Partnerships would be maintained and/or developed, to enhance collaboration in support of fish and wildlife resources, recreational opportunities, cultural and paleontological resources, and educational programs; and to explore funding opportunities and grants for projects of mutual interest. We would also accomplish common goals through partnerships, promote eco-tourism opportunities, and encourage environmentally friendly development. Workshops and training sessions with professional colleagues and the general public would be conducted to obtain ideas, techniques, and support for Refuge management decisions.

Volunteer Opportunities. Volunteers are key components of the successful management of public lands, and are vital to implementation of Refuge programs, plans, and projects. Volunteer opportunities would be maintained and expanded to best utilize facilities and Refuge staff, and to assist with building partnerships and conducting public outreach. A volunteer management plan would be developed, to address volunteer/staff roles, recruitment and retention of volunteers, volunteer orientation and training, and administration of the Malheur Wildlife Associates.

Transportation Coordination. Roads, bridges and trail systems play a vital role in providing public access to compatible wildlife dependent recreation opportunities. Under all alternatives, the Service would look for opportunities to partner with the Oregon Department of Transportation, BLM's Burns District, and Harney County, to maintain and improve safe and appropriate transportation access in and around the Refuge.

Refuge Revenue Sharing Payments. Annual payments to Harney County under the Refuge Revenue Sharing Program would continue according to the established formula and subject to payments authorized by Congress. Total payments made to the County in recent years are listed in Chapter 5.

Sustainable Practices for Maintaining and Updating Existing Infrastructure. Periodic maintenance and updating of Refuge buildings and facilities would be necessary regardless of the alternative selected. Infrastructure maintenance is necessary for safety and accessibility, and to support staff and management needs, and is incorporated in the Service Asset Maintenance Management System and Environmental Management System. The Refuge would implement green technology and sustainable practices to progress toward energy independent and carbon negative operations.

Endangered Species Act Section 7 Consultations. All projects would be compliant with the Endangered Species Act. Section 7 consultation was not completed programmatically on the CCP. The need for Section 7 consultations for special projects or actions not described in this plan (e.g. management actions related to aquatic health) will be conducted on a case-by-case basis.

Section 106 Compliance. Any new ground-disturbing projects or modifications (e.g. removal of historic water control structures or dams) will undergo a review under Section 106 of the National Historic Preservation Act.

Integrated Pest Management (IPM). In accordance with Department of the Interior and Service policies, an integrated pest management (IPM) approach would be implemented where practicable, to eradicate, control, or contain pests and invasive species (herein collectively referred to as pests) on

Refuge lands. Pesticides may be used where physical, cultural, and biological methods or combinations thereof, are impractical or incapable of providing adequate control, eradication, or containment. We would select IPM methods based on effectiveness, cost, and minimal ecological disruption, including minimum potential effects to nontarget species and the Refuge environment. If we need to use a pesticide on the Refuge, we would identify the most specific (selective) chemical available for the target species, unless persistence or other environmental and/or biotic hazards would preclude it. In accordance with 517 DM 1, pesticide use is restricted to pesticides registered with the U.S. Environmental Protection Agency (EPA), that are in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act, and regulations, orders, or permits issued by EPA.

Environmental harm by pest species is identified as a biologically substantial decrease in environmental quality, indicated by a variety of potential factors including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may result from the direct effects of pests on native species, including preying and feeding on them, causing or vectoring diseases, preventing them from reproducing, killing their young, and out-competing them for food, nutrients, light, nest sites or other vital resources; or hybridizing with them so frequently that within a few generations few if any truly native individuals remain. Environmental harm may also result from an indirect effect of pest species. For example, decreased waterfowl use may result from invasive plant infestations that reduce the availability of native wetland plants used by waterfowl as forage during the winter.

Environmental harm may involve detrimental changes in ecological processes. For example, cheat grass infestations in shrub steppe habitat can greatly alter fire return intervals, which can displace native species and communities of bunch grasses, forbs, and shrubs. Environmental harm may also cause or be associated with economic losses and damage to human, plant, and animal health. For example, invasions of fire-promoting grasses that alter plant and animal communities and eliminate or sharply reduce native plant and animal populations can also greatly increase fire-fighting costs.

See Appendix G for the Refuge's IPM program for managing pests. Appendix G also describes the selective use of pesticides for pest management on Refuge lands where necessary. Throughout the life of the CCP, most proposed pesticide uses on Refuge lands would be evaluated for potential effects to biological resources and environmental quality. These potential effects would be documented in Chemical Profiles. Pesticide uses with appropriate and practical best management practices (BMPs) for habitat management as well as cropland/facilities maintenance would be approved for use on Refuge lands where there would likely be only minor, temporary, and localized effects to species and environmental quality, based on non-exceedance of threshold values in Chemical Profiles. However, pesticides may be used on Refuge lands where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety (e.g., mosquito-borne disease).

Hazard Analysis and Critical Control Point Plan. A Hazard Analysis and Critical Control Points Plan (HACCP) is a tool for natural resource managers to use when identifying critical control points in their activities to decrease the spread of invasive species. The HACCP Wizard Version 2.04 will be used to develop plans for staff, contractors, volunteers and other users of the Refuge to evaluate and conduct their activities in a manner that limits the chance of spreading invasive species.

Water Rights. The right to use water on the Refuge is managed through Oregon's Water Resources Department. Almost all water use on the Refuge has a State-certified water right. The exception is spring water in the Refuge's Double-O Unit which is threatened by groundwater withdrawals in the

area. To protect the habitats and values associated with springs, the Service would take steps to file a groundwater right under all alternatives.

Water Quality. Water quality is addressed through the Oregon Department of Environmental Quality. Refuge-specific water quality guidelines have not yet been established through a formal Total Maximum Daily Load study conducted by the State. Although water quality impairments exist in the Blitzen River before it reaches the Refuge boundary, various studies have indicated a continued increase in temperature and turbidity and a decrease in dissolved oxygen levels within some Refuge water bodies (see Chapter 3) during specific times of the year. Refuge staff would continue to identify and implement best management practices to address water quality.

Blitzen River Water Management. The Refuge would continue to maintain a minimum flow of 25 cubic feet per second (cfs) in the Blitzen River as a minimum flow to benefit aquatic resources.

Research, Monitoring, and Inventory. Refuge staff would continue to work with others to share information and expertise on habitat management, terrestrial and aquatic health, and restoration/rehabilitation techniques. Partnerships with local universities, NGOs, Tribes, State and local agencies, and others would be expanded to conduct research that would advance sound science associated with decision-making on the Refuge.

Malheur NWR State-and-Transition Model. The Refuge would continue to partner with ecologists, wildlife biologists, and scientists from various State and federal agencies and nongovernment organizations to develop the Malheur NWR State-and-Transition Model (STM) to increase our understanding of the Refuge's wetlands. Through the STM we would describe various habitat types along a hydrological gradient and identify the conditions that likely cause transitions between associated plant assemblages. The STM would serve as a roadmap for managing wetlands and uplands toward target habitat conditions and would increase our understanding of the short-term and long-term effects of management treatments on Refuge habitats.

Nonpriority Uses. Nonpriority wildlife-dependent recreational uses would be allowed at the Refuge if found appropriate and compatible. These uses would be allowed under the stipulations identified in Appendix C. Incidental uses such as horseback riding would be permitted only on the Center Patrol Road. Bicycling and cross country skiing would be permitted on all public roads, and pets would be permitted in designated areas. All-terrain vehicle (ATV) use would be limited to the 42-mile Blitzen Valley auto tour route on Center Patrol Road, Buena Vista Lane, the Buena Vista Overlook Access Road, and Krumbo Lane. Special stipulations would apply for ATV use on the Refuge as outlined in Appendix B.

Prohibited activities would include fires, swimming, camping, and collecting natural objects (such as plants, animals, minerals, antlers, etc.), and objects of antiquity. See Appropriate Use Determinations in Appendix A, and Compatibility Determinations in Appendix B, for more information. Such recreational activities not specifically addressed in this document may be allowed on Refuge lands, if the Refuge Manager determines that they are appropriate and compatible.

Predator Control. Although predator control could be justifiable, specific attainable objectives must be determined before conducting predator control. It has been noted, for example, that removing coyotes often leads to an increase in other predator populations such as foxes, raccoons, and mink, which can be even more detrimental to wildlife production. If predator control is deemed necessary during the life of the CCP, the proper public process would be followed. Productivity of select key

avian species would be monitored under the guidance of the Inventory and Monitoring Plan to assess whether the Refuge is serving as a source or sink for local avian populations, and if the Refuge is not serving as a source, management options including manipulation of habitat conditions and predator control would be considered.

Environmental Consequences

Implementation of any one of the three alternatives presented in the CCP/EIS would be expected to cause both beneficial and adverse impacts to Refuge resources, recreation opportunities, and local communities and their economies. The CCP/EIS addresses these impacts, with the majority of discussion and detail focused on impacts that are potentially significant. The following briefly summarizes the various impacts we identified from each of the three alternatives.

Alternative 1

Overall, we anticipate Alternative 1 would have the greatest long-term, adverse impact to the Refuge's fish, wildlife, plants, habitats, recreation opportunities, cultural resources, and wilderness values. These adverse impacts would primarily result from:

- The continued presence of nonnative invasive carp.
- The spread of nonnative invasive plants.
- Impacts to water flow and riparian habitats.
- Impacts to recreation opportunity from the lack of adequate facilities.

Alternative 2

We anticipate Alternative 2 would have the greatest long-term beneficial impacts on the Refuge's fish, wildlife, plants, habitats, recreation opportunities, and cultural resources, primarily as a result of more intensive and aggressive management actions to improve ecological integrity throughout the Refuge. We also anticipate that the same management actions would have a number of short-term, less intensive, adverse impacts. Beneficial impacts would result from:

- Improving the aquatic health of the Refuge's lakes and wetlands, primarily by control of common carp.
- Managing wet meadows and wetland habitats for specified attributes, and initiating comprehensive riverine/wetland strategic planning for watersheds within the Refuge.
- Providing a more developed and structured visitor experience, with additional birding, fishing, and hunting opportunities.
- Protecting and developing historic, cultural, and paleontological resource plans.

Alternative 3

Alternative 3 is expected to result in both adverse and beneficial impacts to a variety of resources. Overall, we anticipate long-term impacts from Alternative 3 would be more beneficial to Refuge resources when compared with Alternative 1, but less beneficial when compared with Alternative 2. Beneficial impacts from Alternative 3 would include improved aquatic ecological integrity from the removal of common carp. Adverse impacts from Alternative 3 would include focusing less on carp removal by making development of a riverine/wetland strategic plan an equal management priority, identifying habitats in transition as the highest habitat management priority; and less development of visitor experiences.

Yellow-headed blackbirdî
©Barbara Wheeler

Chapter 1 Introduction and Background

1.1 Introduction

> *The sedges were full of birds, the waters were full of birds: avocets, stilts, willets, killdeers, coots, phalaropes, rails, tule wrens, yellow-headed black birds, black terns, Forster's terns, Caspian terns, pintail, mallard, cinnamon teal, canvas-back, redhead and ruddy ducks, Canada geese, night herons, great blue herons, Farallon cormorants, great white pelicans, great glossy ibises, California gulls, eared grebes, Western grebes—clouds of them, acres of them, square miles—one hundred and forty-three square miles of them!*
>
> *—Dallas Lore Sharp [1914] remarking on Lake Malheur Bird Reservation*

In the late 1880s, plume hunters decimated North American bird populations in pursuit of breeding feathers for the hat industry. Hunters targeted large flocks of colonial nesting birds and shorebirds, killing birds indiscriminately and orphaning chicks. Eventually, the large numbers of colonial nesting birds on Malheur Lake were discovered by plume hunters. In 1908, wildlife photographers William L. Finley and Herman T. Bohlman discovered that most of the white herons (egrets) on Malheur Lake had been killed in 1898 by plume hunters. After 10 years the white heron population still had not recovered. With backing from the Oregon Audubon Society, Finley and Bohlman proposed establishment of a bird reservation to protect birds using Malheur, Mud, and Harney lakes.

Government lands identified as the Lake Malheur Reservation were set aside on August 18, 1908, by President Theodore Roosevelt using Executive Order No. 929 "as a preserve and breeding ground for native birds." An August 12, 1908 letter to the President from the Secretary of the Interior stated that the purpose and intent was "to preserve the habitat values of the three lakes (Malheur, Mud and Harney Lakes) for migratory waterfowl, and especially, the colonial nesting species."

Decisions made today for refuge management will have far-reaching consequences for the hundreds of species dependent on refuge habitats, as well as for current and future Harney County residents and refuge visitors. This document is a plan for the next 15 years. Planning is a means to an end, and that end is good decisions. We have attempted to think through the critical resources and public use issues carefully, to design a plan that will meet the conservation and recreation challenges of the coming years.

1.2 The Significance of Malheur National Wildlife Refuge

Malheur National Wildlife Refuge (Malheur Refuge, or the Refuge) is situated within the Harney Basin in southeastern Oregon (Map 1). Located in the Northern Great Basin, this portion of the State is lightly populated, generally arid with cold winters, and characterized by wide open spaces.

The Refuge, measuring 187,757 acres, constitutes a small percentage of the Northern Great Basin's total acreage but is a tremendously important source of wildlife habitat relative to other portions of the Northern Great Basin. The Refuge represents a crucial stop along the Pacific Flyway and offers resting, breeding, and nesting habitat for hundreds of migratory birds and other wildlife. Many of the species migrating through or breeding here are highlighted as priority species in national bird conservation plans.

Historical bird counts show that the Refuge and the Silvies River floodplain just north of the Refuge may support anywhere between 5 and 66 percent of the Pacific Flyway's migrating populations for various priority waterfowl. On the Refuge, breeding habitat is significant for waterbirds, with the Refuge currently supporting over 20 percent of the Oregon population of breeding greater sandhill cranes (*Grus canadensis tabida*). Most colonial waterbird numbers have easily exceeded 10 percent of the regional population at peak, even reaching up to 77 percent of the Great Basin population for certain species. Numbers of migrating shorebirds have been documented at levels high enough to qualify the Refuge as a Regional Western Hemispheric Shorebird Reserve. The Refuge also supports very high densities of certain nesting riparian passerines and the largest local population of bobolinks (*Dolichonyx oryzivorus*) in the western U.S.

In addition to these biological values, the Refuge is well-loved by its visitors, many of whom return year after year. The Refuge is cherished for its excellent birding, the opportunity to find solitude in a remote, open landscape, its many historic remnants and geologic sites of interest, and its proximity to an Oregon landmark, Steens Mountain. The Refuge has strong historic ties to local residents as an important contributor to local economies. Far-flung communities of birders also feel a strong connection to the Refuge, with awareness that the Audubon Society played a pivotal role in its initial establishment. Both local and distant communities will continue to play a large role in the Refuge's future.

Challenges for maintaining and enhancing these biological and social values are explored below. Further information regarding the area's physical environment, biological resources, and public use patterns are found in Chapters 3, 4 and 5 of this document.

1.3 Proposed Action

The U.S. Fish and Wildlife Service (USFWS or the Service) is proposing to adopt and implement a comprehensive conservation plan for Malheur National Wildlife Refuge, located in the Northern Great Basin of southeast Oregon in Harney County. This document is a comprehensive conservation plan and environmental impact statement (CCP/EIS) for the Refuge. The CCP sets forth management guidance for the Refuge over the next 15 years, as required by the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee as amended by the National Wildlife Refuge System Improvement Act of 1997). The Improvement Act (P.L. 105-57) mandated that CCPs be developed for all refuges in the National Wildlife Refuge System.

The proposed action in the CCP/EIS is to implement Alternative 2, which has been identified as the Service's Preferred Alternative. This document explores two other options (alternatives) for the CCP and discloses anticipated effects for each alternative, pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321-4347). Alternatives are presented in Chapter 2, and effects are analyzed in Chapter 6. Appendices provide supporting information.

The goals, objectives, and strategies under Alternative 2 best achieve the purpose and need for the CCP while maintaining a balance among the varied management needs and programs. Alternative 2 addresses the issues and relevant mandates and is consistent with principles of sound fish and wildlife management.

The Preferred Alternative may be modified between the draft and final documents depending upon comments received from the public or other agencies and organizations. The Regional Director for

the Service's Pacific Region will decide which alternative will be adopted for implementation. For details on the specific components and actions constituting the range of alternatives, see Chapter 2.

1.4 Purpose and Need for Action

The purpose of the CCP is to provide consistent, reasonable, scientifically grounded guidance. This guidance will ensure that, over the next 15 years, the Refuge will:

- protect, maintain, and enhance lake, in-stream, riparian, marsh, meadow, and upland (sagebrush steppe, basin big sagebrush islands, salt desert scrub) habitats, for the benefit of migratory and breeding birds and a diverse assemblage of other native species;
- protect and maintain rare, unique, and special habitats at Malheur Refuge, including cliffs, rimrock, lava flows, cold and hot springs, dunes, and playas for the benefit of migratory and breeding birds and a diverse assemblage of other native species;
- contribute to the conservation, protection, and recovery of rare species, including any federally listed or candidate species, State sensitive species, and other priority species (Appendix E);
- provide compatible wildlife-dependent recreation opportunities for visitors, fostering an appreciation and understanding of the Refuge's fish, wildlife, plants, and their habitats;
- adequately inventory, protect, restore, and interpret the Refuge's unique cultural, historical, and paleontological resources;
- gather scientific information to contribute to better decision making and monitor environmental change; and
- actively engage in off-refuge collaborative conservation efforts.

The CCP is needed for a variety of reasons. These reasons consist of the need to:

- review the contribution of the Refuge to Flyway and landscape goals for migratory and breeding birds and other priority species, to assess current management strategies in light of these goals, and to recommend appropriate actions to ensure that the Refuge will provide the quantity and quality of habitats necessary for meeting these goals;
- review the Refuge's water system operations and infrastructure in relation to all habitats and identify needs related to providing water for priority species;
- maintain a consistent management plan and direction regardless of refuge staff changes;
- effectively address the problem of the spread and expansion of invasive species, such as carp and perennial pepperweed, across a wide range of habitats;
- improve degraded habitat conditions;
- properly prescribe the use of tools such as haying, grazing, crop cultivation, and burning in the creation and maintenance of desired habitat conditions;
- ensure that neither refuge management activities, including habitat management and administrative activities, nor public uses result in damage or loss of irretrievable cultural and paleontological resources;
- assist in cultivating strong relationships with partners such as the Burns Paiute Tribe, other governments, refuge neighbors, and various nongovernmental organizations;
- determine what improvements or alterations should be made in the "Big Six" Refuge System wildlife-dependent uses (wildlife observation, wildlife/nature photography, environmental

education, interpretation, hunting, and fishing) or other programs and services offered to refuge visitors; and
- increase the energy efficiency and sustainability of refuge operations.

1.5 Legal and Policy Guidance

The Refuge is managed as part of the National Wildlife Refuge System and must adhere to various legal and policy guidelines. In developing a CCP, the planning team considers the various laws, regulations, agency missions and policies, and ecosystem goals, together with the Refuge's purpose and refuge-specific issues and goals. The broader mandates that apply to each refuge are explained and described in this section.

1.5.1 The U.S. Fish and Wildlife Service

All refuges are managed by the U.S. Fish and Wildlife Service, an agency within the Department of Interior. The Service is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people.

U.S. Fish and Wildlife Service Mission: The mission of the U.S. Fish and Wildlife Service is "working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people." National natural resources entrusted to the Service for conservation and protection include migratory birds, endangered and threatened species, interjurisdictional fish, wetlands, and certain marine mammals. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with state fish and wildlife programs, and helps other countries develop wildlife conservation programs.

1.5.2 National Wildlife Refuge System

The 150-million-acre National Wildlife Refuge System (Refuge System, NWRS) encompasses 551 National Wildlife Refuges, thousands of small wetlands and other special management areas. The Refuge System is the world's largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to encompass refuges in all 50 states and waterfowl production areas in 10 states. More than 36 million visitors annually fish, hunt, observe and photograph wildlife, or participate in environmental education and interpretive activities on National Wildlife Refuges.

The needs of wildlife and their habitats come first on refuges, in contrast to other public lands that are managed for multiple uses. Refuges are guided by various Federal laws and executive orders, Service policies, and international treaties. Fundamental are the mission and goals of the Refuge System and the designated purposes of the refuge unit as described in establishing legislation, executive orders, or other documents establishing, authorizing, or expanding a refuge.

National Wildlife Refuge System Mission and Goals: The mission of the Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United

States for the benefit of present and future generations of Americans" (16 U.S.C. 668dd-668ee, as amended).

The goals of the National Wildlife Refuge System, as articulated in the Mission, Goals, and Purposes Policy (601 FW 1) are to

- conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;
- develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life-history needs of these species across their ranges;
- conserve those ecosystems, plant communities, wetlands of national or international significance and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;
- provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); and
- foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

National Wildlife Refuge System Administration Act: Key concepts and guidance of the Refuge System derive from the National Wildlife Refuge System Administration Act of 1966 as amended (16 U.S.C. 668dd-668ee). Of all the laws governing activities on National Wildlife Refuges, the Refuge Administration Act undoubtedly exerts the greatest influence. The National Wildlife Refuge System Improvement Act (Improvement Act; P.L. 105-57) amended the Refuge System Administration Act in 1997 by including a unifying mission for all National Wildlife Refuges as a system, a new process for determining compatible uses on refuges, and a requirement that each refuge will be managed under a CCP, to be developed in an open public process.

The Refuge Administration Act states that the Secretary of the Interior shall provide for the conservation of fish, wildlife and plants, and their habitats within the System as well as ensure that the biological integrity, diversity, and environmental health of the System are maintained. House Report 105-106 accompanying the Improvement Act states that "the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first." Biological integrity, diversity, and environmental health are critical components of wildlife conservation. As later made clear in the Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3), "the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions."

Under the Refuge Administration Act, each refuge must be managed to fulfill the Refuge System mission as well as the specific purposes for which it was established. The Refuge Administration Act requires the Service to monitor the status and trends of fish, wildlife, and plants in each refuge.

"Big Six"

The six wildlife-dependent recreational uses identified under the Refuge System Improvement Act are hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses are to receive enhanced consideration over other uses in planning and management.

Additionally, the Refuge Administration Act identifies six wildlife-dependent recreational uses for the Refuge System. These uses are hunting, fishing, wildlife observation and photography, environmental education and interpretation. Under the Refuge Administration Act, the Service is to grant these six wildlife-dependent public uses special consideration in the planning for, management of, and establishment and expansion of units of the National Wildlife Refuge System. When determined compatible on a refuge-specific basis, these six uses assume priority status among all uses of the refuge in question. The Service is to make extra efforts to facilitate priority wildlife-dependent public use opportunities.

When preparing a CCP, refuge managers must re-evaluate all general public, recreational, and economic uses (even those occurring to further refuge habitat management goals) proposed or occurring on a refuge for appropriateness and compatibility. No refuge use may be allowed or continued unless it is determined to be appropriate and compatible. Generally, an appropriate use is one that contributes to fulfilling the refuge purposes, the Refuge System mission, or goals or objectives described in a refuge management plan. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. Updated appropriate use and compatibility determinations for existing and proposed uses for Malheur National Wildlife Refuge are in Appendices A and B of this Draft CCP/EIS.

The Refuge Administration Act also requires that, in addition to formally established guidance, the CCP must be developed with the participation of the public. Issues and concerns articulated by the public play a role in guiding alternatives considered during the development of the CCP and together with other formal guidance, can play a role in selection of the preferred alternative. It is Service policy that CCPs are developed in an open public process and that the agency is committed to securing public input throughout the process. Appendix J of the Draft CCP/EIS details public involvement that has been undertaken during the CCP process.

1.5.3 Other Laws and Mandates

Many other laws govern the U.S. Fish and Wildlife Service and Refuge System lands. Examples include the Migratory Bird Treaty Act of 1918, Refuge Recreation Act of 1962, National Historic Preservation Act of 1966, and the Endangered Species Act of 1973. For additional information, a list and brief description of laws of interest can be found at http://www.fws.gov/laws/Lawsdigest.html.

All laws that pertain to the National Wildlife Refuge System are implemented through regulations covering the National Wildlife Refuge System, published in Title 50, subchapter C of the Code of Federal Regulations (50 C.F.R. 401-453). These regulations govern general administration of units of the Refuge System.

The Refuge System also maintains and updates a Refuge System manual, which elaborates upon these laws and regulations and provides further policy and guidance for the Refuge System. Over the last few years, the Service has developed or revised numerous policies and Director's Orders to reflect the mandates and intent of the Improvement Act. Some of these key policies include the Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3); the Compatibility Policy (603 FW 2); the Comprehensive Conservation Planning Policy (602 FW 3); Mission, Goals, and Purposes (601 FW 1); Appropriate Refuge Uses (603 FW 1); Wildlife-dependent Public Uses (605 FW 1); Wilderness-related Policies (610 FW 1-5); and Coordination and Cooperative Work

with State Fish and Wildlife Agencies (601 FW 7). These policies and others in draft or under development can be found at http://refuges.fws.gov/policymakers/nwrpolicies.html.

1.5.4 Summary Hierarchy of Guidance

In developing a CCP, a refuge must consider the various broader laws, regulations, missions, goals, and policies. The CCP must be consistent with these and also with the refuge's purpose, when addressing refuge-specific issues and goals. Figure 1-1 illustrates the hierarchy of planning guidance for refuges.

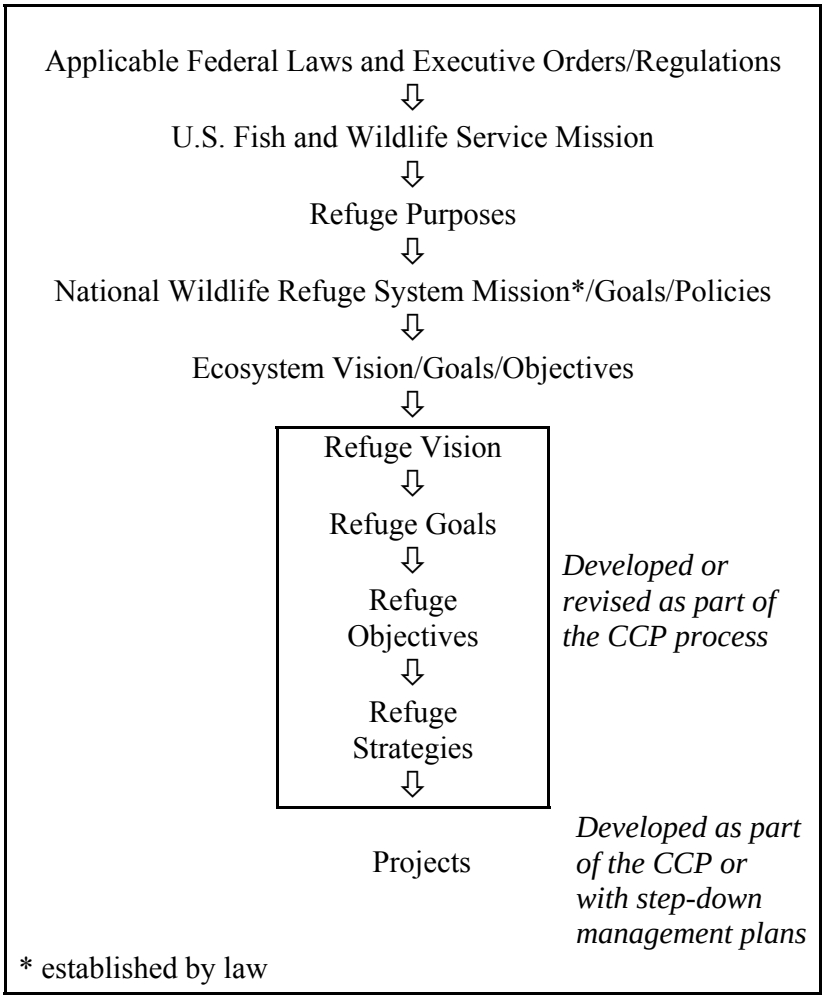

Figure 1-1. Hierarchy of guidance within the National Wildlife Refuge System.

1.6 Refuge Establishment and Purposes

1.6.1 Legal Significance of the Refuge Purpose

The purpose for which a refuge was established or acquired is of key importance in refuge planning. Purposes must form the foundation for management decisions. The refuge purposes are a driving

force in the development of the refuge vision statements and goals in a CCP and are critical to determining the compatibility of existing and proposed refuge uses.

The purposes of a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit.

Unless the establishing law, order, or other document indicates otherwise, purposes dealing with the conservation, management, and restoration of fish, wildlife, and plants, and the habitats on which they depend take precedence over other purposes in the management and administration of any unit. Where a refuge has multiple purposes related to fish, wildlife, and plant conservation, the more specific purpose will take precedence in instances of conflict.

Refuges often consist of units that were acquired at different times and under different authorities. The original establishing purpose applies to each and every unit of a refuge, regardless of when it was acquired. When an additional unit is acquired under an authority different from the authority used to establish the original unit, the addition takes on the purpose of the original unit, but the original unit does not take on the purpose of the addition.

By law, refuges are to be managed to achieve their purposes. When a conflict exists between the Refuge System mission and the purpose of an individual refuge, the refuge purpose may supersede the Refuge System mission.

1.6.2 Purpose and History of Refuge Establishment

Malheur Refuge encompasses three main units that were established at different times. The following discussion is organized by these units. The purposes are also summarized at the end of the discussion.

Malheur, Mud, and Harney Lakes

When the Refuge was established in 1908, Euro-Americans had been living on homesteads and ranches in the area for nearly 40 years. As is common elsewhere in the arid west, access to water was the determining factor for settlement. However, the shifting shorelines of Malheur, Mud, and Harney lakes, combined with an absence of legal surveys, created a situation where ownership boundaries and governmental authorities were ambiguous. Homesteaders and ranchers competed for control over riparian areas and water, essential to livelihood in these arid regions. Ownership rights were legally murky because Oregon had not codified its water law and because the boundary between “land” and “riparian areas” is fluid (Langston 2003). As a result, the early years of settlement (prior to and after refuge establishment) were marked by prolonged legal wrangling among the Federal and State governments and private landowners over authorities and ownership lines. The following discussion includes some of the legal history that occurred as these issues were resolved.

In 1895, no wildlife refuges existed anywhere in the nation. During this year, in response to several court cases disputing land title and the legal doctrines governing water and riparian use, the U.S. government initiated survey of a meander line around Malheur, Mud, and Harney lakes. Known as the Neal Survey, it established a legal boundary between lands held in private ownership and those lands and waters held by the government as public domain lands. The meander line helped to distinguish land acquired under a homestead claim from surrounding lands held in ownership by the

Federal government. A 1901 U.S. Supreme Court ruling, *Marshall v. French*, determined that Marshall's homestead claim on Malheur Lake, which straddled the meander line, had been made on lands within the public domain rather than lands claimed by the French-Glenn Livestock Company, thus settling a dispute between the two landowners. This decision by the Supreme Court provided a legal basis for the President to declare unclaimed lands around the lakes as Federal property when the Refuge was established.

As described in Section 1.1, plume hunters wreaked havoc on Malheur Lake, decimating its waterbird colonies by 1898. Wildlife photographers William L. Finley and Herman T. Bohlman documented the destruction and observed only limited recovery on the lake even after 10 years. They, in concert with the Oregon Audubon Society, petitioned the Federal government for establishment of a bird reservation on the lakes.

Government lands within the Neal Survey line were set aside on August 18, 1908, by President Theodore Roosevelt using Executive Order No. 929 "as a preserve and breeding ground for native birds." A letter dated August 12, 1908, to the President from the Secretary of the Interior stated that the purpose and intent was "to preserve the habitat values of the three lakes for migratory waterfowl, and especially, the colonial nesting species." The new Lake Malheur Reservation[1] purportedly encompassed 81,786 acres around the lakes but was unsurveyed at the time of establishment and the exact acreage for the new reservation was not known.

In 1916, the State of Oregon filed a claim for title to Malheur Lake as part of an effort to reclaim wetlands for agricultural purposes. The State argued that it had legal jurisdiction over lands within the meander line of all navigable bodies of water within the state, including Malheur Lake. In 1935, the Supreme Court, using the decision in *Marshall v. French*, upheld a lower court ruling that the State did not have title under its navigability claim and that the United States had not abandoned any lands by issuing patents. However, the Court also ruled that homestead claims on Malheur, Mud, and Harney lakes still needed to be reviewed and settled before the Federal government could take possession. The Federal government made offers to buy out the homesteads, but a "fair" price for inholdings could not be agreed upon.

In the interim, President Herbert Hoover issued Executive Order No. 5891 on July 16, 1932, which temporarily withdrew all public lands around Malheur and Harney lakes for classification as to their suitability for migratory bird refuge purposes. Plot locations but not exact acreages were identified. On June 1, 1933, President Franklin D. Roosevelt issued Executive Order No. 6152, which withdrew additional public lands west of Harney Lake and in the Silver Lake area for a similar suitability study.

In June 1934, Executive Order No. 6724, Declaration of Taking, provided funds under the "Emergency Conservation Fund (transfer from War to Agriculture—Act of March 31, 1933-March 31, 1935)" known as the $10,000,000 fund for the purchase of 3,845.84 acres below the Neal meander line from willing sellers on Malheur, Mud, and Harney lakes.

During the Great Depression years, drought hit the area and lake levels receded with decreased precipitation, As a result, adjacent landowners increased their agricultural practices on the newly

[1] The original name "The Lake Malheur Reservation" was changed to Malheur Migratory Bird Refuge on July 19, 1935. On July 25, 1940, Presidential Proclamation No. 2416 officially changed the name from Malheur Migratory Bird Refuge to Malheur National Wildlife Refuge.

exposed land. In December 1936, the U.S. filed suit against landowners claiming ownership of lands inside the meander line. The Ninth Circuit Court of Appeals ruled in favor of the private landowners but did not attempt to apportion the lands among the individuals involved, so the Federal government continued to administer the lake area (including the exposed areas now farmed by settlers) as a waterfowl refuge.

In 1937, the U.S. government asked that Malheur Lake be placed in receivership (i.e., administered by an uninterested third party) until all land within the meander line was purchased or condemned. The courts complied and a receiver appointed by the court regulated, by permit, the use of lakebed lands by adjacent landowners. Funds received from economic permits on the Refuge were held by a court-appointed receiver until 1940, when the receivership was dissolved after another court ruling upheld the ruling of private ownership.

In an attempt to hasten some sort of court action that would define ownership boundaries within the meander line of Malheur Lake, a presidential proclamation was sought to close the lake to economic use. Proclamation No. 2516, dated October 1, 1941, "closed all lands within the Meander Line of Malheur and Harney Lakes and the streams and waters connecting said lakes to the taking, capturing or killing, or attempting to take, capture, or kill migratory birds." A modification of the hunting closure on Malheur Lake came via Presidential Proclamation No. 2818 (in 1948). This proclamation made it possible to open portions of the lake to hunting (approximately 4,241 acres). Proclamation No. 2859 (in 1949) redefined those areas closed to hunting and again expanded the portion of the lake open to hunting. The hunting area was increased a third time by order of the Secretary of Interior on October 21, 1953. The remainder of the original refuge area established in 1908 remained closed to hunting until November 19, 1982. On that date, the proclamation closures were eliminated and now no longer serve as a legal constraint to waterfowl hunting (USFWS 1985).

In April 1944, the Oregon U.S. District Court ruled in the case of the *United States v. Malheur Lake Property Owners*. The ruling found that 1) the original Neal Survey meander line was a valid survey of the lake boundary; 2) Executive Order No. 929 establishing Malheur Lake Reservation was valid; and 3) the patentees of lands through which the Neal Survey line passed or bounded did have property rights that extended to the center of Malheur Lake. The court also defined the exact location of the centerline of the lake, which generally ran east-west through the lakebed. The boundaries of the tracts claimed by the defendants were specifically laid out and designated as legally owned private tracts. The court decreed that 23,947.10 acres were held in private ownership, and 23,913.30 acres were in government ownership. It also ruled the government should compensate those landowners for use and occupation of the defendants' land since January 1937. No specific amount was set for compensation.

In September 1944, the Migratory Bird Conservation Commission approved the acquisition of all of the privately owned lands within the meander line of Malheur Lake. Negotiations were undertaken in the hopes of reaching price agreement with the owners of this property, but this effort failed. Negotiations continued and agreements were finally reached for the purchase of 13,003.84 acres. In January 1945, the Secretary of the Interior requested that condemnation proceedings be filed for the remaining 10,943.26 acres of privately owned property within the lakebed of Malheur Lake.

In 1947, Federal condemnation hearings were held in Burns for the remaining tracts on Malheur Lake. The Federal government had offered $10 per acre for similar tracts on the lake and the defendants, using testimony from similar hearings in the Klamath Falls area, felt that the value should be $100 per acre. The court accepted the value of $100 per acre, and the government dropped

their condemnation proceedings. The Refuge negotiated with the remaining landowners over the next nine years and through purchase or exchange managed to acquire the remaining lakebed lands within the Neal Survey meander line of Malheur Lake.

Public Land Order (PLO) No. 1511 on September 24, 1957 revoked Executive Orders 929, 5891, and 6152 and amended Executive Order 7106:

> Executive Order No. 7106 of July 19, 1935, establishing the Malheur Migratory Bird Refuge which was redesignated the Malheur National Wildlife Refuge by Proclamation No. 2416 of July 25, 1940, is hereby amended by eliminating from the first paragraph thereof the words "and in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" … Subject to valid existing rights, the following-described public lands in Harney County, Oregon, are hereby withdrawn from all forms of appropriation under the public-land laws, including the mining but not the mineral leasing laws, and reserved under the jurisdiction of the Bureau of Sport Fisheries and Wildlife of the Department of the Interior as an addition to the Malheur National Wildlife Refuge.

The legal description of an additional 18,017.54 acres was included in this PLO and added to the 22,016.54 acres of public land that was originally withdrawn by Executive Orders No. 5891 and No. 6152.

The PLO withdrew lands of the public domain from all forms of appropriation under public land laws, including homesteading, desert land, and small mining, but not the mineral leasing laws, and reserved those lands solely under the jurisdiction of the Bureau of Sport Fisheries and Wildlife (now known as the U.S. Fish and Wildlife Service). In total, 40,034.08 acres around Malheur and Harney lakes were withdrawn from the public domain under this PLO.

Between 1978 and 1983, three additional tracts were added to the Refuge. The 1,518-acre Hill Tract just west of Refuge Headquarters was the last large portion of lakebed to be acquired and was purchased in 1978. A 1981 exchange involved acquisition of 480 acres on Harney Lake for 950.36 acres in the Kern Reservoir area above Krumbo Reservoir. In 1983, 80 acres of lakebed within the meander line on the north side of Malheur Lake was exchanged for 120 acres above the meander line. PLO No. 6470 was issued by the Secretary of the Interior on September 26, 1983. The order transferred 199.9 acres on the east side of Malheur Lake from the jurisdiction of the Bureau of Land Management (BLM) to the Service.

A 2,462-acre inholding on Mud Lake was acquired in 1984 in exchange for 1,042 acres of refuge land in the Diamond Swamp area. Acquisition of the Mud Lake property would allow the Refuge to better manage the flow of water and lands of the Dunn Ranch (Mud Lake area) to benefit migratory birds, which are the primary management concern for the Refuge.

In exchange for 277 acres of refuge land in the Diamond Swamp area deemed to have low wildlife value, 360 acres of private land in the center of Mud Lake were acquired in 1999. The final acquisition in the 1990s was the divestment, in 1999, of 28 acres north of Frenchglen to the State of Oregon for part of a 904-acre parcel on Mud Lake; the remainder of the acreage was acquired through purchase. The last two acquisitions would protect wetland habitat and help to maintain or improve water quality in Mud, Harney, and Malheur lakes, while consolidating an irregular boundary.

A 240-acre parcel on the southeast side of Mud Lake was donated to the Refuge in 1994 by the Hunt family. In 1998, the 362-acre Opie parcel on the north side of Malheur Lake in the vicinity of Lawen was purchased using Migratory Bird Conservation Commission funds to support wildlife-dependent uses and to protect wetland habitat and Malheur Lake water quality.

Land acquisitions between 2000 and 2003 focused on property on the south side of Malheur Lake. Migratory Bird Conservation Commission funds were used to purchase 280 acres on the southwest side of the lake to protect wetland habitat and Malheur Lake water quality. Migratory Bird Conservation Commission funds were again used to purchase 702.78 acres on the south side of Malheur Lake in 2001. A 2003 exchange and purchase of 267 acres on the south side of Malheur Lake for 193 acres in the Diamond Swamp vicinity was the most recent land acquisition. The last two acquisitions were made to protect wetland habitat; help to maintain or improve water quality in Mud, Harney, and Malheur lakes; and consolidate an irregular boundary.

The Blitzen Valley

The cyclical trends of drought and flood in the Great Basin were made dramatically apparent when Malheur Lake dried up in the early 1930s. Recognizing that the lake could not be viewed in isolation from its primary sources (the Donner und Blitzen River and the Silvies River), William L. Finley again played an integral role in the Refuge's history by championing purchase of the Blitzen Valley as an addition to the Refuge. Control of the valley meant control of the Blitzen River and control of the river allowed the reservation to restore water to the lakes (which were dry as a result of the drought) by releasing water held behind ranch dams. The addition of the Blitzen Valley was aimed at acquiring the water rights held in private ownership for waters flowing from Steens Mountain and ultimately ending in Malheur Lake.

The 64,717-acre Blitzen Valley portion of the Refuge was acquired from the Eastern Oregon Land and Livestock Company for $675,000 on February 21, 1935 using funds made available pursuant to the provisions of the *Act for the Relief of Unemployment through the Performance of Useful Public Work* (48 Stat. 22) and the National Industrial Act (48 Stat. 195). The Blitzen Valley addition was formally added to the Lake Malheur Reservation under Executive Order No. 7106 signed by President Franklin D. Roosevelt on July 19, 1935. The order specified that the land was for use "as a refuge and breeding ground for migratory birds and other wildlife." At the same time, the name of the reserve was changed to Malheur Migratory Bird Refuge.

An additional 1,125.20 acres of Blitzen Valley land held in private ownership was purchased in 1936 with funds made available by the N.I.R., Agriculture, Wildlife Refuges Fund, known as the $6,000,000 fund. This fund conferred migratory bird purposes for lands (Castineira 2010).

PLO No. 4661 was issued by the Secretary of the Interior on April 16, 1969. In this PLO, 4,021.14 acres of small tracts of scattered uplands above the Blitzen Valley, acquired as part of the Eastern Oregon Land and Livestock Company Blitzen Valley acquisition, were deemed to have limited wildlife value and were relinquished to BLM jurisdiction.

Other additions to the Refuge were made in the 1990s. In 1997, a 225-acre parcel at the south end of the Blitzen Valley was purchased with funds reprogrammed from the land acquisition fund for San Francisco Bay National Wildlife Refuge. This parcel was acquired for use as an administrative area for operations at the south end of the Blitzen Valley; moving operations at the P Ranch to a less public location. A 320-acre tract inholding in the Dunn Dam vicinity of the Blitzen Valley was

acquired in 1998 under the authority of the Migratory Bird Conservation Commission Act of 1929 (as amended).

Double-O

The Double-O Unit was added to the Refuge in 1941. The deepening nationwide Depression and the ongoing drought forced reductions in the number of cattle the land could support. The Hanley family sold 14,517.89 acres at the Double-O to the U.S. government for addition to the Refuge under authority of the Migratory Bird Conservation Commission Act of 1929 (as amended) for $116,143 as "a reservation for migratory birds."

Summary of Refuge Purposes

- "a refuge and breeding ground for migratory birds and other wildlife" Executive Order No. 7106, dated July 19, 1935, as modified by PLO No. 1511, dated September 24, 1957.
- "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" 16 U.S.C. 715d (Migratory Bird Conservation Act).
- "for the development, advancement, management, conservation, and protection of fish and wildlife resources" 16 U.S.C. 742f(a)(4).
- "for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude" 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).
- "conservation, management, and … restoration of the fish, wildlife, and plant resources and their habitats … for the benefit of present and future generations of Americans" 16 U.S.C. 668dd(a)(2) (National Wildlife Refuge System Administration Act).

1.6.3 Land Status and Ownership

Table 1-1. Malheur Refuge Acreage by Type of Acquisition

Type of Acquisition	Acres
Acquired by purchase, willing seller	43,665.57
Acquired by purchase, condemnation (E.O. No. 6724)	5,070.39
Acquired by purchase (Blitzen Valley Project)	64,713.54
Acquired by exchange	12,287.73
Withdrawn from public domain	73,222.07
Acquired by donation	240
Out of fee title by exchange/sale/transfer	*-11,442.76*
Total	**187,756.54**

Source: USFWS 2011.

1.7 Relationship to Other Plans and Assessments

1.7.1 Previous and Future Refuge Plans

Previous Refuge Plans: Several previous comprehensive planning efforts have guided decisions and operations at Malheur Refuge. In the early 1980s, under the leadership of Joe Mazzoni and George Constantino, the Master Plan was developed (USFWS 1985), which outlined major "outputs" of the Refuge (both wildlife and public use), and outlined wildlife, public use, and land/water management strategies by refuge unit. It replaced the former Master Plan Technical Report, prepared in March 1965.

Unit-specific five-year plans were prepared subsequent to the completion of the Master Plan. The Blitzen Valley Management Plan (USFWS 1990) was signed by then-Refuge Manager Forrest Cameron. The focus of this document was to improve the Blitzen Valley's ability to meet migratory bird production objectives as outlined in the 1985 Master Plan. With the selection of seven focal species, this plan, and focused primarily on water management, carp, predator, and vegetation management issues. Prescriptions in the plan were documented for six units delineated within the Blitzen Valley.

Similarly, the Double-O Habitat Management Plan (David and Ivey 1995) was a step-down management plan. While less detailed than the Blitzen Valley Management Plan, it outlined major actions to be pursued within the unit.

Future Refuge Planning: The CCP will be revised every 15 years or earlier if monitoring and evaluation determine that changes are needed to achieve refuge purposes, vision, goals, or objectives. The CCP provides guidance in the form of goals, objectives, and strategies for refuge program areas but may lack some of the specifics needed for implementation. Step-down management plans will therefore be developed for individual program areas, as needed, following completion of the CCP. Step-down plans require appropriate NEPA compliance.

1.7.2 Ecosystem Plans and Assessments

When developing a CCP, the Service considers the goals and objectives of existing national, regional, state, and ecosystem plans and/or assessments. The CCP is expected to be consistent, as much as possible, with existing plans and assist in meeting their conservation goals and objectives (602 FW 3). This section summarizes some of the key plans reviewed by members of the core team (Appendix I) while developing the CCP.

Migratory Birds

Birds of Conservation Concern: The 1988 amendment to the Fish and Wildlife Conservation Act mandates the USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973." Based on the efforts and assessment scores of three major bird conservation efforts (Partners in Flight, the U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan), this report (USFWS 2008) identifies, by Bird Conservation Region (BCR), the bird species most in need of conservation attention. Waterfowl game species covered by the North American Waterfowl Management Plan are excluded from the

list. Malheur Refuge is located within BCR Region 9, for which 28 species are listed. The list includes two waterbirds, three shorebirds, and several raptors. The rest are upland or riparian associated species.

Partners in Flight (PIF): The primary goal of the Conservation Strategy for Landbirds in the Columbia Plateau of Eastern Oregon and Washington (Altman and Holmes 2000) is to ensure long-term maintenance of healthy populations of native landbirds. Focal species and habitat objectives for habitat types present at the Refuge, including riparian shrub, cliffs and rimrock, steppe-shrubland, sagebrush, shrublands, and juniper-steppe. Malheur Refuge is targeted in this plan as important for two focal species: yellow-billed cuckoo and bobolink.

North American Waterfowl Management Plan: This plan, first formulated in 1986, provides a strategy to protect North America's remaining wetlands and to conserve waterfowl populations through habitat protection, restoration, and enhancement. The plan was updated in 2004 with an emphasis on strengthening the biological foundation, using a landscape approach, and expanding partnerships. The 2004 update contains species-specific population objectives and evaluations of whether the continental population is currently short or over the target. There are also flyway goals for production by species, but the plan did not target population objectives for wintering or migratory waterfowl by area (North American Waterfowl Management Plan 2004). Implementation of this plan is accomplished at the regional level by partnership, within 11 Joint Venture areas. Malheur Refuge is located within the area of the Intermountain West Joint Venture.

Pacific Flyway Plans: Flyway management plans are the products of Flyway Councils, developed to help State and Federal agencies cooperatively manage migratory game birds. Several flyway management plans pertain to Malheur Refuge, but specific management objectives are not identified for the Refuge in these plans. Species that occur on the Refuge and are identified in these plans as important are:

- Pacific population of western Canada geese (Subcommittee on Pacific Population of Western Canada Geese 2000)
- Wrangel Island population of lesser snow geese (Pacific Flyway Council 2006)
- Rocky Mountain population of trumpeter swans (Pacific Flyway Study Committee)

Intermountain West Regional Shorebird Management Plan: This plan (Oring et al. 2000) notes that perhaps a million shorebirds breed in the Intermountain West and that millions more migrate through the area each year. The plan recognizes that finding ample high-quality fresh water will be the greatest challenge faced by shorebirds in the Intermountain West. The regional plan articulates seven goals and associated objectives and strategies related to habitat management, monitoring and assessment, research, outreach and planning. The Harney Basin is recognized as a Key Shorebird Area. High priority species found in eastern Oregon include 10 of the 13 species in the Intermountain West with scores of 4 or 5 in the plan's species scoring process. These high priority species include snowy plover, black-necked stilt, American avocet, willet, long-billed curlew, marbled godwit, western sandpiper, least sandpiper, long-billed dowitcher, Wilson's phalarope and red-necked phalarope.

Intermountain West Joint Venture Coordinated Implementation Plan for Bird Conservation in Eastern Oregon: This plan (Oregon Habitat Joint Venture 2005) identified important habitat types for bird conservation, including flood-irrigated pastures and hay meadows, alkaline wetlands, emergent marsh, wet meadows, and riparian shrub are identified to provide a strategic framework for

site-specific habitat protection and restoration projects within the priority areas in eastern Oregon. The plan recommends specific acreage figures in the Harney Basin for the following habitat types:

- Grassland: 3,000
- Sagebrush steppe: 5,000
- Playa vernal pool: 20,000
- Pasture-hay: 70,000
- Alkaline wetlands: 20,000
- Emergent marsh: 40,000
- Wet meadow: 30,000
- Riparian shrub: 2,000

Oregon Closed Basin: Wetlands Implementation Plan (Ivey 2000): This plan recommends objectives and strategies related to conservation of wetlands for the Oregon Closed Basin, the Oregon portion of the Northern Great Bain. This plan has several key recommendations:

- Improve water delivery system to enhance efficiency and flexibility of irrigation and wetland management strategies.
- Protect at least an additional 10,000 acres through acquisition of lands from willing sellers.
- Improve passage and screening facilities to enhance the Blitzen River and tributaries for Great Basin redband trout and other native fishes.
- Use fishways, traps, and screens to limit common carp migration into the Blitzen River and Double-O Unit to enhance productivity of wetlands and other aquatic habitats.
- Enhance 30 miles of in-stream riparian habitat in the Blitzen River and tributaries for redband trout and other native fish and wildlife. Improve 40 miles of Blitzen River and Bridge Creek channels to restore more natural hydrology and improve water quality.
- Improve water management capabilities in 1,100 wetland acres of the Double-O Unit to allow better wetland management and carp control.
- Enhance wetlands by improving brood ponds to reduce predation on breeding waterfowl and waterbirds.
- Control invasive exotic plants on 30,000-40,000 acres and develop strategies to prevent future introductions.

State Plans

Oregon Conservation Strategy (OCS): This document, authored by the Oregon Department of Fish and Wildlife (ODFW 2006) is an overarching strategy for conserving fish and wildlife within Oregon. The Strategy identifies specific Conservation Opportunity Areas (COAs) where high-priority species and habitat conservation may be most efficiently addressed. The Harney-Malheur area is identified as COA No. NBR-08. Key habitats identified in the OCS for this COA include riparian and wetlands. The plan references conservation actions for these and other habitats included in other planning documents. Some of the plan's conservation actions relate directly to the Refuge:

- Initiate actions to maintain alkaline wetland habitats in conservation status at the following locations: 20,000 acres (Harney Basin).
- Initiate actions to maintain emergent wetland habitats in conservation status at the following locations: 40,000 acres (Harney Basin).

- Initiate actions to maintain wet meadow habitats in conservation status at the following locations: 50,000 acres (Harney Basin); 10,000 acres (Silvies/Bear Valley); 20,000 acres (Malheur Refuge Headquarters).
- Initiate actions to maintain riparian shrub habitats in conservation status at the following locations: 2,000 acres (Harney Basin); 300 acres (Aldrich Mountains); 200 acres (Malheur Refuge Headquarters).
- Restore drainage; improve water management facilities; use fishways, traps, and screens to limit carp migration to enhance productivity of wetlands and other aquatic habitats: Malheur Lake, Harney Basin.
- Improve fish passage; for example, modify barriers or use spans where appropriate.

Nine mammals, 15 plants, three herptiles, eight invertebrates, 16 fish species, populations or segments, and 15 birds are listed as strategic (high priority) species in the OCS. Many of these species are found on Malheur Refuge.

State Comprehensive Outdoor Recreation Plan: A detailed summary is provided in Chapter 5, Section 5.7.2

1.8 Special Designation Lands

1.8.1 Important Bird Areas

Malheur Refuge has been designated by the Audubon Society as an Important Bird Area (IBA). This program recognizes that habitat loss and fragmentation are the most serious threats facing populations of birds across America and around the world. An IBA is a site that provides essential habitat for one or more species of birds and that is recognized as being important on a global, continental, or state level. IBAs often support a significant proportion of the total population of one or more species. In the United States, the IBA program has become a key component of many bird conservation efforts, including Partners in Flight, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan (Audubon 2011).

Malheur Refuge was selected and approved as an IBA for the following reasons (Audubon IBA 2008):

- It hosts 20 percent of the of the world's population of white-faced ibis.
- It has high densities of willow flycatchers.
- It has one of the highest Breeding Bird Survey counts for the watch-listed Brewer's sparrow.
- It supports breeding populations of watch-listed western snowy plover (400 individuals), long-billed curlew, Franklin's gull, short-eared owl, bobolink, and trumpeter swan.
- Significant populations of American white pelican, cinnamon teal, and redhead use the Refuge for breeding.
- It supports 20 percent of Oregon's breeding population of greater sandhill cranes.
- The Refuge supports breeding populations of Franklin's gulls, Forster's terns, Caspian terns, and black terns.
- Great blue herons and great egrets nest on the Refuge in scattered colonies.
- Post-breeding concentrations of ring-billed gulls sometimes reach 25,000 in August.
- Up to half of the world populations of Ross's geese pass through the area.

- A significant proportion of the total populations of green-winged teal, American wigeon, northern shoveler, northern pintail, canvasback, and ruddy duck pass through the Refuge.
- Hundreds of thousands of waterfowl (including up to 100,000 snow geese, 15,000 green-winged teal, 15,000 mallards, 250,000 northern pintail, 250,000 northern shovelers, 4,000 canvasbacks, 2,000 ring-necked ducks, 5,000 lesser scaup, and 50,000 ruddy ducks) pass through the Refuge during migration.
- Concentrations have been recorded of up to 25,000 western sandpipers, 350 pectoral sandpipers, 35,000 long-billed dowitchers, 15,000 Wilson's phalaropes, 15,000 American avocets, and 200 black-necked stilts.

1.8.2 Wilderness Status

There is no designated wilderness within Malheur Refuge. However, a wilderness review was conducted in conjunction with the CCP process as outlined in 602 FW 1 and 602 FW 3. The purpose of a wilderness review is to identify and, if appropriate, recommend for congressional designation National Wildlife Refuge System lands and waters that merit inclusion in the National Wilderness Preservation System.

The wilderness review process consists of three phases: wilderness inventory, wilderness study, and wilderness recommendation. Lands and waters that meet the minimum criteria for wilderness are identified in the inventory phase. These areas are called wilderness study areas (WSAs). WSAs are evaluated through the CCP process to determine their suitability for wilderness designation. In the study phase, a range of management alternatives are evaluated to determine if a WSA is suitable for wilderness designation or management under an alternate set of goals and objectives that do not involve wilderness designation. The recommendation phase consists of forwarding or reporting recommendations for wilderness designation from the Director through the Secretary of the Interior and the President to Congress in a wilderness study report.

Through this process, 10 units were defined for evaluation (see Appendix D) on the Refuge. The majority of Malheur Refuge is a highly altered wetland and upland system. The lands and waters have been significantly altered prior to and during Service ownership. The Refuge has actively managed these lands to meet the needs of wildlife species at both refuge and Pacific Flyway levels to enable the Refuge to meet its establishing purposes. The effects of management have included changes to the soils, flora, and fauna. Human-made developments abound in the form of an extensive road system; hundreds of miles of primary dikes, ditches, and fences; altered creeks and river; and thousands of water management structures.

Three units of the Refuge (Malheur Lake, Upper Bridge Creek/Knox Springs, and Barnes Springs) may potentially exhibit wilderness characteristics that are currently not present. Each of these areas is experiencing significant invasive species (plant and or animal) impacts that compromise the achievement of refuge purposes, the NWRS mission, and biological integrity, diversity, and environmental health.

In this inventory (Phase I), the Harney Lake Unit was found to meet the minimum wilderness criteria for size, naturalness, and outstanding opportunities for solitude and primitive/unconfined recreation. A total of 31,157 acres were found to have wilderness characteristics, which is 1,157 acres greater than an existing WSA proposed in 1969 that was never finalized (see Appendix D, Section D.1.4). Based on the findings in this inventory Harney Lake will be further evaluated in the wilderness study phase as a step-down process to the CCP.

1.8.3 Research Natural Areas

The Refuge manages two Research Natural Areas (RNAs): the Harney Lake RNA and the Stinking Lake RNA. RNAs are part of a Federal system of tracts protected for research and educational purposes. Each constitutes a site where natural features are preserved for scientific purposes and natural processes are allowed to dominate. The main purposes are to provide

1. baseline areas against which effects of human activities can be measured;
2. sites for study of natural processes in undisturbed ecosystems; and
3. gene pool preserves for all types of organisms, especially rare and endangered species.

According to the Standards and Policy Guidelines issued for RNAs (Dec. 1976 revision), an RNA is a unit in which natural conditions are maintained except when deliberate manipulation maintains the unique features of the site.

Refuge policy on RNAs (8 RM 10) addresses RNA management and stresses that RNAs must be reasonably protected from any influence that could alter or disrupt the characteristic phenomena for which the area was established. RNA policy encourages discontinuing recreational uses if these uses threaten serious impairment of research or education values. Vegetation management is permitted only where necessary to preserve vegetation, and must be documented in a plan approved by the Regional Director. Natural processes are stressed for wildlife population management.

The guiding principle in management of RNAs is to prevent unnatural encroachments (activities which directly or indirectly modify ecological processes on the tracts). Uncontrolled grazing is not allowed, nor is public use that threatens significant impairment of scientific or educational values. Management practices necessary for maintenance of the ecosystem may be allowed.

Harney Lake Research Natural Area: The Harney Lake RNA was established in 1975 to "exemplify southeast Oregon alkaline lakes (playas) and associated vegetation and wildlife" (Copeland 1979). The RNA encompasses 30,000 acres and consists of the 28,000-acre lake itself and a 2,000-acre strip of land surrounding the lake (see Map 12). The lake is a vast body of very shallow water during wet periods and a vast alkali flat in dry periods. At the lowest elevation in the Harney Basin, the lake exceed 10 feet in depth during the flood of the mid-1980s.

The RNA includes habitat for snowy plovers, avocets, American white pelicans, terns, and migrating ducks and geese. Raptors, including golden and bald eagles, use the area at least seasonally. Among the animal species known or expected to use the RNA are 33 bird and 13 mammal species which were identified as species of concern in Oregon at the time the RNA was established. These include nesting golden eagles, prairie falcons, and snowy plovers. Mammals of special concern include the Malheur shrew, Merriam's shrew, and the northern grasshopper mouse.

Significant changes in substrate, alkalinity, and moisture occur over short distances on Harney Lake. These changes produce a complex, intergrading mosaic of plant communities, which can be broadly described as saltbush-greasewood, sagebrush steppe, and tule marshes. The lakebed is mostly devoid of vegetation; however, bulrush communities surround small springs on the southern and eastern portions of the lake.

Stinking Lake Research Natural Area: The Stinking Lake RNA was established in 1975 to "preserve and example of a small, spring-fed alkaline lake in southeast Oregon and the associated

high desert vegetation and wildlife" (Copeland and Greene 1982). Important natural features include a variety of salt desert plant communities, a permanent cold spring and associated wetlands, and a large number of birds and small mammals. The RNA encompasses 1,555 acres in the Double-O Unit of the Refuge (see Map 12). The cold spring on the west side of the lake and precipitation are the only sources of water. The lakebed encompasses 752 acres, but the actual lake surface varies with rainfall and flow volume from the spring. The lake is rimmed on three sides by rimrock and low dunes on the fourth side.

The Stinking Lake RNA is best known for large number of migratory shorebirds using the lake and shoreline. Thousands of American avocets, Wilson's phalaropes, willets, and western sandpipers rest and feed on flies on the saline flats. Certain birds (black-bellied plover, pectoral sandpiper, and dunlin) are rare elsewhere on the Refuge but can often be found at Stinking Lake. Among the animal species known or expected to use the RNA are 19 bird and 14 mammal species which were identified as species of concern in Oregon at the time the RNA was established. Two inhabitants of the spring waters, the speckled dace and a small crayfish, are worth mentioning. The dace appear to differ from other speckled dace in the area. The crayfish is a rare subspecies encountered occasionally in the Harney Basin and some parts of the Snake River drainage (Copeland and Greene 1982).

Vegetation in the RNA consists of salt desert plant communities (saltbush-greasewood, and sagebrush steppe) with small amounts of wetland vegetation (tule marshes) adjacent to the spring and big sagebrush on the rimrock. Along portions of the lakeshore and in highly alkaline areas the vegetation is dominated by alkali saltgrass or Nevada bulrush (Copeland and Greene 1982).

1.9 Planning Process and Issue Identification

1.9.1 Planning Process

A core planning team, consisting of the refuge project leader, deputy project leader, wildlife biologist, ecologist, public use planner, archaeologist, and a regional planner, began developing the CCP in 2009. The core planning team is identified in Appendix I.

Collaborative Process: This CCP was also developed through a collaborative process in order to solicit and incorporate public input throughout all stages of plan development, as well as build support for its content and implementation.

An extended team (see Appendix I), comprising technical specialists versed in resource issues and key intergovernmental partners, assisted in CCP development and was invited to several workshops or consulted via e-mail and conference calls. These groups were particularly important in assisting with focal species selection, defining the ecological considerations and transitions (see Appendix L, Ecology Work Group) and in assisting in developing recommendations for carp assessment and treatment (the Aquatic Health Coalition). Members of the extended team also provided comments at key points in development of the Draft Plan.

A variety of other organizations and individuals contributed to this CCP (see Appendix I). A series of interactive meetings to review key topics addressed in the CCP, review drafts of the CCP, and otherwise facilitate discussion between the Service and stakeholders, was chaired by the Oregon Consensus Program and the High Desert Partnership. Each collaborative meeting was attended by 30-40 participants, including technical experts, scientists, government agencies, conservation

organizations, local and statewide residents, recreation groups, Tribal representatives, refuge visitors, and elected officials.

Technical working groups were created by the Service to serve as forums for specific complex resource issues. To address concerns about carp, the Aquatic Health Coalition was created to involve partners in strategizing effective methods for dealing with the carp issue, to leverage partner involvement and to secure funding. Three aquatic health working groups have been formed within the Coalition to develop strategies for carp population assessment, carp control on- and off-refuge, and partnership enhancement and funding opportunities. Participants include fish and wildlife biologists, researchers, subject matter experts and ecologists from various Federal and State agencies, nongovernmental organizations, and institutions.

To address issues of concern about invasive species and transitions of habitat types, the Refuge established the Ecology Working Group (Appendix L). Consisting of ecologists and wildlife biologists representing a broad assortment of organizations, this group is focusing on the development of habitat models that describe successional conditions and provide guidance in achieving specific plant-community objectives.

Early in the planning process, a review of numerous plans and assessments was completed (see Section 1.7). A comprehensive list of resources of concern was compiled based upon review of the plans referenced above, many of which highlight priority species or habitats for conservation. A workshop was held with the extended team to assist in further defining the list to focus on priority species, species groups, and communities of concern for the Refuge. The final Priority Resources of Concern list is located in Appendix E. Much of the biological emphasis of the CCP is focused on maintaining and restoring these priority resources.

Public use planning centered on developing goals, objectives, and strategies around the Big Six uses. Other nonwildlife-dependent uses that currently occur were also addressed.

Public scoping began in August 2009. Scoping meetings were held in several locations around the region and state. Public comments were also solicited through distribution of a planning update to the Refuge's mailing list, refuge visitors, and other interested parties. A complete summary of public involvement is in Appendix J.

An internal draft was distributed to Service Region 1 reviewers and members of the extended team, collaborative group, and technical working groups including states and the Burns Paiute Tribe, in April 2011. All changes requested by those who reviewed this internal draft and the actual changes made were documented.

1.9.2 Key Issues Addressed in the CCP

An issue is defined as *a concern or problem; a matter that is in dispute; or a vital or unsettled matter* (Merriam-Webster 2011). The primary intent of a planning process is to make sound decisions and to better address problems and concerns. Thus a key component of the planning process is a structured definition of the issues (problems, concerns, opportunities) that lay before us in the current and future management of Malheur Refuge. Each of the issue statements that follow presents background information and is followed by key questions that we hope to resolve in the CCP.

This issue summary is a description of the main management issues facing Malheur Refuge. Issues were derived from discussions with staff, partners, other agencies, longtime refuge observers, and the public. Each of the issues is within the scope of the CCP/EIS and they are considered by the Service to be the major issues to address in the planning process:

- The importance of Malheur Refuge and the Silvies floodplain to migratory and breeding birds
- Invasive species, including common carp and perennial pepperweed
- Habitat and vegetation management
- Riverine conditions: geomorphology, hydrology, fisheries, and riparian habitat
- Water system infrastructure and water delivery
- Preserving the legacy of human and paleontological history at Malheur Refuge
- Visitor access, facilities, and information
- Providing quality wildlife observation, photography, interpretation, and environmental education
- Providing quality fishing and hunting opportunities
- Wilderness
- Collaboration

The Importance of Malheur Refuge and the Silvies Floodplain to Migratory and Breeding Birds

Waterfowl: Malheur Refuge and the Silvies floodplain support several priority waterfowl species as defined by the North American Waterfowl Management Plan, including tule and Pacific greater white-fronted goose, northern pintail, mallard, lesser scaup, snow goose, wood duck, redhead, canvasback, ring-necked duck, and American wigeon. The Refuge also supports breeding population of the Rocky Mountain Population trumpeter swans—a priority in the Pacific Flyway.

Historical data show that substantial numbers of these species may occur on the Refuge, varying with habitat conditions. For example, comparing peak refuge counts conducted in the 1980s and 1990s during spring and fall migration with annual Pacific Flyway midwinter population indices, the Refuge has supported up to

- 66 percent of the white goose population (spring 1996);
- 63 percent of the American wigeon population (fall 1993);
- 48 percent of the tundra swan population (in fall 1980 after carp control on Malheur Lake);
- 40 percent of the American green-winged teal population (fall 1993);
- 24 percent of the ruddy duck population (spring 1995);
- 22 percent of the northern shoveler population (fall 1993);
- 10 percent of the northern pintail population (spring 1996); and
- 5 percent of the mallard population (fall 1996).

Additionally, redhead and canvasback duck counts on the Refuge have exceeded the Pacific Flyway midwinter indices (328 percent for redheads in fall 1992 and 148 percent for canvasbacks in fall 1995). This is because the midwinter counts do not include Mexico, where substantial numbers of redheads and canvasbacks winter.

During spring migration, the Silvies River floodplain, which lies just north of the Refuge, supports high numbers of migrant waterfowl. A study conducted by the Service in the late 1970s and early 1980s found that 56 percent of the waterfowl use in the Harney Basin occurred on the private lands of the floodplain during the spring. Scientists from the U.S. Geological Survey (USGS) have documented the importance of such flood irrigated areas in southeastern Oregon and northeastern California; these areas support about 80 percent of the Pacific Flyway pintails during spring migration (Miller et al. 2010). Therefore, it is important for the Refuge to work with private partners on the floodplain with a goal of maintaining these flood irrigation values.

Waterbirds: Malheur Refuge supports the highest number of breeding greater sandhill cranes of any refuge in the western United States. This species is a priority species in the Pacific Flyway and the Intermountain West Waterbird Conservation Plan (Ivey and Herziger 2006), and it is listed as a "sensitive" species in Oregon. A statewide crane pair survey in 2000 found 245 pairs on the Refuge, 21 percent of the Oregon population. An additional 78 pairs were recorded on the Silvies Floodplain (Ivey and Herziger 2001).

High numbers of colonial-nesting waterbirds have also been counted on the Refuge. The Refuge supports several colonial waterbird species identified as priority species in the Intermountain West Waterbird Conservation Plan (Ivey and Herziger 2006), including western and Clark's grebes, American white pelicans, California gulls, and Forester's terns. Comparing peak refuge counts of nesting waterbirds with population estimates for the Great Basin Bird Conservation Region, most colonial waterbird peak counts exceeded 10 percent of the regional population. Malheur Refuge supported 20,500 breeding white-faced ibises (35 percent of regional population in 1998); 7,782 breeding western and Clark's grebes (50 percent of the regional population in 1983); 4090 breeding American white pelicans (15 percent of the regional population in 1988); and 1,730 breeding great egrets (77 percent of the regional population in 1983).

Shorebirds: Malheur Refuge supports several breeding and migrating shorebird species that are designated as high priority species in the Intermountain West Shorebird Plan. Priority breeding species include the snowy plover, long-billed curlew, American avocet, and black-necked stilt. Priority migrant species that are common at Malheur Refuge include the long-billed dowitcher, western and least sandpiper, and red-necked phalarope. Numbers of migrant shorebirds using the Refuge were estimated during the Malheur-Harney Basin Study from 1975-1984 (USFWS 1975-1984). Total shorebird numbers exceeded 20,000 during fall migration during most years, with a peak of over 41,000 in August 1975. Western sandpipers, long-billed dowitcher and Wilson's phalaropes tend to be the most abundant migrant species using the Refuge, each with peaks exceeding 15,000 birds. The numbers of migrant shorebirds at the Refuge qualifies the area as a Regional Western Hemispheric Shorebird Reserve, although the Refuge has not been designated as such.

Landbirds: Oregon and Washington Partners in Flight identified priority landbird species in various habitats in the 2000 Columbia Plateau Bird Conservation Plan. Many of these priority species are found at Malheur Refuge. Malheur Refuge is known to support very high densities of nesting willow flycatchers and yellow warblers; both are priority riparian habitat associates. Other refuge priority riparian birds include Bullock's orioles and yellow-breasted chats. The Refuge also supports the largest local population of bobolinks in the western U.S. (a wet meadow–dependent species). Other priority species found in the uplands on the Refuge include loggerhead shrike, sage sparrow, sage thrasher, black-throated sparrow, lark sparrow, and Brewer's sparrow (all shrub-steppe dependent).

The Refuge supports also burrowing owls, Swainson's hawks, and ferruginous hawks (upland associates).

Key Questions for the CCP

- What are the trends in migratory and breeding bird populations over the last 20 years?
- What are the key factors affecting trends?
- What is the role that Malheur Refuge should assume in the larger region with respect to supporting migratory and breeding bird populations?

Invasive Species, Including Common Carp and Perennial Pepperweed

Common Carp: Common carp were apparent in refuge waters by the early 1950s. By the mid-1950s, carp were established in large numbers throughout the Refuge. Currently carp are found in Malheur, Mud, and Harney lakes; in refuge wetlands; and throughout large areas of the Silvies and Blitzen River systems. Carp compete directly with waterbirds for aquatic food. In addition, carp feed by disrupting the benthic environment, which causes water turbidity issues that further decrease the productivity of the aquatic environment. Decreases in habitat quality and productivity within lakes, ponds, and marshes have been observed since the introduction of carp into the system, where there has been an absence of effective population control.

Carp control methods have included drawdowns, rotenone, electroshocking, physical barriers, fish screens, traps, poison bait stations, and blasting. Rotenone can be very effective but has proven to be less than 100 percent effective. Any benefit is short-lived because all fish are not killed, the remaining fish have a high fecundity, and the interconnectedness of the waters in the Silvies River, Blitzen, and the Refuge's lakes provide a continual source of carp. Rotenone negatively affects native fishes, spotted frogs, and other wildlife.

Electroshocking has been very useful in controlling carp in dewatered ponds and canals, but like other methods of control, is not 100 percent effective. This treatment works well for small, specific areas.

The construction and/or repair of physical barriers have proven to be very effective in reducing carp impacts in wetlands. At Malheur Lake it would be necessary to consider barriers that do not degrade water quality and reduce connectivity (i.e., impede passage of native aquatic species).

Noxious/Invasive Plants: The Refuge has been involved in weed control efforts for decades. Field management strategies incorporated the repression of Canada thistle through cultural practices such as haying as early as the 1950s. By the 1970s, the use of chemicals was commonplace for Canada thistle, perennial pepperweed, poison hemlock, and Russian knapweed. Biological control was used for the first time in 1982 in an attempt to control thistle.

Since that time, the list of noxious weeds that require attention within the Refuge has continued to grow. Those species that are listed as noxious by Harney County and are chemically treated on an annual basis include diffuse and Russian knapweeds, perennial pepperweed, puncture vine, Scotch thistle, medusahead rye, and white top. Individual salt cedar are occasionally discovered within the Refuge adjacent to Malheur and Harney Lakes and are eradicated immediately. Other nuisance species that are subject to control measures include Russian olive, reed canarygrass, common and hybrid cattail, and common reed.

Weeds and invasive species in upland habitats include medusahead, which has invaded shrublands on the southernmost portion of the Refuge (approximately 30 acres). Perennial pepperweed, Russian knapweed, and other invasive species occupy a large percentage of lowland shrub communities. In addition to these, common reed, reed canarygrass, and other undesirable weeds are expanding in marshes.

Effective control of invasive species is an important issue to many in the public, judging from the number of comments received on this topic during scoping.

Key Questions for the CCP

- How could current management strategies be improved upon? Especially, what possible strategies could control carp in the lakes and rivers associated with the Refuge?
- What would the effects of any large-scale efforts be on habitats, wildlife, and other aquatic species?
- How does this issue interact with those pertaining to fish passage, wetland management, and the water delivery system?
- How can the management of water and emergent marsh and meadow habitats be modified to balance wildlife production goals while discouraging the encroachment of emergents and invasives such as reed canarygrass?
- Are more plant management options (such as prescribed grazing during the growing season) desirable as strategies for meeting desired structure and condition?

Habitat and Vegetation Management

Lacustrine (lakes) and Playa: Malheur Lake was once capable of annually producing over 100,000 ducks (Cornely 1982) and ranked as one of the most productive waterfowl areas in North America. The lake also once played a much more significant role in the Pacific Flyway for migratory birds. Fluctuating water supplies over time stimulated marsh productivity and provided a variety of habitats.

The negative impacts of common carp became noticeable in the early 1950s and the productivity of this system has been far from optimal since that time. As carp populations increase, submergent vegetation, aquatic invertebrates, and other food staples for waterfowl and other waterbirds began to decrease. (See previous issue discussion of invasive carp.)

The 30,000-acre Harney Lake RNA and the 1,555-acre Stinking Lake RNA were established in 1975. The Harney Lake RNA protects the alkali lakes and associated and unique vegetation and wildlife species; this RNA is mostly undisturbed, particularly in dune and hot springs areas. Important natural features of the Stinking Lake RNA include a variety of salt desert plain communities, a permanent cold spring, and an alkaline lake. Public entry into Malheur Refuge's RNAs is by Special Use Permit only and must be for scientific research purposes.

Compared to other Refuge habitats, the lakes are not heavily manipulated, except by upstream diversion in the major watersheds. Malheur Lake has remnants of a dike system built primarily to protect farmed areas from high water on the north- central portion of the lake and to hold more water in the center of the lake where the best marsh habitat was (Cole Island).

Palustrine Emergent (seasonally flooded wet meadows) and Dry Meadow: Seasonally wet meadows provide foraging, resting, and nesting habitat for a variety of waterbirds and waterfowl, such as the sandhill crane, white-faced ibis, cinnamon teal, mallard, and gadwall; shorebirds, such as the American avocet and black-necked stilt; and neotropical migrants, such as the bobolink. Meadows are optimally characterized by native grasses (e.g., spike bentgrass, American sloughgrass, Nevada bluegrass, creeping wildrye), sedges, rushes, and native forbs.

Meadows undergo a number of manipulations to ensure desired vegetation structure, including flood irrigation, prescribed fire, haying, and grazing. Generally, meadows are provided flood irrigation (inundations of 0 to 3 inches deep) annually, beginning in March and extending until July or August.

Other meadow treatments vary from year to year. The Refuge removes residual vegetation in treated meadows with prescribed fire, rake-bunch grazing, haying, and mowing to stimulate early season growth of meadow plant species and manage desirable levels of litter accumulation. Short, early growing vegetation provides high protein foods to support feeding, breeding, and brood-rearing ducks, cranes, geese, and shorebirds. Periodic removal of decadent litter has been demonstrated to enhance nesting conditions. Most meadow treatments require a period of drying, which can interfere with brood rearing for some species. Untreated (idle) meadows are allowed to rest with residual vegetation from the previous growing season left on-site. The residual vegetation provides escape and nesting cover for cranes, waterfowl, and waterbirds.

Managing plant species composition in meadows is difficult. Weeds, especially perennial pepperweed, are a serious problem, and are currently managed primarily with herbicides. Since some practices (haying and rake-bunch grazing) are currently implemented only after the growing season ends, they do not exert negative pressure on invasive species or encroaching native species. Some in the public continue to believe that grazing poses unacceptable threats to resources on National Wildlife Refuges, as evidenced by comments received during scoping. Some members of the public dislike the use of fences, believe that they cause harm to wildlife, and feel that they are not well maintained. Preliminary data from a pilot study involving selective, intensive grazing of perennial pepperweed by sheep on the Refuge have suggested that this could be an effective treatment option.

Some observers believe that refuge meadow habitats are experiencing serious encroachment from emergents such as cattail. Some units have been managed as idle with fairly constant hydrology due to a lack of interior fences or inability to fine-tune water placement. In some areas the plant community has shifted from grasses toward emergents, thus reducing habitat diversity. Reversing this trend has proven difficult.

Palustrine Emergent (seasonally flooded marsh associated with wet meadows): Marshes ideally provide emergent nesting cover and limited open-water feeding areas for waterfowl and marsh birds. This habitat is generally located adjacent to ponds and experiences shallower flooding depths. Water depths range from 6 inches to 3 feet and flooding typically occurs from late winter/early spring through July. Marshes are used by overwater nesters, such as sandhill crane, rails, and redheads; provide escape cover for waterfowl broods, particularly late-season nesters, such as gadwall, redhead, and grebes; and provide habitat for other species, such as amphibians. Water depths may range to 4 feet.

Open water areas should make up 20-40 percent of this habitat and host a diversity of submergent plant species such as sago pondweed. This is difficult to maintain. Cattail, an emergent, has a high tolerance of water level fluctuations and higher pH soils and forms large acreages in some places.

Common strategies used on the Refuge to set back succession include flooding, drawdown, and mowing. Disking, herbicides, and prescribed fire also assist in achieving the desired ratio and in managing litter.

Emergent marsh management is closely linked with the management of adjacent meadows. It is often necessary to fully irrigate meadows in order to maintain desired pond levels, resulting in emergent encroachment into adjoining meadow systems.

Palustrine Open Water/Emergent (semipermanently flooded wetland impoundments): Ponds and associated vegetation are semipermanently flooded and provide food resources for brooding diving and dabbling ducks and support sandhill crane roosting and nesting. Emergent plants provide nesting and escape cover for broods and molting adults.

Fire and herbicides are used to manage for the targeted emergent-to-open-water ratio of 50:50. Drawdowns and disking provide opportunities for growth of smartweed, other moist soil plant species, and submergents. Infrastructure improvements have assisted in carp control and water management. Carp removal is also critical, to enable submergent plants to grow in undisturbed substrates and nonturbid water. To eliminate carp, we often dry up ponds, but this is not a completely effective management tool, as carp have shown a tenacious resistance to eradication in these habitats. Infrastructure improvements have assisted in carp control and water management.

Maintaining pond water levels through summer can be difficult, particularly in the Blitzen River units because of insufficient water supply. Even where late summer diversions are feasible, they can result in reductions in flow that are unacceptable for native aquatic species. Dikes surrounding ponds support predators, such as raccoon and mink, which prey on young waterfowl, cranes, and other waterbirds. Larger impoundments tend to promote higher brood survival.

Uplands (salt desert scrub, sagebrush lowland, sagebrush steppe, and dunes): Upland habitats include sagebrush steppe, salt desert scrub, dune, and sagebrush lowland. They provide habitat for ground nesting migratory birds, landbirds, and a diverse variety of mammals. Observers have noted a decrease in native forbs and grasses throughout these habitat types, as well as western juniper encroachment in shrublands on the southwest side of the Blitzen Valley. However, juniper cutting is not supported by many in the public, as evidenced by comments received during scoping. Crested wheatgrass was seeded on the Refuge following wildfires in the 1970s and 1980s. While successful in preventing establishment of cheatgrass, crested wheatgrass has hindered the re-establishment of native shrub, grass, and forb species in most areas.

Cropland: The Refuge annually plants 70-100 acres of winter wheat, rye, oats, and spring barley, to support greater sandhill cranes during fall staging. Past Flyway plans stressed retaining cranes on the Refuge as late as possible to reduce mortality in California's Central Valley after migration. Planted grains complement wetland foods, especially after the ground freezes. Deer, pheasants, geese, and dabbling ducks also use croplands.

The dryland farming program encounters various operational issues such as controlling weeds, ensuring successful seed establishment, preventing soil compaction from equipment, and managing yield variability.

Key Questions for the CCP

- How much area should be maintained in each habitat type and what are the desired structures and plant compositions to best support the diversity of species using these habitats? What should the interspersion of these habitats be and at what scale should we achieve target conditions?
- Should the Refuge prioritize maintenance or restoration of some habitats over others? How would such prioritization play out, including consideration of broader issues such as invasive species, fisheries, water quality, climate change, and visitor experiences?
- What kinds of management tools should be used, and when, and where, considering effectiveness, efficiency, compatibility with refuge purposes, and minimizing negative consequences? What modifications should be made to current management tools?
- Is the Refuge currently meeting crane, duck, and waterbird production goals? What is our past record? What limiting factors may be preventing achievement of these goals?
- Considering the needs of priority wildlife species and groups, how should we balance habitat management practices (flood irrigation, haying and grazing, burning, herbicide application, predation management, etc.)? What kinds of timing considerations are necessary to prevent nesting season or migration conflicts, to work effectively with plant growing seasons, and to fit in with water rights, variable water supply, and other issues?
- To what extent can manipulated habitats in the Blitzen Valley and Double-O Unit be shifted to Malheur Lake? How would this change the habitat mix and management opportunities in these areas?
- What research opportunities should be pursued?

Riverine Condition: Hydrology, Geomorphology, Riparian Habitat, and Fisheries

The value of the Refuge's migratory bird habitat is currently dependent on the availability and management of water resources. Management of the Blitzen Valley and the Double-O units is critical for meeting the Refuge's purposes because of their high values to migratory birds. In these areas, there is sufficient water and infrastructure to provide the necessary habitats.

Hydrology: The Blitzen River begins on Steens Mountain and flows north through the Blitzen Valley into Malheur Lake, joined by other tributaries originating on Steens Mountain as it flows northward. A system of dikes, canals, drains, and water control structures was developed beginning in the late 1880s to facilitate grazing and farming. Between 1907 and 1913, 17.5 miles of the river were channelized and straightened. The Blitzen River was also diked and deepened and more than 50 miles of secondary river channels were excluded from riverine hydrology. Portions of this water distribution system still exist and are used to manage water in the Blitzen Valley. Additional dikes, canals, drains and water control structures were added between 1935 and 1942 by the Civilian Conservation Corps (CCC). The area represents the most intensively managed and most productive habitat on the entire Refuge. On the Double-O Unit, water comes from large springs along the southwest margin of the basin and from Silver Creek to the northwest. The Double-O springs have water control infrastructure adequate to provide approximately 6,000 acres of wetland and marsh habitat. Silver Creek provides irrigation to the remaining 3,000 acres of wet meadow habitat but is only available in years of above-normal water conditions.

Geomorphology: The Blitzen River has a variety of physical conditions including a deep, wide channel; limited willows; steep, bare banks; few deep holes; and minimal habitat complexity.

Connectivity between the river and its floodplain is limited in many areas. This could be a function of anthropogenic factors, such as water withdrawals, channelization, substrate trapped behind upstream dams, flood management, and historic grazing practices. For many reaches of the Blitzen River and its tributaries, the predevelopment hydrology is not fully understood.

Riparian Habitat: The Refuge contains riparian habitat along the Blitzen River, its tributaries, ditches and canals, and remnant traces of previously active sloughs in the Blitzen Valley, as well as a few patches in the Double-O Unit. The south Blitzen Valley also supports extensive stands of willow associated with irrigated meadows, and these stands are very important for riparian landbirds. Smaller stands of willow are associated with wet meadows and seasonal wetlands in the north Blitzen Valley and the Double-O. Since major reductions in livestock grazing occurred during the 1970s, riparian habitats have increased and expanded, especially in the south Blitzen Valley. Although riparian development is hampered in many areas due to the floodplain isolation related to geomorphologic factors described above, the condition of the Refuge's riparian habitat is generally good. There is much diversity in the plant communities along the Blitzen River, its tributaries, and the East Canal. In other portions of the Refuge, diverting water for irrigation or incision of stream banks has lowered the water table; this has prevented riparian species from re-establishing.

Various efforts, including fence exclosures, vegetation management, plantings, and in-stream weir placement, have been undertaken in the last decade on the Blitzen River and its tributaries. On Bridge and Mud creeks these efforts have markedly improved riparian and riparian habitats. The Blitzen River, however, is deeply incised and channelized in many areas and vegetative restoration has proved difficult. Weirs placed in the Blitzen River were intended to improve riparian habitats, but their overall effectiveness needs to be thoroughly evaluated.

Fisheries Habitat/In-stream Flows: The Refuge has an interim agreement with ODFW to maintain minimum in-stream flows for native fish and other aquatic species. The Refuge currently tries to maintain a minimum flow of approximately 25 cubic feet per second (cfs) in the Blitzen River.

The Refuge has a permit for a winter water right (October 1 through March 1), which designates bypass flows ranging from 43 cfs to 54 cfs depending upon the time of year. The Refuge and ODFW are nearing completion of a 1D Phabsim model that will provide an objective basis for year-round in-stream flow targets. The Refuge has pending transfers before the Oregon Water Resources Department to change the existing irrigation water rights to a different purpose—wildlife refuge management. This would provide significant flexibility in how, where, and when the Refuge could apply its water so that it is most beneficial for wildlife and habitat management.

In the Double-O Unit, the Refuge has senior irrigation water rights that are seldom served because of water availability and infrastructure issues. The large spring water resources of the Double-O Unit are effectively used for irrigation and pond management.

Denil-style fish ladders were installed on three dams on the Blitzen River in the late 1990s and at two in-line structures on canals. Studies by Anderson (2009) revealed substantial delays at the old ladders and denils. New fish passage and screening at the dams began to be addressed in 2010 through projects funded by the American Recovery and Reinvestment Act. Upgraded or new screening of diversions for fish began to take place in the late 1990s and continues as funding becomes available.

Water Quality: Refuge practices to manage water and migratory bird habitat have the potential to adversely impact water quality. Irrigation and water management on the Refuge may decrease in-

stream flows, exacerbate high water temperatures, reduce dissolved oxygen concentration, increase turbidity, increase nutrient loading, and degrade fish habitat. Nutrients, fecal coliforms, and other pathogens may enter the Blitzen River via irrigation return flows, drawdowns, and overland flow, decreasing water quality.

The Blitzen River, Krumbo Creek, Bridge Creek and Canal, and Mud Creek currently are 303(d) listed with impaired water quality. Temperature is an impaired parameter for all of these segments and most others do not meet the regulatory standards for flow modification, sedimentation, pH, DO, and phosphate-phosphorus. Some of these water quality issues can only be addressed at a larger watershed scale, such as the Blitzen River, which is already impeded prior to flowing onto the Refuge by elevated water temperatures and low DO in the upper Blitzen River. At this point there is no total maximum daily load (TMDL) for the Blitzen system. In 2006, the Oregon Department of Environmental Quality (ODEQ) specified a target date of 2010 for starting this TMDL. However, the current ODEQ website indicates that this has not occurred.

Best management practices (BMPs) currently underway to improve water quality include riparian plantings, fence exclosures for cattle, carp control in wetlands, and management of surface return flows when meadow and wetland habitats are being drained. Slower drawdowns in wetlands may reduce turbidity or surface return flows to the river; however, these increase salinity levels and temperature that can affect the biotic composition of meadows, marshes, and wetlands.

Key Questions for the CCP

- How should the Refuge work with cooperating agencies, neighbors, and regulators to implement the BMPs that will further address water quality issues?
- Is river and riparian management sufficient for sustaining or enhancing populations of priority fish species? How could the Refuge enhance its management of aquatic resources including native fishes?
- How should we approach riparian restoration on the Refuge? What are feasible strategies that complement site potential?
- How should the Refuge balance in-stream restoration of the upper Blitzen River with water management in Blitzen Valley?
- What role will climate change play in the future condition and management of these habitats? What parameters should be monitored and assessed?
- What role do the Refuge's water rights play in the management of these habitats?
- How much, if at all, has prior/current management altered this system (e.g., soil characteristics, gravel, sediment distribution, channel form, erosion rates, connectivity, riparian vegetation)? What assessments and tools are necessary to evaluate trade-offs among management strategies so that sustainable approaches for both aquatic and terrestrial habitats can be developed?
- Are life histories of priority aquatic species sufficiently understood to inform management decisions?
- What are the objectives for establishing in-stream flow targets, and what actions can be taken to determine whether attaining targets are having desired effects?

Water System Infrastructure and Delivery

The water delivery system operates by stacking water behind six dams on the Blitzen River. The water is diverted (mainly during spring and early summer) via canals, ditches, and feeder ditches to flood-irrigate a number of meadows and wetlands before returning to the Blitzen River as irrigation return flows, surface sheet flow, or subsurface percolation.

The existing flow-through delivery system is thought to mimic the natural flooding regime during peak flow events associated with spring runoff (mid-April through late May), but relies on an enormous system of ditches, water control structures, culverts, dikes, spreaders, and other structures the remainder of the year. Costs associated with maintaining this system are high.

Generally speaking, the system lacks the capacity to independently flood or draw down individual wetlands, marshes, or meadows. The irrigation system is only capable of managing fields at a gross scale (typically 1,000+ acres). The system's inefficiency and sheer size makes it difficult to maintain desirable meadow and wetland water levels at key points in time for breeding waterfowl and sandhill cranes. For instance, keeping brood water in meadows until August for cranes requires the Refuge to divert a large volume of water during a low-flow period to keep ditches charged. Water infrastructure also limits site-specific habitat management efforts such as disking, mowing, haying, and invasive species control.

Ditches require clear passage to move water efficiently; however, riparian plants and beavers regularly create clogs in the system. Past ditch cleaning with an excavator has exacerbated the system's inefficiency by deepening delivery ditches. Chemical control of vegetation is expensive and raises concerns about effects on habitats.

Key Questions for the CCP

- What opportunities and constraints does the existing water delivery system provide for wildlife and habitat management? How can we improve its efficiency and increase our effectiveness in meeting desired habitat and population outcomes?
- Are more efficient or "river-friendly" water management practices complementary or in conflict with wildlife management objectives for marshes, ponds, and meadows? If there is tension between the two, how could this be resolved?
- What are the best methods for cleaning ditches from the standpoint of effectiveness, cost, and environmental health?
- What changes could be made to the water delivery system to improve water quality?
- Should the practice of removing woody vegetation along key water ways (dikes and canals) continue to maximize efficiency for water delivery?
- Would a water budget assist in guiding operation of the water delivery system and assist in evaluating management options?
- What tools exist (or are needed) to evaluate options to benefit both river and wildlife management objectives?

Preserving the Legacy of Human and Paleontological History at Malheur Refuge

Archaeological data indicate that humans have lived in and around Malheur Refuge for over 9,800 years. Although less than 30 percent of the Refuge has been formally surveyed, over 300 sites have been recorded on the Refuge and are widely distributed across the landscape. These sites include

lithic scatters, summer villages, burials, rock shelters, winter villages, rock art, traditional cultural properties, hunting blinds, and vision quest sites. Two precontact sites have been listed on the National Register of Historic Places (NRHP) for their scientific value.

The modern descendants of the early inhabitants of the Refuge are members of the Burns Paiute Tribe. The precontact sites, as well as traditionally collected plants and animals, at Malheur Refuge continue to be important to the Tribe.

Three historic ranches (P Ranch, Sod House Ranch, and the Double-O Ranch), dating from the early Euro-American ranching and homesteading period, are also present on the Refuge and are listed on the NRHP. Historic sites that date back to the 1870s are generally located near reliable water sources or are associated with livestock grazing. A number of buildings and features constructed between 1935 and 1942 by the CCC are located on the Refuge and are eligible for listing on the NRHP. Four CCC-constructed lookout towers have been listed on the National Historic Lookout Register.

The paleontological resources at Malheur Refuge have not been investigated in detail. Camel vertebrae fossils have been found on the Refuge in Pleistocene (2.6 million to 11,700 years ago) volcanic ash deposits. Beyond this very little is known about the significance or educational potential of the site or others that the Refuge may contain. The Paleontological Resources Preservation Act (PRPA; P.L. 111-011) directs the Secretary of the Interior to manage and protect paleontological resources on Federal lands, including inventory, monitoring, and scientific and educational use of paleontological resources.

Because they are not renewable and are often subtle, fragile, and easily damaged, cultural and paleontological resources are quite vulnerable to weathering, destruction, degradation, or looting. The Refuge System's vision document, *Fulfilling the Promise*, illustrates that cultural resources are more than merely a legal responsibility. They represent a trust resource, a recreational destination, and perhaps most importantly, a tool for education and a mechanism for inspiring support for the Refuge System. A cross-section of the American experience is available at Malheur Refuge, from the first peoples subsisting on the same marsh and riverine resources of concern today, to the earliest pioneers, settling in a harsh and uncertain landscape. The legacy of the pioneering conservationists and the epic experiment in mass employment that was the CCC are also contained at the Refuge. These stories of the past enrich the visitor experience and support community pride. There is an opportunity to better understand and interpret lithic scatters, the role of rock art, the use of chert quarries, activities at winter villages, the evolution of hunting technology, and the overall use of the landscape around the Refuge.

Ground disturbance creates potential for impacts to cultural and paleontological resources. Habitat management tools, including flood irrigation, ditch maintenance, disking, prescribed fire, herbicide use, grazing, planting, and riverine restoration, can involve ground disturbance from access and movement of equipment in addition to the actual activity. Any of these activities has the potential to adversely impact such resources. When these resources have not been completely inventoried (as is the case at the Refuge), understanding adverse impacts is more difficult; knowing what is present is the first step in knowing what could be affected.

Recreational use of the Refuge can inadvertently hasten the demise of cultural or paleontological resources. Recreational use also creates opportunities for looters, especially in more remote areas.

A number of information or research needs related to cultural resource and paleontological management have been identified, including a field inventory in places sustaining or proposed for high public use; an inventory and assessment of stabilization and restoration needs for historic sites; a model identifying the sensitivity of various habitat types for the presence of cultural resources; a museum plan; and a paleontology inventory.

Key Questions for the CCP

- What sort of educational and interpretive messages and experiences should be provided, on-site or off-refuge, to provide residents and visitors the unique perspective of archaeology and history at Malheur Refuge?
- In the absence of a 100 percent inventory, which areas are likely to be most sensitive or contain the most significant precontact sites? Should recreational use in these areas be restricted? If not, which strategies would be most effective in preventing looting and destruction of cultural resources?
- What criteria should we establish to help us determine if a site is significant, and how should management activities adjust?
- How should we balance the continued administrative use of historic sites, including headquarters, dikes, roads, maintenance, and upgrades, with the historic features of the site?

Visitor Access, Facilities, and Information

Malheur Refuge receives visitors from across North America and the world. Nearly half of refuge visitors come from out of state. Nearly all visitors stay more than one day. Various independent groups organize regular trips to Malheur Refuge, especially during the spring. The Refuge is also a partner for the John Scharff Migratory Bird Festival each spring and is a stop for organized tours and independent visitors during the festival weekend. Malheur Refuge is a destination refuge, with attendant concerns, opportunities, and responsibilities.

A visitor center, staffed by trained volunteers, is located at Refuge Headquarters, and is open weekdays, as well as on the weekends during the spring, summer, and fall. Other visitor information is provided through the refuge website, local tourism information outlets and lodgings, directional and entry signs, and orientation maps and brochures at selected locations on the Refuge.

Currently access is mostly provided and promoted in the Blitzen Valley Unit. Public access to the Double-O Unit has not been encouraged or emphasized, although a gravel county road runs through the unit and the area is identified on refuge maps.

Up until the late 1980s, dike tops, management roads, and some other areas were open to public access outside of the breeding and nesting season. The Refuge's adoption of the concept of minimal disturbance in the 1990s resulted in restrictions in such access. Currently the public can use public roads, trails, and viewing facilities at any time of year, or areas specifically designated for fishing or hunting during those seasons. Occasionally, access into closed areas is made available to tour groups (such as during the John Scharff Migratory Bird Festival) with advance permission and Special Use Permits. Some members of the public have expressed the desire to have access more widely available on the Refuge, to provide a greater diversity of viewing experiences. There is concern from others that additional access may disturb wildlife or jeopardize the preservation of cultural resources.

Key Questions for the CCP

- Are marketing efforts and communications reaching current and potential visitors?
- Are brochures, signs, and maps clear and easily located throughout the Refuge's units? Do visitors understand when they are on Malheur Refuge?
- Should additional visitor access be provided in areas currently closed, for example, allowing access for wildlife observation and photography on or adjacent to Malheur Lake?
- Which aspects of previous facilities planning should be revived, implemented, and funded?
- What is the best way to regulate and manage the occasional use of the Refuge by commercial groups?
- Where and how should the Refuge provide additional access opportunities for people with disabilities?

Providing Quality Wildlife Observation, Photography, Interpretation and Environmental Education

Wildlife Observation and Photography: The most popular activity on the Refuge is wildlife observation and photography, especially in the spring and fall. Key sites are located in the Blitzen Valley, along the 42-mile auto tour route reaching from Refuge Headquarters, with its views of Malheur Lake, down to Page Springs and Frenchglen at the foot of Steens Mountain.

Birders are often quite interested in unusual or rare birds, especially passerines (perching birds or songbirds), which tend to congregate in areas with large trees and shrubby undergrowth. Malheur Refuge Headquarters and Benson Pond are favorite spots for such sightings and the appropriate vegetation management needed to draw in such species is of acute interest to many birders. Many scoping comments were received on this topic. Since some of the favored trees and shrubs used by these passerines are non-native or invasive, a decision should be made about where and how much of this kind of vegetation to maintain or promote.

In addition to the sites mentioned above, eight foot-trails are available on the Refuge, including a cross-state trail known as the Desert Trail. This trail is not maintained, and route layout and connections are poorly understood. Very few people use this trail for long-distance backpacking.

A Basin and Range "Birding Trail" has been proposed, to link the Refuge and other Great Basin birding sites. In concept, this type of trail would be supported by a map and make use of existing roads and facilities.

Environmental Education: The environmental education program at Malheur Refuge is a small staff- and volunteer-led program. At this time, no indoor facilities at Refuge Headquarters are available for this program. Limited transportation funds and staff time constrain program offerings. Environmental education activities are often focused on visitors and families participating in events such as the John Scharff Migratory Bird Festival, Free Fishing Day, and others.

Interpretation: Most of the Refuge's interpretive stops are located along the Center Patrol Road, or Highway 205 (a State-designated Scenic Byway). Interpretative materials are also associated with historic sites and found at Refuge Headquarters. Interpretation emphasis has been on signs, brochures, and web information. On-refuge and off-refuge presentations for Malheur Refuge are limited.

A number of previous planning efforts (some interagency) identified interpretative needs and proposed various facilities on and around the Refuge. Lack of funding has limited implementation of these plans. It is important to review the good ideas and the barriers to implementing these interpretive ideas, as well as considering new venues that incorporate technology into the interpretive experience.

Key Questions for the CCP

- Do current facilities, programs, and habitat management practices adequately support quality experiences in wildlife observation, photography, interpretation, and environmental education, and are they compatible with refuge purposes? In what ways can these programs be more effective?
- Are current trail offerings sufficient? Is maintaining the Desert Trail in alignment with other refuge objectives?
- What audiences should program offerings and facilities efforts be focused on? Novices? Advanced birders? Local students? Age groups? What balance of on- and off-site programming is desirable?
- How should the Refuge use partnerships to leverage and extend limited resources in these programs?
- What opportunities are available to directly connect children with nature?
- What additional visitor facilities should be developed, if any?
- In what ways can the Refuge improve its communication and coordination with visiting wildlife viewing groups at Malheur Refuge and with other partners?
- Are key messages supported by interpretive offerings and educational curricula? What are the perceptions and take home messages absorbed by new visitors, repeat visitors, and tour participants?

Providing Quality Fishing and Hunting Opportunities

Hunting: An estimated 1,400 hunters recreate on the Refuge each year. Hunting is the only "dispersed" recreational use on the Refuge, where hunters are permitted to wander cross-country within designated hunting units. The main issues identified with the hunting program include lack of opportunity, road access, and regulatory consistency.

Waterfowl hunting is provided on the north side of Malheur Lake, but hunting success and participation have declined sharply since carp became established in the lake. Access to this unit varies significantly from year to year due to fluctuating water levels.

Pheasant hunting occurs in the Buena Vista Unit and is a popular opportunity, partly due to the fact that off-refuge pheasant hunting opportunities are limited in the surrounding area. Special regulations are in effect in the unit to reduce conflicts with greater sandhill cranes during fall staging.

Hunters may take a wide variety of game in the Boundary Hunt Unit, including waterfowl, upland game, big game, coyotes, etc. The hunt unit covers the narrow western border of the Refuge west of Highway 205 and south of Foster Flat Road, and includes some land southeast of Krumbo Reservoir. The refuge boundary is not well marked along its shared boundary with BLM and follows rimrock in many areas; hence, this hunt unit is managed consistent with regulations used on BLM lands. The

hunt is primitive with no designated facilities. Above Krumbo Reservoir, access is gained from Diamond Lane at Moon Hill Road and the condition of the road is poor.

Fishing: Two separate fishing areas are open for fishing opportunities on the Refuge: Krumbo Reservoir and the south fishing loop, which encompasses a portion of the Blitzen River, the East Canal, and Bridge and Mud creeks.

Krumbo Reservoir was originally developed as a water storage area. Warm water fish, including crappie and large-mouthed bass were introduced several decades ago; large-mouthed bass remain, but are not actively managed for. Non-native rainbow trout have been stocked for many decades. ODFW stocks the reservoir annually with sterile rainbow trout. This program is technically out of compliance with Service policy, which prohibits stocking of non-native species. A small population of non-sterile rainbow trout that remains from historic plantings spawns in Krumbo Creek.

The reservoir provides a reliable fishing opportunity in Harney County and is very popular with local residents. Bank and boat fishing (with nonmotorized boats or electric motors) are allowed. The reservoir and adjacent lands are closed to all public access outside of the designated fishing season to minimize wildlife conflicts.

The south fishing loop is open year-round for a native redband trout fishery. Special regulations are in effect in this area. This area is a popular fly fishing area with local residents and out-of-area anglers.

East Canal, part of the south loop, is a popular fishing area. East Canal was formerly open for vehicular access. It was changed to hike-in only access in the late 1990s, which some members of the public believe unnecessarily restricts access.

Carp have successfully established in the river and canal system and have severely reduced and impacted the aquatic habitat. The redband trout fishery may directly benefit from Refuge efforts to control carp populations.

Key Questions for the CCP

- Does the current array of hunting and fishing opportunities meet demand from a diverse set of consumptive recreationists and provide high-quality experiences, compatible with Refuge purposes?
- Is there a need for additional waterfowl, big game, upland game, or non-game (i.e., coyote) hunting areas?
- Are restrictions to avoid conflicts with natural and cultural resources adequate?
- How can access concerns and problems be best dealt with?
- Is transitioning from a stocked non-native rainbow fishery to a stocked redband fishery in Krumbo Reservoir a reasonable alternative to consider in the CCP?
- What modifications to the program might improve fishery or game populations and improve the experience for visitors?
- Is the use of live bait a concern?
- Should a recreational carp fishery be provided? Are there opportunities for recreational carp fishing outside the south fishing loop?
- Are native redband trout present in Krumbo Creek? If so, could the population establish a fishery in the reservoir?

- Is there evidence that fertile non-native rainbow trout in Krumbo Reservoir are affecting redband trout in the Blitzen River basin?

Wilderness

Harney Lake was previously recommended for wilderness designation, but the recommendation was neither completed nor terminated. All refuges undertake new wilderness reviews as a part of the CCP process.

Key Questions for the CCP

- Which areas qualify as wilderness study areas? How would management and use of any potentially eligible refuge areas be affected by wilderness designation?

Collaboration

Involving the public in major refuge decisions and working successfully with partners to increase effectiveness have been recent emphases for the Refuge. Several resource issues, such as effective control of invasive or habitat restoration, cannot be effectively addressed without awareness of and attention to landscape level conditions. Refuge actions in the areas of habitat management and water rights are other areas where larger communities are affected. The need for collaboration and outreach has been a message the Refuge has consistently received from diverse interests both prior to and during scoping. The Refuge has a need to ensure that key stakeholders understand, support, and are involved in a meaningful and productive manner throughout the planning process.

Effective collaboration creates an opportunity for the Refuge to engage the diverse public in constructive dialogue that seeks agreement on key issues. This process will enhance relationships between the Refuge and stakeholders and among the stakeholders themselves. These relationships will enable the Refuge to address challenges in a more efficient and comprehensive manner.

1.9.3 Issues outside the Scope of the CCP

The following issues were raised by the public and not addressed in the CCP/EIS:

- The need for pullouts for bird watchers along State and County roads.
- Issues related to the placement of transmission lines over or adjacent to the Refuge in conjunction with the development of alternative power projects on Steens Mountain (see http://www.blm.gov/or/districts/burns/plans/steen_trans/index.php).
- Use of the Silvies River floodplain for agricultural purposes and without an emphasis on wildlife uses.

1.10 Refuge Vision and Goals

1.10.1 Refuge Vision

Together with our surrounding community, partners, friends, staff, and all those who cherish this unique place where desert and water meet:

Malheur National Wildlife Refuge commits to care for, conserve, and enhance the health of the Malheur Lake, Blitzen Valley, and Double-O units, including the playas, dunes, marshes, rivers, meadows, and ponds that are all part of this landscape.

We will observe nature and manage in harmony with ecological forces, while recognizing and maintaining the Refuge as a key anchor for migratory and breeding waterfowl, waterbirds, shorebirds, songbirds, and raptors.

We will work diligently to improve the health of the land and water, reducing the destructive impact of carp and other invasive species, addressing imbalances in floodplain function, and restoring the original abundance of fish and wildlife for which Malheur Refuge is famous.

We will celebrate and welcome our visitors, noting and protecting the features that draw people again and again—the expansive landscape, the plenitude and diversity of wildlife, and the signs of a timeless history.

We will allow and enhance opportunities to experience abundance, solitude, and renewal, for people birding, fishing, hunting, and learning on the Refuge. In respect to our ancestors and their fortitude, we will carefully preserve the legacies they left behind on this land.

Collaboration with our neighbors, partners, and friends will be a critical cornerstone in our day-to-day work; we recognize that nature crosses boundaries and we can be successful only in partnership. We recognize that our activities are inextricably linked to the health of the local economy. We commit to environmental stewardship and sustainable management. We commit to learn from our efforts, successes, and failures; to be humble about what we know; and to continuously strive for greater understanding in our stewardship of this remarkable place.

1.10.2 Refuge Goals

The Service defines a goal as a "descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose, but does not define measurable units" (602 FW 1). Refuge goals are a means to achieving refuge purposes. Goals translate into one or more objectives that define these conditions in measurable terms. A well-written goal directs work toward achieving a refuge's vision and ultimately, the purposes of a refuge. Collectively, a set of goals is a framework within which to make decisions. This CCP defines 14 goals for the Malheur Refuge.

GOAL 1. Enhance aquatic health and habitat conditions essential to the conservation of the flora and fauna that depend on Malheur Lake and associated water bodies.

GOAL 2. Protect, maintain, and rehabilitate riverine and riparian habitats to conditions essential for the conservation of native fish and wildlife species.

GOAL 3. Protect, maintain, and rehabilitate riparian habitats to conditions essential for the conservation of wildlife species.

GOAL 4. Enhance, protect, and/or maintain primary habitats essential to the conservation of a diversity of aquatic and terrestrial wildlife species.

GOAL 5. Enhance and maintain rare and unique habitats.

GOAL 6. Welcome visitors and offer them a safe experience of the Refuge's outstanding features: diversity of wildlife, signs of earlier inhabitants, scenic landscapes, and solitude. As a result, visitors will leave the Refuge with a memorable experience that fosters a connection between themselves and nature and with an appreciation of Malheur Refuge's unique resources.

GOAL 7. Connect the hearts and minds of visitors with the places and resources the Refuge protects, and enlighten visitors' experiences with an understanding of, appreciation for, and knowledge about historic and natural resources, and the importance of conservation and stewardship.

GOAL 8. Provide reasonable challenges and opportunities, and provide uncrowded conditions for the hunting and fishing public.

GOAL 9. Initiate and nurture relationships to build support for the Refuge, and fortify refuge programs and activities to achieve the Refuge's purpose and goals.

GOAL 10. Manage prehistoric and historic cultural resources for their educational, scientific, and cultural values for the benefit of present and future generations of refuge users and for the communities that are connected to these resources.

GOAL 11. Identify and protect prehistoric and historic resources on the Refuge that are eligible for or listed on the National Register of Historic Places.

GOAL 12. Manage the Refuge's paleontological resources for their educational and scientific values for the benefit of present and future generations of refuge users.

GOAL 13. Gather scientific information (surveys, research, and assessments) to support adaptive management decisions.

GOAL 14. Integrate our conservation-based mission with the best available science and become a leader in advancing best practices for the design and management of innovative, sustainable refuge and community development opportunities.

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2.1 Considerations in Alternative Design

The established refuge purposes serve as the foundation on which this plan is constructed (see Chapter 1). Formulating alternatives that correspond with refuge establishment purposes is mandated for National Wildlife Refuges by the NWRS Administration Act of 1966 (as amended 16 U.S.C. 668dd-668ee). Malheur Refuge's purposes and natural resource considerations are therefore foundational in formulating alternatives for this CCP. House Report 105-106 accompanying the National Wildlife Refuge System Improvement Act of 1997 states, "the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first."

This CCP was also developed through a collaborative process in order to solicit and incorporate public input throughout all stages of plan development, as well as build support for its content and implementation. A variety of organizations and individuals contributed to this CCP (see Appendices I and J). Together with vested collaborators and stakeholders, we created, reviewed, and refined the content of these alternatives, goals, and objectives for the Wildlife and Habitat, Visitor Services, Cultural Resource, and Paleontology programs through a series of interactive meetings.

Each collaborative meeting was attended by 30 to 40 participants, including technical experts, scientists, government agencies, conservation organizations, local and statewide residents, recreation groups, Tribal representatives, refuge visitors, and elected officials. Technical working groups were created by the Service to serve as forums for specific complex resource issues.

Of the resource concerns discussed by participants these significant issues were identified as priorities: improvement of aquatic health through carp population control; enhancement of the inventory and monitoring program (including climate change); habitat management (including implementation and adaptive management); active engagement with partners to implement and evaluate management and restoration activities within and beyond our refuge boundaries; and strategic assessment and planning for the restoration of refuge watersheds, primarily the Blitzen River and its tributaries.

The poor aquatic health of the Refuge's lakes and wetlands is the biggest and most immediate issue facing the Refuge over the next 15 years. Common carp are the largest contributor to degradation of aquatic habitats. With carp as the top priority, staff time and funding will be predominantly directed at reducing the carp population to a threshold goal of 100 pounds of carp per acre in refuge lakes (see Appendix S). Studies (Bajer et al. 2009) have shown that at this level, carp impacts to the food web are reduced and other organisms can flourish despite the presence of carp. Carp control strategies must also address minimizing carp numbers in wetland and riverine habitats throughout the Harney Basin. To reach this goal the Refuge will need active partners to assist with assessment and control projects. The Aquatic Health Coalition has been created to leverage partners and secure funding. Three aquatic health working groups have been formed within the coalition to develop strategies for carp population assessment, carp control on- and off-refuge, and partnership enhancement and funding opportunities. Participants consist of fish and wildlife biologists, researchers, subject matter experts and ecologists from various Federal and State agencies, nongovernmental organizations, and institutions. The desired condition for refuge aquatic habitats would be represented by teeming masses of phytoplankton and zooplankton, reduced suspended silts, and a flourishing diversity of macroinvertebrates, vegetation, and fish—all for the benefit of migratory birds and resident wildlife.

A comprehensive inventory and monitoring (I&M) program is critical to the mission of the Refuge, and the development of an effective I&M program has been identified as an integral part the CCP. This program will allow the Refuge to gather the necessary data to evaluate the impacts of various management strategies, climate change, and other major influences as they relate to CCP goals and objectives. To carry out the I&M program the Refuge will not only need its staff, but others, such as citizen scientists, partners, and other interested parties, to assist with data collection, input, and analysis. We aim to create an I&M program that is transparent, uses best available science, is collaborative, and links to adaptive management strategies.

The Refuge has a diversity of habitats spread across a large landscape interwoven with waterways, both natural and artificial. This complex and interconnected systems of land and water require intensive management. The upland landscape is also overwhelmed with invasive plants (pepperweed (*Lepidium latifolium*) and large monotypic stands of reed canarygrass (*Phalaris arundinacea L.*)) covering thousands of acres. To address this habitat management priority the Refuge established the Ecology Working Group (Appendix L). Consisting of ecologists and wildlife biologists representing a broad assortment of organizations, this group is focusing on the development of habitat models describing successional conditions that will provide guidance in achieving specific plant community objectives. Partners and working groups will continue to work together with the Refuge in the pursuit of the best available science to further our understanding of the effects of implementing management activities, evaluating methods and techniques, and initiating adaptive management to address needed changes. The desired outcome is to work collaboratively with others to address habitat management needs using best available science, innovative methods and techniques, and transparency. The Refuge is committed to keeping our partners, neighbors, and others engaged in our progress and will host an annual educational science day to highlight the methods, techniques, and strategies being used for refuge management.

The restoration of ecosystem function both on- and off-refuge is of great interest to our collaborators. Several watersheds terminate on the Refuge and influence its ecological health. To address these larger landscape issues the Refuge will actively engage with partners to develop and implement solutions. The Blitzen River, for example, was once a free-flowing river that was harnessed while in private ownership to irrigate meadows for livestock. After acquisition of the valley by the Service, water continued to be diverted to meadows and wetlands to provide habitat for migratory birds. Water is fed by gravity from the river into the water delivery system, which consists of approximately 2,000 miles of ditches and canals, and through about 1,000 water control structures. To date millions of dollars have been spent to improve passage and screening at existing facilities and structures for redband trout (*Oncorhynchus mykiss gairdnerii*). The best quality wetland habitat for migratory birds on the Refuge is found within the human-made wetlands and ponds of the Blitzen Valley because the aquatic health of the Refuge's lakes have been so detrimentally impact by invasive carp. Although the Refuge's highest priority is to reach a desired carp control threshold goal of 100 pounds per acre across the entire aquatic landscape, efforts will be made to continue making progress on improving passage and screening to enhance conditions for native fish and to facilitate trapping carp and restricting their movements; on improving water quality and where possible, lowering summer stream temperatures to make riverine conditions more attractive to redband trout and less favorable to carp; and on reducing negative impacts of flood events to nesting birds. The Refuge may pursue small-scale projects that enhance habitat for redband trout and lower water temperatures in the upper Blitzen Valley, which will contribute to the aquatic health objective of a reduced carp population. Watershed restoration is a very complex, multilayered project that will require extensive cultural resource clearances and surveys, water rights evaluation, infrastructure changes, and discussion about desired outcomes. The end result should be substantial improvements

for the Blitzen River and neighboring watersheds, as represented by healthy populations of native fish and mussels, a flourishing diversity of macroinvertebrates and plants, improved passage and screening for redband trout and other native fish, carp passage deterrents, lower water temperature, and reduced turbidity for the benefit of migratory birds and resident wildlife.

Following the description of the three alternatives, Table 2-2 summarizes the key differences between the alternatives. Following the summary table, detailed descriptions of the goals, objectives, and strategies for each alternative are presented.

2.2 List of Goals

GOAL 1. Enhance aquatic health and habitat conditions essential to the conservation of the flora and fauna that depend on Malheur Lake and associated water bodies.

GOAL 2. Monitor, protect, maintain, and/or rehabilitate riverine and riparian habitats to conditions essential for the conservation of native fish and wildlife species.

GOAL 3. Protect, maintain, and rehabilitate riparian habitats to conditions essential for the conservation of wildlife species.

GOAL 4. Enhance, protect, and/or maintain primary habitats essential to the conservation of a diversity of aquatic and terrestrial wildlife species.

GOAL 5. Enhance and maintain rare and unique habitats.

GOAL 6. Welcome visitors and offer them a safe experience of the Refuge's outstanding features: diversity of wildlife, signs of earlier inhabitants, scenic landscapes, and solitude. As a result, visitors will leave the Refuge with a memorable experience that fosters a connection between themselves and nature, and with an appreciation of its unique natural resources.

GOAL 7. Connect the hearts and minds of visitors with the places and resources the Refuge protects, and enlighten visitors' experiences with an understanding of, appreciation for, and knowledge about the historic and natural resources, and the importance of conservation and stewardship.

GOAL 8. Provide reasonable challenges and opportunities, and provide uncrowded conditions for the hunting and fishing public.

GOAL 9. Initiate and nurture relationships to build support for the Refuge, and fortify refuge programs and activities to achieve the Refuge's mission and goals.

GOAL 10. Manage prehistoric and historic cultural resources for their educational, scientific, and cultural values for the benefit of present and future generations of refuge users and for the communities that are connected to these resources.

GOAL 11. Identify and protect prehistoric and historic resources on the Refuge that are eligible for or listed on the National Register of Historic Places.

GOAL 12. Manage the Refuge's paleontological resources for their educational and scientific values for the benefit of present and future generations of refuge users.

GOAL 13. Gather scientific information (surveys, research, and assessments) to support adaptive management decisions.

GOAL 14. Integrate our conservation-based mission with the best available science and become a leader in advancing best practices for the design and management of innovative, sustainable refuge and community development opportunities.

2.3 Alternative 1

Alternative 1 represents the "no change" alternative as required by NEPA as amended (42 U.S.C. 4321-4347). The refuge staff would continue programs at current levels, as described in Chapters 3, 4, and 5.

Lake and Wetland Habitat: Aquatic health management,[1] specifically controlling common carp (*Cyprinus carpio*) requires a multifaceted program. For decades, water drawdowns and rotenone treatments were the dominant carp control tools. At this time, refuge staff are using water rotations and dewatering of strategic wetland units in the Blitzen Valley and the Double-O Unit to augment habitat conditions and to decrease carp populations. Strategic water rotations/dewatering are pursued within all units on a regular basis. This strategy is to control all life stages of carp and to decrease available habitat for successful spawning. Furthermore, due to the listing of the redband trout (*Oncorhynchus mykiss gairdneri*) as a sensitive species by the State of Oregon, fish screens and ladders have been constructed on the mainstem of the Blitzen River and many diversions to decrease entrapment of this native species in wetland units. This also is advantageous to carp control because it increases the Refuge's ability to control carp movement upstream.

On-the-ground work is focused on gathering scientifically sound information related to habitat assessments such as water quality (e.g., dissolved oxygen, turbidity, temperature, macroinvertebrate diversity, and pH), carp population dynamics, and control strategies. Grant funding is pursued to conduct research for a long-term solution to improving aquatic health and specifically carp control. The Aquatic Health Coalition has formulated a Harney Basin–wide carp control plan which provides more details.

Riverine strategies have focused on the placement of rock weirs in designated reaches of the Blitzen River, as well as Bridge and Mud creeks. Through these projects, refuge staff sought to provide habitat improvement and bank stabilization by increasing stream complexity through the addition of rock structures (e.g., inverted weirs, rock veins, boulder clusters) and large woody debris (e.g., root wads). River bank stabilization was also sought by raising the grade of the stream bottom water level with rock structures and by resloping incised banks and re-establishing riparian vegetation (e.g., sedges, willow, rose) to benefit redband trout. Post-project assessments have reached conflicting conclusions regarding the success of these efforts. Ease of fish passage (e.g., ladders, screens) on the Blitzen River, relevant tributaries, and fisheries (e.g., East Canal) continues to be improved. Riparian shrub propagation has also taken place on several reaches of Mud and Bridge creeks and the Blitzen River. Native fish passage, placement and maintenance of carp barriers, and vegetative rehabilitation

[1] Although aquatic health also includes other management issues such as properly functioning wetland cycles and river-related issues (i.e. dissolved oxygen and stream temperature), the invasion of aquatic species (e.g., common carp) is recognized as the most significant factor for compromising aquatic systems and associated wildlife populations within the Refuge.

efforts would continue under this alternative. Comprehensive water quality studies would continue to take place contingent upon available funding, with the aid of the U.S. Fish and Wildlife Service (USFWS) Water Resources Branch, Region 1 staff. Additional riverine enhancement would consist of isolated, small-scale, in-stream improvements when resources are available.

Terrestrial and wetland habitat management would continue as currently practiced. Current habitat objectives address the needs of various waterbirds, shorebirds, and waterfowl by providing conditions necessary for nesting, pairing, and migration. Current focal or target species include the greater sandhill crane (*Grus canadensis tabida*), willow flycatcher (*Empidonax traillii*), redhead (*Aythya americana*), mallard (*Anas platyrynchos*), gadwall (*Anas strepera*), cinnamon teal (*Anas cyanoptera*), and an assortment of shorebirds, as specified in the Blitzen Valley Management Plan (Rule et al. 1990) and Double-O Habitat Management Plan (David and Ivey 1995). Management targets four major habitat types, consisting of upland, riparian, marsh, and meadow habitats. A specified irrigation schedule (March 1 through July 25) is used throughout most of the Refuge, with targeted areas receiving winter irrigation (prior to March 1). Plant litter, which becomes detrimental to wildlife over time, is reduced through the use of prescribed burning, haying on or after August 10, and rake-bunch grazing occurring on or after September 1. Approximately 40 percent of meadows are left untreated annually, with the exception of irrigation and infrequent prescribed burns. Besides water management, the only vegetation treatment strategy used in wetland and meadow habitats before August 10 is the application of herbicides for invasive plant control. Minimal habitat restoration work occurs. The current trend involving emergent encroachment into wet meadows would continue due to the favorable conditions that extended flood irrigation creates for common and hybrid cattails.

Public uses, including wildlife observation, wildlife/nature photography, interpretation, environmental education, hunting, and fishing, would continue with the current facilities and programs in place. No new public use facilities would be developed. Areas currently closed to public access would remain in effect to provide sanctuary during the winter waterfowl season. The Refuge would not pursue any additional land protection measures under the no change alternative.

Cultural resources, specifically archaeological resources, would continue to be considered during project planning for all refuge programs. Historic resources would continue to be stabilized and restored as funding becomes available through partnerships. Paleontological resources would continue to be protected. Interpretation of archaeological and historic resources would remain the same.

2.4 Alternative 2

Alternative 2, the Service's Preferred Alternative, can be summarized as follows:

- The primary focus and top priority would be to improve the aquatic health of lakes and wetlands, primarily via aggressive control of common carp.
- Habitat management for specified habitat attributes with wetland habitats[2] would follow. A comprehensive riverine/wetland strategicplan for watersheds within the Refuge would be initiated.

[2] Wetland habitats include wet meadows that depend on flood irrigation during the growing season.

- A more developed and structured visitor experience would be available with additional birding, fishing, and hunting opportunities.
- Historic, cultural, and paleontological resource plans would be developed and protected.

Alternative 2 recognizes that the Refuge is legally mandated to conserve and protect migratory birds to achieve its establishing purposes. Addressing aquatic health is key to meeting this obligation and full attention would be given to its improvement. The greatest obstacle to this effort is common carp, an introduced fish that negatively impacts water quality and in turn impacts native fish, wildlife, and plants that depend on the Refuge's aquatic resources. Primary management emphasis would be placed on improving aquatic health, with staff time and budget largely directed to carp control. Partnerships and staff resources would also address the needs of the visitor services and habitat management programs. Development of a comprehensive riverine/wetland strategicplan would be initiated with the rate of progress determined by staff and resource availability, as well as interest and resource contributions from partners.

Lake and Wetland Habitats: The emphasis of Alternative 2 is to improve the aquatic health of the Refuge's lake and wetland habitats, to enhance the feeding, resting and nesting components necessary for a variety of shore/wading birds, waterfowl, and other wildlife species. This would be achieved largely through carp population control. As turbidity decreases and submergent vegetation and associated invertebrate species become more abundant, the productivity of Malheur Lake and of other water bodies within the Refuge (e.g., Boca Lake and Warbler Pond) would increase.

Because of the sheer size and complexity of the aquatic health problem, primarily due to carp, a variety of assessment and control tools will be needed to effectively address it. Existing partnerships such as the Aquatic Health Coalition (made up of Federal, State, nongovernmental organization, and Tribal participants) would assist in strategizing and implementing the most effective suite of control, inventory, funding, and monitoring methods.

Although the overall carp assessment and control strategy for the Harney Basin is currently being considered, it would incorporate methods successfully implemented worldwide and customized, as needed, to suit the Refuge. Strategic assessments of lake, river, and wetland habitats and carp population dynamics would guide control activities and provide enhanced understanding of the system's innate ability to recover from carp impacts. Control strategies would include, but not be limited to, the application of piscicide, chemo-attractants, chemo-repellants, barriers, commercial harvest, angling, and water manipulation. The need for continued amendments to and the construction of additional strategically placed in-stream structures (i.e., traps, screens, and fish wheels) that allow native fish passage and impede/prohibit carp movement through the system would also be considered.

Riverine Habitat: The Blitzen River and its tributaries currently provide the foundation and lifeblood on which fish and wildlife depend. Because a vast majority of refuge-managed habitats are reliant on irrigation via a complex network of dams, canals, and ditches associated with the river, it is important to understand the connectivity between the Malheur/Mud and Harney Lake systems and associated wetlands in light of carp control. This alternative allows for initiating the development of a comprehensive riverine/wetland strategicplan, which would depend on staff and funding availability. The primary focus of refuge staff is the improvement of lake and wetland aquatic health through carp control. However, we may make efforts to reduce summer river temperatures through changes in water management to increase the cold water barrier, which keeps carp out of wetlands in the upper Blitzen Valley.

The mechanisms for addressing river-related issueswould be placed in motion strategically under this alternative by completing necessary assessments and pilot projects as funding, staff time, and resources provided through partnerships allow. The Refuge recognizes that achieving a greater understanding of riverine habitat parameters and opportunities for improvement is very important. If, during the life of this CCP, the minimum carp threshold (e.g., 100 pounds per acre) is met and maintained, more staff time and resources would be directed to addressing whether river rehabilitation efforts are needed and, if so, how such efforts should be identified, prioritized, and achieved.

I&M efforts would place a high priority on information that assists the Refuge in building a baseline data layer that could be used in pursuing riverine activities while furthering our understanding of adjacent habitats. More in-depth, site-specific assessments would be done if opportunities arise (e.g., funding availability and additional refuge staff).

Wetlands and terrestrial habitats would continue to be managed to promote the life-history needs of focal resources (see Appendix E). The overarching theme for the management of wetland and terrestrial habitats would be greater flexibility in identified strategies to adequately meet establishing objectives. Flexibility is critical for maintaining a variety of plant communities within habitats, such as emergent marsh, wet meadow, and dry meadow, to meet foraging, breeding, brood rearing, and other life-cycle needs of migratory birds and other native wildlife. For example, bobolinks and sandhill cranes both depend on wet meadows during the breeding season. They do, however, differ greatly in their use of and the conditions needed within these meadows. To address the wide assortment of needs found within each habitat type, vegetation management tools would address the accumulation of litter and plant community succession. Tools would include, but would not be limited to, traditional late summer haying and autumn/winter rake-bunch grazing (to meet the foraging needs of wildlife species that arrive early) and highly prescriptive warm-season (growing season) grazing, mowing, farming, extended dewatering, etc. (to reclaim acres lost to invasive plants, such as common cattail and reed canarygrass) or to rehabilitate communities that have transitioned beyond desired conditions.

Wildlife viewing, photography, and interpretation, the cornerstones of the public use program, would provide quality opportunities for observing nature. Management under this alternative would be focused on expanding developed facilities and programs for casual visitors and birders (of all abilities). Both spur and loop trails (at least 1 mile) would be added to allow visitors to explore and learn about wildlife and the Refuge, and several trails would be upgraded or built to ADA standards for accessibility compliance. A number of specific viewing facilities to enhance visitors experiences, such as viewing overlooks and elevated viewing platforms, would also be upgraded and developed. These projects would include restoring the historic Audubon photography blind at the Refuge Headquarters Display Pond; building two ADA-compliant, first-come, first-served permanent screened photography blinds; and building an elevated viewing platform at Malheur Lake. For advanced birders, the Refuge would maintain and replant cottonwood trees and other non-endemic trees and shrubs at six historic landscapes to continue to provide habitat used by rare and incidental passerines (perching birds or songbirds).

Connecting the hearts and minds of visitors with the Refuge would be accomplished with docent-led tours conducted on a seasonal basis at different locations on the Refuge, and would include opportunities for guided kayak and canoe tours on Malheur Lake. Expanded vehicle access would be available, with year-round vehicle access to Krumbo Reservoir, along the Boat Landing Road near Refuge Headquarters, and the southern portion of the East Canal Road to the confluence of Bridge

Creek. In addition, boating that is not directly supporting the fishing program would be available at Krumbo Reservoir to enhance wildlife viewing.

Interpretive features and programs are another high priority, and key interpretive themes would include the significance of the Refuge to breeding and migratory birds, precontact and post-contact historic events, wilderness, geology, aquatic health, water importance, resource challenges, and the National Wildlife Refuge System. A stronger emphasis would be placed on developing and using modern media. The George Benson Memorial Museum at Refuge Headquarters would be enhanced, with interpretive panels added to connect visitors with places and the resources that the Refuge protects. Additional outdoor interpretive panels would be placed at key field sites and would focus on improving aquatic health and associated management activities, and weaving historical events with the ecology of the Refuge. Special events and public presentations by refuge staff and volunteers would be expanded and promoted to enlighten visitors' experiences.

Welcome and Orientation: Refuge staff would emphasize improvements in welcome and orientation features, with an emphasis on the use of modern and traditional media to reach and orient visitors. Up to eight outdoor welcome and orientation panels would be located near Refuge entrances and at other congregation areas to direct and guide visitors during their visit. To welcome visitors, developed sites with visitor amenities, such as picnic tables, shelters, and vault toilets, would be upgraded and at least five new developed sites features would be built. An enlarged visitor contact station and gift shop at Refuge Headquarters and a seasonal contact station at P Ranch would be built to provide personal contact between visitors and Refuge staff and volunteers.

Environmental education would be provided, but with more strategic use of Refuge staff time and resources. Strategies would include coordinating efforts with other environmental education initiatives. Existing modules from national and regional programs, such as the Junior Duck Stamp Program and International Migratory Bird Day, would be used as refuge staff and volunteers become available. An outdoor environmental education shelter and learning area at Refuge Headquarters would be built to augment the existing environmental education program and other environmental education initiatives.

Hunting opportunities for upland game would be enhanced by improving the Saddle Butte access on the north side of Malheur Lake and extending the season opener to the fourth Saturday of October (approximately three weeks earlier than current program) to the end of the State pheasant season in the Buena Vista Hunt Unit. The northern part of Malheur Lake and the Boundary Hunt Unit would remain open under slightly modified regulations.

The waterfowl hunt would also be enhanced by promoting a youth hunt and with improvements to the Saddle Butte access. In addition, new waterfowl hunt areas would be provided (approximately doubling or tripling the existing hunt area) by opening a portion of the south-central area of Malheur Lake and within the existing Buena Vista Hunt Unit. The season opener for the new waterfowl hunt units would be on the fourth Saturday of October to the end of the State waterfowl season. One new access point with an expanded parking area and an enhanced boat launch would be provided at the airboat launch site near Refuge Headquarters to access the new hunt unit of Malheur Lake. In partnership with potential users, the Refuge would also support adding accessible facilities in the Buena Vista Hunt Unit for waterfowl hunters with disabilities.

Fishing opportunities along the upper Blitzen River, the southern portion of East Canal, and Mud and Bridge creeks would continue. Vehicle access would be allowed on the East Canal Road to the

confluence of Bridge Creek to make this opportunity more accessible for visitors and would enable access to Granddad Reservoir located on BLM land. In addition, a new pedestrian crossing at Bridge Creek would enhance fishing access to the 7 miles of Bridge Creek located west of the East Canal to its confluence with the Blitzen River. Opening a new bank fishing opportunity with a parking area at Sodhouse Lane to the bridge on the Boat Landing Road, part of the Headquarters Loop Trail, would open a new area to fishing on the Blitzen River. The season for this fishing unit would be from August 1 to September 15. Orientation panels with maps, brochures, regulations, and additional information would be added to fishing areas to provide information to visitors about fishing opportunities.

At Krumbo Reservoir, year-round access would be provided for wildlife viewing, boating, and fishing in coordination with State seasons and would increase public fishing opportunities. The stocking program of sterile rainbow trout would continue in coordination with ODFW, and steps would be undertaken to conduct a genetic introgression study on redband trout.

Volunteer Program: To help enhance the public use program and other refuge programs, a full-time volunteer coordinator would be added to the staff. The volunteer coordinator would increase recruitment, retention, and the return rate of volunteers. The position would also expand the program to better use facilities and refuge staff, assist with building partnerships, and increase public outreach.

Protection of cultural and paleontological resources would be strengthened by the development, in cooperation with partners, of step-down management plans for administrative sites where historic or prehistoric resources are present, and for archaeological and paleontological resources. Interpretation of historic sites would be expanded through the development and implementation of site-specific interpretive plans. Opportunities for Native Americans to collect plant materials for traditional uses would be expanded. I&M of archaeological resources would increase as part of step-down management plan implementation.

Boundary Unit lands: Some Refuge lands located within the Boundary Hunt Unit (Refuge lands west of State Highway 205 and isolated parcels in the Krumbo watershed) are managed by the BLM under cooperative land management agreements with the USFWS. Under these agreements, typical BLM land management practices and uses are allowed to occur. Upon final signature of this CCP, these cooperative land management agreements will be allowed to expire, except for those pertaining to the use of Diamond and Nine Mile corrals. Refuge lands will be managed by the USFWS to further Refuge purposes, until a land interchange or new cooperative land management agreement is negotiated with BLM.

Energy Independence: The refuge staff would seek to become energy independent and carbon negative, and would continue to emphasize partnerships to maximize adaptive management.

Inventory and monitoring for all programs would be strengthened. Program-wide I&M plans would be developed to guide annual management actions. The fish, wildlife, and vegetation plans would emphasize focal species and national monitoring efforts. A geodatabase would be created to track data collected under these plans.

2.5 Alternative 3

Alternative 3 can be summarized as follows:

- Co-equal priorities would be to improve the Refuge's aquatic health of lakes and wetlands, primarily via aggressive control of common carp and to initiate the development of a comprehensive riverine/wetland strategicplan for watersheds within the Refuge.
- Habitat management to specified habitat attributes would place the highest priority on habitat in transition, followed by wetland habitats.
- The visitor experience would be less structured and developed, with additional birding, fishing, and hunting opportunities.
- Historic, cultural, and paleontological resource plans would be developed and protected.

Alternative 3 places primary management emphasis on both aquatic health (carp control) and completion of a comprehensive riverine/wetland rehabilitation plan. Partnerships and staff resources would also address the needs of the visitor services and habitat management programs.

Lakes and Wetland Habitat: Under Alternative 3, primary management emphasis would continue to be placed on aquatic health via carp control. Actions and outcomes discussed under Alternative 2 relevant to Malheur Lake, refuge wetlands, and carp control would be essentially the same under Alternative 3.

Riverine Habitats: A co-equal priority under this alternative would be the development and completion of a comprehensive riverine/wetland strategicplan. The eventual outcomes of the riverine plan would be to enhance habitat for native fishes, to enhance water quality within the river, to provide for greater floodplain connectivity, and to improve the extent and quality of riparian habitat, if necessary.

The river strategic planning effort would commence with assessment of the geomorphology, ecology, and hydrology of the Blitzen River and the river's influence on other refuge management programs such as visitor services, cultural and historic resources, and water rights. Assessment prior to management changes will not only enhance understanding of this dynamic system, but will also assist in reducing the risk that is present whenever riverine enhancement is pursued. By using a large range of riverine experts and evaluating an array of possible enhancement scenarios, the Service would be able to develop an informed strategy for addressing this critical issue. The first seven years would be spent collecting necessary information (geomorphological, hydrological, and biological assessments) to determine if enhancement is necessary and, if so, where it should take place. The next five years would be used for implementing and monitoring pilot projects to gain a better understanding of system response to enhancement activities. Using results from the pilot projects, a comprehensive plan would be crafted to begin implementation of rehabilitation efforts deemed necessary.

Other Habitats: Because the river evaluation and enhancement effort would proceed slowly and would likely not be fully implemented until the end of the 15-year timeframe, no discernable difference would exist between Alternatives 2 and 3 with regard to the management of wetland and terrestrial habitats within the Blitzen Valley.

Wildlife Viewing, Photography, and Interpretation: As in Alternative 2, the cornerstone of the public use program will be providing quality wildlife observation and wildlife/nature photography opportunities. Management under this alternative for wildlife viewing, photography, and interpretation would be similar to Alternative 2, but there would be less emphasis on developed facilities and more emphasis on self-guided and off-trail experiences. The 42-mile Blitzen Valley auto tour route (Center Patrol Road) would be seasonally closed to vehicle access (from August 15 to the fourth Friday of October in the Buena Vista Unit, and August 15 to March 1 in the P Ranch Unit) and would be redesigned into two or three shorter auto tour routes available year-round. Walk-in, free-roam access along the closed portions of the Center Patrol Road and dike tops in both units would be allowed during the seasonal closure to provide opportunities for self-guided and off-trail experiences. This would provide 11 weeks of free-roam opportunity in the Buena Vista Unit and 27 weeks in the P Ranch Unit.

Docent-led tours would be included as in Alternative 2. Year-round vehicle access would be allowed on the Boat Landing Road near Refuge Headquarters to the elevated viewing platform at Malheur Lake. Seasonal pleasure boating at Krumbo Reservoir would remain available, but vehicle access to Krumbo Reservoir would be seasonal with walk-in access from November 1 to the fourth Friday of April to provide visitors with improved opportunities for solitude and appreciation of the surrounding landscape. The southern portion of the East Canal Road to the confluence of Bridge Creek at the East Canal would be open to year-round, walk-in access. Both spur and loop trails (at least 1 mile) and a number of specific viewing facilities, such as overlooks and platforms, would be added with limited investment. Existing trails would be upgraded or built to ADA standards for accessibility compliance. The historic Audubon photography blind at Refuge Headquarters Display Pond would be restored. Photography opportunities would be restructured with temporary photography blinds erected on a day-to-day basis when free-roam areas are open to the public. The Refuge would maintain and replant trees and shrubs at four historic sites to provide habitat used by rare and incidental passerines.

Interpretive features and programs would be the same as Alternative 2.

Welcome and orientation features would be similar to Alternative 2, except less investment would be made for developed sites. Existing developed sites would be upgraded, and picnic tables and shelters would be built at only two existing developed locations, such as Refuge Headquarters and P Ranch.

Environmental education efforts would be the same as Alternative 2.

Hunting: The upland game and the waterfowl hunts would be managed as under Alternative 2, except a Buena Vista waterfowl hunt would not be permitted and ADA-compliant facilities would not be developed. However, a youth hunt opportunity on the State-designated weekend would be explored for the Double-O Unit.

Fishing opportunities would be similar to Alternative 2, but vehicle access along the East Canal to the confluence of Bridge Creek would not be permitted and the pedestrian crossing at Bridge Creek would not be built. Walk-in and primitive access on the East Canal Road would expand opportunities for solitude.

At Krumbo Reservoir, the fisheries would be managed as under Alternative 2; however, only walk-in access would be available from November 1 through the fourth Friday of April to provide opportunities for solitude.

Volunteer program efforts would be the same as Alternative 2.

Protection of cultural and paleontological resources would be strengthened by development, in cooperation with partners, of step-down management plans for administrative sites where historic or prehistoric resources are present, and for archaeological and paleontological resources. Interpretation of historic sites for these resources would be expanded through the development and implementation of site-specific interpretive plans. Opportunities for Native Americans to collect plant materials for traditional uses would be expanded. I&M of archaeological resources would increase as part of step-down management plan implementation and in conjunction with river rehabilitation plans. I&M would be implemented for paleontological resources as part of the implementation of the management plan developed for these resources.

Boundary lands would be the same as Alternative 2.

Energy independence efforts would be the same as Alternative 2.

Inventory and monitoring efforts would be the same as Alternative 2.

2.6 Features Common to All Alternatives

All alternatives contain some common features. These are presented below to reduce the length and redundancy of the individual alternative descriptions.

Actions will be implemented over the life of the CCP as funding becomes available. Implementation priorities are designated in Appendix C.

Adaptive Management: The Refuge will be using an adaptive management (AM) decision-making process to implement management strategies authorized in the CCP. AM is a science-based public participation process for evaluating and adjusting a conservation effort relative to goal achievement as experience and knowledge are gained through implementation, study, and discussion. The Refuge and its collaborative partners support the fact that AM promotes flexible decision making, which can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. As the CCP is implemented, AM will help the Refuge achieve diverse goals while enhancing wildlife benefits, advancing scientific knowledge, and improving working relationships among stakeholders.

The principle of AM recognizes that ecosystem function is inherently complex and often results in knowledge gaps. AM implementation means a firm commitment to the development of measurable outcomes and the application of rigorous evaluation and monitoring methods to determine whether management goals are being met. Careful monitoring of these actions advances scientific understanding and helps adjust policies or operations as part of an ongoing learning process. This is not a trial-and-error process but rather emphasizes learning while doing, which recognizes the importance of incorporating new information as it becomes available. AM requires flexibility and an ability to acknowledge risks and failures and use new knowledge in a constructive manner to make adjustments while building a foundation for ongoing learning/adjustment. This may include changing

which Resources of Concern are used for habitat management as a result of new data acquired during the Inventory and monitoring process.

The Refuge is committed to a rigorous and inclusive AM approach to enhance public confidence in the Refuge's ability to transfer the theory into practice. The Refuge recognizes that there is a critical need for transparency as CCP implementation moves forward. This transparency as it pertains to AM needs to include both the learning and decision-making processes. The following discussion describes how the Refuge will move forward through AM.

- ***Information Sharing/Learning:*** The Refuge is committed to an AM process that will bring diverse interests together through various forums to share information and site-specific results so that all those engaged, including the Refuge, can learn together (Figure 2-1). These forums would evolve over time but would include collaborative mechanisms with others such as (and potentially evolving from) the collaborative groups that have been active during the CCP process, including the Aquatic Health Coalition, the Ecology Working Group, and an evolution of the Collaborative Planning Group. The timing and frequency of information sharing and learning will be determined by how rapidly new information is being acquired, level of partners' interest and engagement, ecological cycles, and the forum being used. The Refuge will also share the results of its I&M work on an ongoing basis and strive to be responsive to partners' requests for open discussion and collaboration in assessing the need for adaptive changes in management to achieve the goals and objectives of the CCP.

- ***Decision Making:*** As the Refuge and our partners learn through the AM process, new information may show the need for adjustments (e.g. selecting new habitat focal species or evaluation metrics), confirm existing strategies, or identify additional information (Figure 2-1). Based on the best information available at the time, the Refuge will make decisions for future management actions. As with the sharing and learning aspects of AM, the Refuge recognizes the importance of transparency for decisions made during the AM process. The Refuge is committed to bringing together interested parties to assist with the evaluation of available information, as well as consultation about management options and their implications prior to making course-changing decisions. This process does not diminish the Refuge's legal authority to make decisions but rather serves to enhance the decision making process by enabling the Refuge to approach issues from multiple perspectives thereby finding creative solutions to complex challenges.

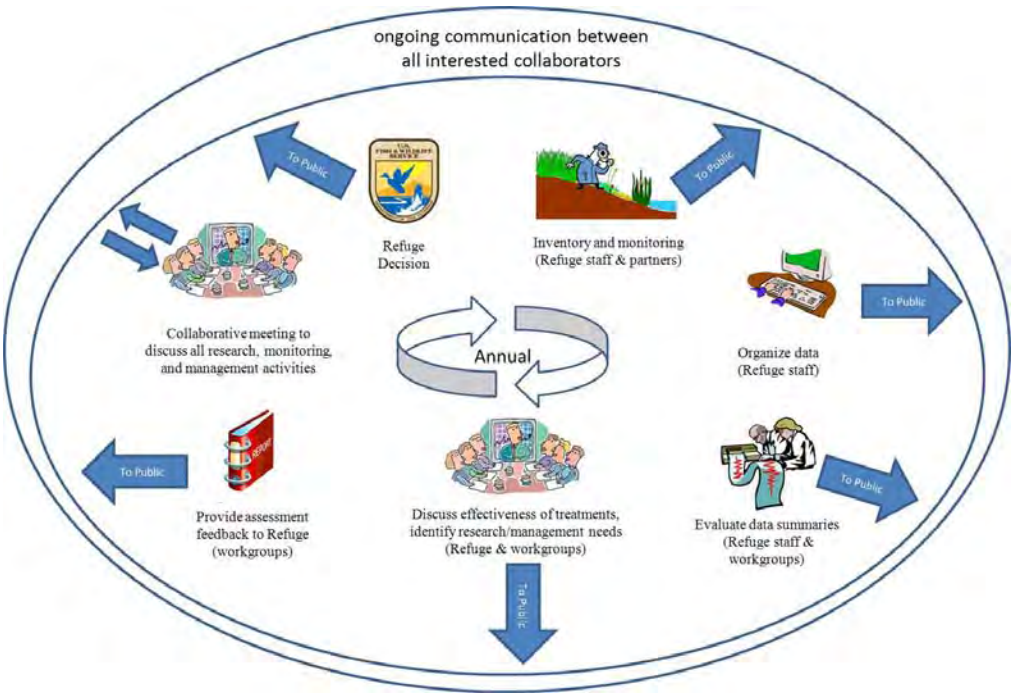

Figure 2-1. Adaptive Management Model

Implementation Subject to Funding Availability: Under each alternative, actions will be implemented over a period of 15 years as funding becomes available. Project priorities are described in Appendix C. The Refuge will continue to work with partners to implement the CCP by sharing results, providing updates on successes and challenges, initiating discussions, encouraging participation, and hosting working groups.

Tribal Coordination: Regular communication with the Burns Paiute Tribe will be common to all alternatives. This tribe is the major local tribal entity the Refuge will coordinate and consult with regarding issues of shared interest. Currently, the Service coordinates with the Tribe on issues related to the Native American Graves Protection and Repatriation Act (NAGPRA; P.L. 101-601) and National Historic Preservation Act (NHPA; 16 U.S.C. 470 et seq.).

State Coordination: The Service will continue to maintain regular discussions with ODFW. Key topics for discussion will be wildlife monitoring, fisheries management (including fish passage and barriers), hunting and fishing seasons and regulations, and the management of species of concern (i.e., sage-grouse).

Harney County Court Coordination: The Service will continue to maintain regular discussions with the Harney County Court as actions under this plan are implemented over the next 15 years.

Maintenance of Infrastructure to Support Management of Wetlands and Meadows: Efforts to enhance the water management system will be made throughout the life of the CCP, to reflect aquatic health (e.g., carp control) and other habitat management needs and constraints. Actions will be directed by existing water rights, funding opportunities, and refuge maintenance priorities.

Refuge Fire Management: the current Refuge Fire Management Plan (FMP) based on the 1985 Refuge master plan and step down plans was updated in 2010. Under this FMP the Refuge is

designated as a single Fire Management Unit (FMU). When this CCP is approved, the FMP must be revised and approved at the Regional level and will act as a step down plan to the CCP. An approved FMP allows a manager to consider a wide range of management responses to wildfires and to conduct prescribed fires. The FMP contains strategic and operational elements that describe how to manage applicable fire program components such as: response to unplanned ignitions, hazardous fuels and vegetation management, burned area emergency stabilization and rehabilitation**,** prevention, community interactions and collaborative partnerships roles, and monitoring and evaluation programs.

Prescribed fire will be used in areas where it is the most appropriate tool to achieve habitat and hazardous fuels reduction goals. Prescribed burns will generally be conducted in the late winter to meet litter management objectives, but may be done at other times depending on desired outcomes.

Climate Change: The refuge staff will participate in and contribute to climate change assessment efforts, including those underway at a landscape scale, such as the Great Basin Landscape Conservation Cooperative (LCC). LCCs are formal science-management partnerships consisting of the Service, other Federal agencies, states, Tribes, nongovernmental organizations, universities, and other entities. LCCs provide science support, biological planning, conservation design, research, and design of inventory and monitoring programs to address climate change and other environmental stressors in an integrated fashion. As needed, objectives and strategies will be adjusted to assist in enhancing refuge resources' resiliency in the face of climate change. The refuge staff will also continue to pursue and engage in mechanisms to conserve energy in refuge operations, including the use of fuel-efficient vehicles.

Partnerships: Partnerships will be maintained and developed to enhance collaboration in support of fish and wildlife resources, recreational opportunities, cultural resources, paleontological resources, educational programs, and to explore ways to share funding and seek grants on projects of mutual interest. Partnerships will also be used to work with others to accomplish common goals, promote mutual understanding, encourage environmentally friendly development, and promote ecotourism opportunities. Workshops and training sessions with professional colleagues and the general public will be developed to obtain ideas, techniques, and support for management decisions to address natural process management, agency mission, and refuge objectives.

Volunteer Opportunities: Volunteers are recognized by the Refuge as key components of the successful management of public lands, and they are vital to implementation of refuge programs, plans, and projects, especially in times of declining budgets. Volunteer opportunities will be maintained and expanded to best use facilities and refuge staff, and to assist with building partnerships and public outreach. A volunteer management plan will be developed and will address the following for all refuge programs: job descriptions, volunteer/staff roles, recruitment and retention of high-quality volunteers, orientation/training, housing, performance evaluations, recognition, administration of the Malheur Wildlife Associates, promotion of the role of the Malheur Wildlife Associates, and Malheur Wildlife Associates program evaluation.

Transportation Coordination: Roads, bridges and trail systems play a vital role in providing access to the public for compatible wildlife-dependent recreation opportunities. Under all alternatives, the Service will look for opportunities to partner with the Oregon Department of Transportation

(ODOT), Burns District of the BLM, and Harney County to maintain and improve safe and appropriate transportation access in and around the Refuge.

Refuge Revenue Sharing Payment: Annual payments to Harney County under the Refuge Revenue Sharing Program will continue according to the established formula and subject to payments authorized by Congress. Total payments made to the County in recent years are listed in Section 5.8.5.

Sustainable Practices for Maintenance and Updating of Existing Infrastructure: Periodic maintenance and updating of refuge buildings and facilities will be necessary regardless of the alternative selected. Periodic updating of infrastructure is necessary for safety and accessibility and to support staff and management needs and is incorporated in the Federal Business Management System and Environmental Management Plan. The Refuge will seek to become energy independent and carbon negative by implementing green technology and sustainable practices.

Endangered Species Act Section 7 Consultations: All projects will be compliant with the Endangered Species Act (ESA, 16 U.S.C. 1531-1544 et seq.). Section 7 consultation was not completed programmatically for the CCP. The need for Section 7 consultations for special projects or actions not described in this plan (e.g., management actions related to aquatic health) will be conducted on a case-by-case basis.

Section 106 Compliance: Any new ground-disturbing projects or modifications (e.g., removal of historic water control structures or dams) will undergo a review under Section 106 of the NHPA (16 U.S.C. 470 et seq.).

Integrated Pest Management (IPM): In accordance with 517 DM 1 and 569 FW 1, an integrated pest management (IPM) approach will be used, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on refuge lands. IPM will involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to non-target species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof, are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide would be needed on refuge lands, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. In accordance with 517 DM 1, pesticide usage would be further restricted because only pesticides registered with the U.S. Environmental Protection Agency (USEPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; 7 U.S.C. prec. 121) and as provided in regulations, orders, or permits issued by USEPA may be applied on lands and waters under refuge jurisdiction.

Environmental harm by pest species refers to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may be a result of direct effects of pests on native species including preying and feeding on them; causing or vectoring diseases; preventing them from reproducing or killing their young; out-competing them for food, nutrients, light, nest sites or other vital resources; or hybridizing with them so frequently that within a few generations, few if any truly native individuals remain. Environmental harm also can be the result of an indirect effect of pest species.

For example, decreased waterfowl use may result from invasive plant infestations reducing the availability and/or abundance of native wetland plants that provide forage during the winter.

Environmental harm may involve detrimental changes in ecological processes. For example, cheatgrass infestations in shrub-steppe greatly can alter fire-return intervals, displacing native species and communities of bunchgrasses, forbs, and shrubs. Environmental harm may also cause or be associated with economic losses and damage to human, plant, and animal health. For example, invasions by fire-promoting grasses that alter entire plant and animal communities eliminating or sharply reducing populations of many native plant and animal species can also greatly increase fire-fighting costs.

See Appendix G for the Refuge's IPM program documentation to manage pests. Along with a more detailed discussion of IPM techniques, this documentation describes the selective use of pesticides for pest management on refuge lands, where necessary. Throughout the life of the CCP, most proposed pesticide uses on refuge lands will be evaluated for potential effects to refuge biological resources and environmental quality. These potential effects will be documented in "Chemical Profiles" (see Appendix G). Pesticide uses with appropriate and practical BMPs for habitat management as well as cropland/facilities maintenance would be approved for use on refuge lands where there likely would be only minor, temporary, and localized effects to species and environmental quality based upon non-exceedance of threshold values in Chemical Profiles.

Hazard Analysis and Critical Control Point Plan: Hazard analysis and critical control points planning (HACCP) is a tool to help natural resource managers identify critical control points in their activities to decrease the spread of invasive species. The HACCP Wizard Version 2.04 (http://www.haccp-nrm.org/Wizard/default.asp) will be used to construct plans for staff, contractors, volunteers, and other users of the refuge to evaluate their activities and address ways to conduct their activities to limit the chance of spreading invasive species.

Water Rights: The right to use water on the Refuge is managed through the State of Oregon's Water Resources Department. Water rights in Oregon are managed by two basic principles: beneficial use and first in time/first in right. Almost all water use on the Refuge has some form of a State-certified water right. The exception is springwater in the Double-O Unit of the Refuge, which is threatened by groundwater withdrawals in the area. To protect the habitats and values associated with springs, the Service will take steps to file a groundwater right under all alternatives.

Water Quality: Water quality is addressed through the ODEQ. Refuge-specific water quality guidelines have not yet been established through a formal TMDL study conducted by the State. Although water quality impairments exist in the Blitzen River before it reaches the refuge boundary, various refuge-led studies have indicated a continued increase in temperature and turbidity and a decrease in dissolved oxygen levels within some refuge water bodies (see Chapter 3) during specific times of the year. Refuge staff will continue to identify and implement best management practices to address water quality.

Blitzen River Water Management: The Refuge will continue to maintain a minimum flow of 25 cfs in the Blitzen River to benefit aquatic resources.

Research, Monitoring, and Inventory: Refuge staff will continue to work with others to share information and expertise on habitat management, terrestrial and aquatic health, and restoration/rehabilitation techniques. Partnerships with local universities, nongovernmental

organizations, Tribes, State and local agencies, and others will be expanded to conduct research that will advance sound science associated with decision making on the Refuge.

Malheur Refuge State and Transition Model: The Refuge is partnering with ecologists, wildlife biologists, and scientists from various State and Federal agencies and nongovernmental organizations to develop the "Malheur Refuge State-and-Transition Model" (STM) to increase understanding of the wetlands managed by the Refuge. It describes various habitat types along a hydrological gradient and discusses the conditions that likely cause transitions between associated plant assemblages. The STM will serve as a "road map" for managing wetlands and uplands toward target habitat conditions and will provide increased understanding of the short- and long-term effects of management treatments on refuge habitats.

Non-priority Uses: Non-priority wildlife-dependent recreational uses will be allowed at the Refuge if found appropriate and compatible. Certain uses will be allowed under the stipulations identified in Appendix B. Incidental uses such as horseback riding will be permitted only on the Center Patrol Road. Bicycling and cross-country skiing will be permitted on all public roads; pets will be permitted in designated areas. All-terrain vehicle (ATV) use is permitted in conjunction with the grazing and haying program. Recreational use of ATVs, snowmobiles, or dirt bikes will not be permitted anywhere on the Refuge. Special stipulations apply for ATV use on the Refuge as outlined in Appendix B.

Prohibited activities include fires, swimming, camping, and collecting natural objects (such as plants, animals, minerals, antlers, etc.), and objects of antiquity. See Appropriate Use Determinations (Appendix A) and Compatibility Determinations (Appendix B) for more information. Such recreational activities not specifically addressed in this document may be allowed on refuge lands, if the Refuge Manager determines that they are appropriate and compatible.

Predator Control: Although such an action is often justifiable, specific attainable objectives must be determined before conducting predator control. It has been noted, for example, that removal of coyotes (*Canis latrans*) often leads to an increase in other predator populations that can be even more detrimental to wildlife production (raccoons (*Procyon lotor*), mink (*Neovison vison*), etc.). If predator control is deemed necessary during the life of the CCP, the proper public process will be followed. Productivity of select key avian species will be monitored under the guidance of the I&M plan to assess whether the Refuge is serving as a source or sink for local avian populations, and if the Refuge is not serving as a source, management options including manipulation of habitat conditions and predator control will be considered.

2.7 Alternatives Considered but Not Developed

River Restoration as Primary Emphasis: Restoration of unimpeded hydrologic processes throughout a large portion of the Blitzen River Valley was considered by the Service but was not carried forward for detailed analysis. Under this scenario, several of the dams and diversions used to manage water in the Blitzen Valley, control the spread of invasive carp, and decrease entrainment of native redband trout would potentially be removed, allowing the river to disperse across the valley in an unregulated fashion. Although this scenario could result in benefits such as increased riparian habitat, an aesthetically pleasing view, improved water quality, unimpeded fish passage, unimpeded transport of materials, and a reconnected floodplain, it could also lead to the loss of prime wetland habitat in the Blitzen Valley, thus falling short of refuge purpose and trust resource responsibilities, as well as the

loss of senior water rights within the Blitzen River watershed. This alternative could also threaten State and County roads, rights-of-way (e.g., power lines), and private property.

Currently, the Blitzen Valley provides the majority of sustainable wetland habitat in the Harney Basin because of the devastating impact of common carp within Malheur Lake. Prior to the introduction of carp, the lake hosted one of the most productive wetlands in the United States. Because of carp infestation and other wetland-related losses, migratory birds have experienced a tremendous loss in habitat availability. Even with the limited amount of wetland habitat still available, the Refuge plays a vital role in providing habitat for these species during breeding and migration. For this reason, refuge staff must first focus on understanding and decreasing the population of carp for better aquatic health refuge-wide before riverine restoration can be addressed.

Because of carp-related impacts, the Refuge is currently not meeting its congressional mandate for Malheur Lake. Broad-scale river restoration could compromise the availability of the remaining functioning refuge wetland habitats and have significant negative impacts to the Pacific Flyway. Before such extensive river restoration is taken, additional understanding of its possible effects is needed. Other, related assessments and surveys are also required by Federal law before such an effort could commence. Archaeological assessments alone could cost over $1 million dollars. The necessity of such requirements could usurp resources needed to address the common carp issue. For these reasons, the Service rejected a detailed analysis of this alternative.

2.8 Comparison and Summary of Management Alternatives Considered

Table 2-1 represents a conceptual future of the Refuge using best science to determine likely outcomes. A reliance on adaptive management is key to successfully incorporating the broad array of factors that will influence implementation of the plan. Numbers denoted in the table represent a range of possible futures and are not attached to specific ground locations unless indicated otherwise. Unless expressly stated to the contrary, Alternatives 2 and 3 are built upon Alternative 1 as a foundation.

Table 2-1. Comparison and Summary of Management Alternatives

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Alternative Theme	**Current Management**	**Top priority will be to improve the aquatic health of lakes and wetlands.** **Create a more developed and structured visitor experience with additional birding, fishing, and hunting opportunities.** **Initiate the development of a comprehensive riverine/wetland rehabilitation plan.**	**Co-equal priorities will be to improve the aquatic health of lakes/wetlands and develop a comprehensive riverine/wetland rehabilitation PLAN.** **Create a less structured and developed visitor experience with additional birding, fishing, and hunting opportunities.**
Habitat Management			
Lacustrine (lakes)	• 500-110,000 acres, limited management, and poor aquatic health • Opportunistic carp population control at low lake levels • Barrier blocking larger carp at Mud Lake confluence	Major emphasis on carp population control for restoring aquatic health (see Invasive Species Control).	Same as Alternative 2, but with less carp control intensity due to riverine assessment activities.
Riverine	• Manage 55-mile riverine system with five dams and diversions, and portion of river channelized • Maintain 55 miles of river and one mile of Bridge Creek in current condition	Strategic approach beginning with most critical, foundational assessments and pilot studies and moving toward the creation of an integrated wetland/riverine rehabilitation plan sometime in the near future, most likely beyond the life of this CCP. Once carp control objectives are reached and successfully maintained (e.g., 100 pounds per acre in Malheur Lake), resource emphasis may expedite the development and implementation of the above-mentioned plan. Aquatic health inventory, monitoring and carp control will occur.	Creation of an integrated wetland/riverine rehabilitation plan for the Blitzen Valley following data collection, model development, and the implementation of pilot studies. Defined timelines will be pursued to complete the plan during the life of this CCP. Aquatic health inventory, monitoring and carp control will occur.
Woody Riparian	Maintain 800-1,000 acres.	Maintain and enhance 1,000-1,500 acres.	
Palustrine Emergent (seasonallyflooded wet meadow)	Enhance and maintain 20,000-25,000 acres.	Same as Alternative 1 with the following additions: • An increase in overall meadow acreage (±2,000 acres) and enhanced diversity of meadow/marsh complexes • Increase management flexibility by utilizing State-and-Transition Model to address management issues with best available science (e.g., summer grazing)	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Palustrine Emergent (seasonally flooded marsh associated with wet meadow)	Enhance and maintain 17,000-18,000 acres. Block carp movement and redband trout intrapment by installing fish screens. Do inventory and monitoring of aquatic health.	• Increased management flexibility to enhance and maintain 15,000-16,000 acres. • Increased blocking of carp movement and redband trout intrapment by installing fish screens. Increased inventory and monitoring of aquatic health.	
Palustrine Open Water/Emergent (semipermanently flooded Wetland Impoundment)	Enhance and maintain 2,200-2,800 acres of wetland impoundments. Increased blocking of carp movement and redband trout intrapment by installing fish screens. Increased inventory, monitoring research and assessment of aquatic health.		
Dry Meadow	Enhance and maintain 4,500-5,500 acres: • Idle strategy dominates • Treatment frequency determined by monitoring of structure and vigor		
Salt Desert Scrub	Maintain 40,000 acres.		
Sagebrush Lowland	Maintain 4,300-4,500 acres.		
Sagebrush Steppe	Maintain 14,000-15,000 acres: • Continue to eradicate invasive western juniper • Investigate the diversification of crested wheatgrass seedings.	Same as Alternative 1 with the following additions: • Implement projects to add native plant diversity in crested wheatgrass seedings • Conduct experimental burns and other treatments (shrub control, etc.) to increase desirable understory cover in pertinent plant communities	
Dune	Protect and maintain 6,300 acres with minimal management.		
Playa	Protect and maintain 29,000 acres with minimal management.		
Cropland	Row crop 80 acres.	Increase row crop up to 1,000 acres.	
Cold and Hot Springs	Maintain and enhance 236 acres. Increased inventory, monitoring research and assessment of aquatic health.		
Cliffs, Rimrocks, and Outcropping	Maintain current acres.		
Special Protection Areas			
RNA and WSA Management	Continue to manage as closed areas except for research and/or maintenance activities and docent- or staff-led tours.		

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Wilderness Study Area	Maintain existing 30,000-acre Harney Lake WSA proposal.	Adjust Harney Lake WSA proposal to reflect 2010 wilderness inventory of 31,157 acres.	
Refuge Boundary and Management Area			
Lands West of State Highway 205 and East of Krumbo Reservoir	Continue to manage approximately 2,626 acres west of State Highway 205 and east of Krumbo Reservoir that adjoin BLM land. The land, which is primarily used for hunting, has some archaeological sites and corrals and is comprised mainly of shrub-steppe and rimrock habitat.	With BLM, explore opportunities to coordinate land management and enhance conservation along the boundary between the Refuge and BLM land (Boundary Unit), considering mechanisms such as cooperative management agreements and/or interchange of lands. Since the land area in question is a thin sliver of uneven ground between road and rimrock, and is unmarked and unfenced in most areas, the area is difficult to manage under Refuge regulations. No difference in public use opportunity is envisioned.	
Invasive Species Control			
Carp Control	Opportunistic and passive control efforts in designated focal areas.	Following assessments (see Goal 13), use appropriate techniques to aggressively control carp that can be applied to the diversity of aquatic habitats throughout the watershed. IPM strategies to control carp would include, but not be limited to, the application of piscicide, chemo-attractants, chemo-repellants, barriers, commercial harvest, angling, and water manipulation. In-stream structures (i.e., traps, screens, and fish wheels) that address native fish passage issues and the prohibition of carp movement through the system would also be considered.	Same as Alternative 2, except with less intensity because more resources will be diverted to addressing river rehabilitation.
Invasive Species Control	Continue current levels of monitoring and control.	Increase monitoring and control for undesirable species, determine efficacy of treatments, and map areas at risk of exceeding threshold levels (see Goals 1-4 for thresholds).	
Wildland Fire and Hazardous Fuels Management			
Biological Fuels Treatment	• Use wildfire, prescribed fire, and mechanical treatment to manage biological fuels • Continue to coordinate with the Burns Interagency Fire Zone	Same as Alternative 1, plus chemical treatment to manage biological fuels.	
Wildland Fire Prevention and Response	• Continue to coordinate with the Burns Interagency Fire Zone • Where required, suppress wildfires, but consider objective opportunities for resource benefits and ability to safely manage fires		

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Hazardous Fuels	• Use wildfire, prescribed fire, and mechanical treatment to manage hazardous fuels • Continue to coordinate with Burns Interagency Fire Zone	Same as Alternative 1, plus chemical treatment to manage hazardous fuels.	
Water Resources			
Watersheds	• Continue to improve aquatic health in Silvies, Double-O, and Blitzen River watersheds by working with public and private partners • Work with public and private partners to protect spring migratory habitat (e.g., snow goose) in the Harney Basin via available land protection and stewardship programs		
Water Rights	• Prove up on new winter water rights for the Blitzen River and tributaries • Finalize transfer of existing Blitzen River water rights to wildlife refuge management	Same as Alternative 1, plus establish a groundwater right for the springs in the Double-O Unit.	Same as Alternative 2, but assess potential water right modifications due to possible changes in Blitzen River habitat, wetland habitats, and water delivery operations supportive of the comprehensive river/wetland rehabilitation plan.
Water Delivery System Assessment and Feasibility	Continue current levels of inventory and condition assessment (i.e., develop GIS layers of water delivery infrastructure).	Complete a full assessment of water control structures of water delivery system for water management efficacy.	
Inventory, Monitoring, Scientific Assessments, and Research			
Inventory and Monitoring	Baseline wildlife surveys to meet intra-agency and interagency obligations.	• Inventory, monitor, and assess fish, wildlife, and vegetation to guide annual management actions • Re-establish a program-wide I&M plan around focal species and national monitoring efforts • Design a geodatabase for inventory and monitoring surveys conducted	Same as Alternative 2, but with a heavy focus on riverine-related I&M.
Research	Passively opportunistic; coordinate with partners to answer critical questions needed for habitat and species management.	Focus on aquatic health and wetland/terrestrial habitat management. Initiate development of the river/wetland rehabilitation plan. Systematically conduct research to further aquatic health and carp control on the refuge.	
Assessment	• Conduct aquatic health assessments on focal areas of the refuge	Same as Alternative 1 plus: • Assess habitat response to management actions primarily from carp control and water connectivity through the watershed	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
	• Assess carp population dynamics and migratory patterns. • Conduct wetland and terrestrial habitat assessments.	• Assess water delivery system to determine water control structures that deter carp passage • Commence assessment of riverine habitat characteristics that will influence future restoration efforts	
Welcome and Orientation			
Welcome and Orientation Panels	Maintain and update 4 existing outdoor welcome and orientation panels at: • Narrows Pull-out • Refuge Headquarters • Buena Vista • Frenchglen	Same as Alternative 1, plus add outdoor welcome and orientation panels at: • Krumbo Reservoir • P Ranch • Harney Lake • Double-O	Same as Alternative 1, plus add outdoor welcome and orientation panels at: • Krumbo Reservoir • P Ranch • Harney Lake
Developed Sites with Visitor Amenities (i.e., picnic tables, shelters, vault toilets)	Maintain five developed sites at: • Refuge Headquarters • Buena Vista • Krumbo Reservoir • P Ranch	Same as Alternative 1, plus provide all or some described developed sites as shown: **Complete Developed Sites** • Double-O **Vault Toilets Only** • Sod House Ranch **Picnic Tables and Shelters Only** • Refuge Headquarters (ADA-compliant) • Buena Vista Overlook • P Ranch	Same as Alternative 1, plus provide picnic tables and shelters at: • Refuge Headquarters (ADA-compliant) • P Ranch
Visitor Contact	Maintain year-round visitor contact station/gift shop at Refuge Headquarters	Same as Alternative 1, plus: • Build an enlarged visitor contact station and gift shop at Refuge Headquarters • Enhance George Benson Memorial Museum to meet ADA standards and to meet preservation standards to protect specimens. • Establish a seasonal contact station at P Ranch, and provide staffing as available with volunteers during spring, summer, and fall • Continue to consider/participate in discussions for an interagency visitor facility off-refuge	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Wildlife Observation and Wildlife/Nature Photography			
Docent-led Tours	Provide docent-led tours in conjunction with the annual John Scharff Migratory Bird Festival.	Same as Alternative 1, plus provide advertised docent-led tours, approximately monthly, to a variety of audiences at different locations on the Refuge, including kayaking and canoeing tours on Malheur Lake.	
Auto Tour Route and Vehicular Access	Maintain refuge public roads on: • 42-mile Blitzen Valley auto tour route (Center Patrol Road) year-round • Seasonal access to Krumbo Reservoir from fourth Saturday of April through October 31	Same as Alternative 1, plus provide year-round vehicle access and vehicle pull-offs when road conditions are not hazardous and at: • Boat Landing Road • Krumbo Reservoir • East Canal Road to the confluence of Bridge Creek Same as Alternative 1, plus participate in Basin and Range Birding Trail on-refuge with Harney County Chamber of Commerce and other partners.	Same as Alternative 1, except: • Seasonally close portion of the 42-mile Blitzen Valley auto tour route (Center Patrol Road) to vehicle traffic from August 15 through fourth Friday of October in the Buena Vista Unit and August 15 through March 1 in the P Ranch Unit to develop two or three year-round smaller auto tour routes, and allow walk-in, free-roam access along the Center Patrol Road and dike tops during seasonal closure in the Buena Vista and P Ranch units • Provide year-round vehicle access only to Boat Landing Road, except when road conditions are hazardous Same as Alternative 1, plus participate in Basin and Range Birding Trail on-refuge with Harney County Chamber of Commerce and other partners.
Trails (foot, bicycle) **Trails (foot, bicycle)**	Maintain 10 trails at: • Headquarters Overlook • Buena Vista Overlook • Crane Pond Overlook • Krumbo Reservoir • Benson Pond Trail • Bridge Creek Trail • River Trail • East Canal Trail	Same as Alternative 1, plus additional trails at: **Spur Trail** • Frenchglen to Barnyard Springs Footpath **Loop Trails (≥ 1 mile)** • Refuge Headquarters along the Blitzen River and Display Pond (Headquarters Loop Trail) • Connect Bridge Creek Trail, River Trail, and East Canal Trail with pedestrian crossings and boardwalks.	Same as Alt. 1, plus develop additional trails at: **Loop Trails (≥ 1 mile)** • Refuge Headquarters along the Blitzen River and Display Pond (Headquarters Loop Trail) **ADA-compliant Trails** • Sections of Headquarters Loop Trail

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
	• Barnyard Springs Footpath • Desert Trail	**ADA-compliant Trails** • Sections of Headquarters Loop Trail • Sod House Ranch (upgrade to ADA standards) • Benson Pond • P Ranch Same as Alternative 1, plus enhance the Desert Trail by: • Proposing alternative route • Posting appropriate Desert Trail signs	• Sod House Ranch (upgrade to ADA standards) • P Ranch Same as Alternative 1, plus enhance the Desert Trail by: • Proposing alternative route • Posting appropriate Desert Trail signs
Viewing Overlooks	Maintain and enhance two viewing overlooks at: • Refuge Headquarters • Buena Vista (upgrade to ADA standards)	Same as Alternative 1, plus develop an ADA-compliant viewing overlook at Krumbo Reservoir.	Same as Alternative 1.
Elevated Viewing Platforms	Currently have no elevated viewing platforms.	Develop elevated viewing platforms at: • Historic CCC lookout tower at Refuge Headquarters • Malheur Lake at airboat launch site • Harney Lake • Double-O	Develop elevated viewing platforms at: • Malheur Lake at airboat launch site • Harney Lake
Photography Blinds	Currently have no photography blinds.	• Restore historic Audubon photography blind at Refuge Headquarters Display Pond • Build two ADA-compliant, first-come/first-served permanent photography blinds at appropriate sites to view wildlife	• Restore historic Audubon photography blind at Refuge Headquarters Display Pond • Allow temporary, day-to-day photography blinds to be erected when free-roam areas are open
Site Management for Rare and Incidental Passerines and Historic Landscapes	Not deliberately provided.	Prepare and implement site plans, to manage vegetation and maintain trees and shrubs at: • Refuge Headquarters	Same as Alternative 2, except do not include Witzel Field and Barnyard Springs.

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
		• Sod House Ranch • Benson Pond • Witzel Field • Barnyard Springs • P Ranch	
Interpretation			
Primary Interpretive Themes	Maintain existing interpretive programs to include natural and historic resources themes.	Same as Alternative 1, plus include: • Historical and current significance of the Refuge to breeding and migratory birds • Precontact and post-contact history • CCC work in the area • Wilderness • Geology • Aquatic health • Water's importance, hydrology, and movement through the landscape • Refuge's primary management objectives, and management challenges, and methods for wildlife, habitat, and other resources • Role and importance of the National Wildlife Refuge System • An understanding of visitors' relationships to, and impacts on, natural and historic resources to become stewards of the land	
Modern and Traditional Media	Maintain and update existing modern and traditional media as shown: • Website and brochures	Same as Alternative 1, plus make greater use of modern media (CDs, podcasts, social media, etc.).	
Panel Locations	Maintain five sites with outdoor interpretive panels at: • Narrows Pull-out • Refuge Headquarters • Sod House Ranch • Buena Vista Overlook • P Ranch	Same as Alternative 1, plus: • Provide indoor interpretive panels in the George Benson Memorial Museum to connect visitors with places and the resources the Refuge protects • Provide additional outdoor interpretive panels at key field sites to appropriately implement key interpretive themes focusing on improving aquatic health and associated management activities, and weaving historic events with ecology of the Refuge	
Special Events	Participate in four local events, on- and off-refuge: • John Scharff Migratory Bird	Same as Alternative 1, plus provide three additional local events, on- and off-refuge, with docent-led activities, booths, educational materials, etc. for: • International Migratory Bird Day (May)	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
	Festival (April) • Free Fishing Day (June) • Invasive Carp Awareness (August) • Harney County Fair (September)	• Ranching Heritage Day combined with Invasive Carp Awareness (August) • National Wildlife Refuge Week (October)	
Presentations	Provide public presentations by refuge staff and volunteers to a variety of visiting groups upon request.	Same as Alternative 1, plus provide upon request: • Advertise through modern and traditional media that public presentations by refuge staff and volunteers are available, approximately monthly, for visiting groups • Coordinate additional public presentations with other environmental education partners	Same as Alternative 2, except provide at least monthly.
Environmental Education			
Environmental Education Program	Reach approximately 500 students, on- and off-refuge, using refuge staff and volunteers with: • Local first and third graders • John Scharff Migratory Bird Festival Fun Fair and "Conservation through the Arts" • Free Fishing Day • Other environmental education programs upon request	Same as Alternative 1, plus: • When refuge staff and volunteers are available, use and implement existing curricula, and national and regional environmental education modules, such as the Junior Duck Stamp Program, International Migratory Bird Day, etc., on- and off-refuge • Coordinate and assist with local environmental education initiatives upon request	
Great Basin Society/Malheur Field Station	Established cooperative agreement (1998).	Review and revise as needed the cooperative Agreement between the Great Basin Society/Malheur Field Station and the Refuge.	
Environmental Education Facilities	Currently have no environmental education facilities.	• Build an outdoor shelter at Refuge Headquarters where environmental education activities can be conducted during inclement weather • Provide an outdoor learning area at Refuge Headquarters for existing environmental education programs, and efforts with other environmental education initiatives	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Hunting			
Upland Game	Maintain upland game hunting at: **Malheur Lake Hunt Unit** • 26,200 acres on north side of Malheur Lake; Open pheasant season same as State **Buena Vista Hunt Unit** • 36,000 acres; Open third Saturday of November-close of State pheasant season **Boundary Hunt Unit** • 2,600 acres west of State Highway 205 and in Krumbo Creek area; Open to deer and pronghorn west of State Highway 205 and south of Foster Flat Road; Open to upland gamebirds, rabbit, and coyote in all Unit areas, according to State regulations.	Same as Alternative 1, except: **Malheur Lake Hunt Unit** • Enhance by improving Saddle Butte access on the north side of Malheur Lake **Buena Vista Hunt Unit** • Extend season opener from the fourth Saturday of October to the end of State pheasant season **Boundary Hunt Unit** • Continue to manage hunt program as under current regulations except include Krumbo Creek area for pronghorn and deer.	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Waterfowl	Maintain waterfowl hunting programs at: **Malheur Lake Hunt Unit** • 26,200 acres on north side of Malheur Lake; Open waterfowl season same as State; Nonmotorized or electric boats permitted **Boundary Hunt Unit** • 2,600 acres west of State Highway 205 and in Krumbo Creek area; Open waterfowl season same as State	Same as Alternative 1, except: **Malheur Lake Hunt Unit** • Promote a youth hunt opportunity on State-designated weekend in the northern Malheur Lake Hunt Unit • Enhance by improving Saddle Butte access on the north side of Malheur Lake • Expand allowable boundary to include south-central area of Malheur Lake with special date regulations of fourth Saturday of October through end of State waterfowl season • Open new boat access for nonmotorized or electric boats on Malheur Lake at the airboat launch site near Refuge Headquarters with expanded parking area and an ADA-compliant boat launch with special date regulations of fourth Saturday of October through end of State waterfowl season • At low water (<10,000 acres), close Malheur Lake to waterfowl hunting **Buena Vista Hunt Unit** • Open hunt unit to waterfowl hunting with special date regulations of fourth Saturday of October through end of State pheasant season; boats will not be permitted • Support reasonable waterfowl hunting opportunities that comply with the ADA in partnerships with potential users **Boundary Hunt Unit** • Continue to allow hunting as under Alternative 1	Same as Alternative 2, except: **Buena Vista Hunt Unit** • Waterfowl hunting will not be permitted in the Buena Vista Hunt Unit or ADA-compliant facilities would not be developed **Double-O Unit** • Explore a youth hunt opportunity on the State-designated weekend in designated areas **Boundary Hunt Unit** • Continue to allow hunting as under Alternative 1

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Fishing			
Stream Fisheries	Maintain fisheries at: **South Fishing Loop** • Upper Blitzen River, southern portion of East Canal, and tributaries open year-round to walk-in access; redband trout with special regulations	Same as Alternative 1, plus: • Allow drive-in access on East Canal Road to the confluence of Bridge Creek with access to Granddad Reservoir (BLM), except when road conditions are hazardous • Build a new pedestrian crossing at Bridge Creek to access a portion of the fishable area west of East Canal to its confluence with the Blitzen River • Open new seasonal bank fishing opportunity from Sodhouse Lane to the bridge on the Boat Landing Road, part of the Headquarters Loop Trail, from August 1 through September 15 • Develop five panels with maps, brochures, regulations, and additional information at main entrance points	Same as Alternative 2, except: • Only allow year-round, walk-in access on East Canal Road to the confluence of Bridge Creek • Pedestrian crossing at Bridge Creek would not be built
Reservoir Fishery	Maintain fisheries at: **Krumbo Reservoir** • Open fourth Saturday of April through October 31 to drive-in access and to nonmotorized or electric boats; stocked with triploid rainbow trout	Same as Alternative 1, except: • Allow year-round, drive-in access, except when road conditions are hazardous • Allow year-round boating access (nonmotorized and electric boats), except when reservoir begins to ice over • Conduct genetic introgression study on redband trout in coordination with ODFW • Develop one panel with maps, brochures, regulations, and additional information at main parking area	Same as Alternative 2, except only allow walk-in access November 1 through fourth Friday of April.
Volunteer Program and Partnerships			
Volunteer Program	Maintain volunteer program: • Runs eight months of the year (March-October)	Same as Alternative 1, plus hire a full-time volunteer coordinator position to: • Increase recruitment, retention, and return rate of volunteers • Expand the program to best use facilities and refuge staff	

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
	• Over 5,000 hours are generated, with at least a 50% return rate	• Assist with building partnerships and increase public outreach	
Law Enforcement			
Regulations	Continue to post regulations at key welcome and orientation sites, as well as locations where fishing and hunting uses predominate (Krumbo Reservoir, Malheur Lake, Buena Vista Unit, etc.).	Same as Alternative 1, plus improve all posting of regulations at key welcome and orientation sites, as well as locations where fishing and hunting uses predominate.	
Staffing/Field Presence	Maintain current law enforcement staffing. Continue to emphasize information, education, and friendly presence in the field during key seasons.		
Cooperative Assistance	Continue cooperative relationships and agreements with Oregon State Police and Harney County Sheriff's office.		
Trespass Cattle	Continue to fence in certain refuge boundary areas to minimize trespass cattle.	Same as Alternative 1, plus improve all fencing in certain refuge boundary areas to minimize trespass cattle.	
Transportation			
Public Roads	Maintain current refuge public roads at: • 42-mile Blitzen Valley auto tour route (Center Patrol Road) • Krumbo Reservoir • P Lane	Same as Alternative 1, plus enhance: • 42-mile Blitzen Valley auto tour route (Center Patrol Road) • P Lane • Boat Landing Road • East Canal Road to the confluence of Bridge Creek • Double-O Road • Saddle Butte hunt access	Same as Alternative 2, except: • Redesign two or three year-round smaller auto tour routes on the Center Patrol Road in the Buena Vista and P Ranch units • Enhance by improving the Boat Landing Road
Pull-offs	Limited vehicle pull-offs to assist with wildlife observation and wildlife/nature photography, hunting and fishing programs.	Develop additional vehicle pull-offs (1-2 vehicle lengths) at: • Boat Landing Road • 42-mile Blitzen Valley auto tour route (Center Patrol Road) • Krumbo Lane • East Canal Road to the confluence of Bridge Creek	Same as Alternative 1, plus develop vehicle pull-offs (1-2 vehicle lengths) at Boat Landing Road.

Alternative Number	Alternative 1	Alternative 2 (Preferred Alternative)	Alternative 3
Parking Areas	Limited parking available to assist with wildlife observation and wildlife/nature photography, hunting and fishing programs.	Develop additional parking areas at: • Bridge on Boat Landing Road • Airboat launch site (to ADA standards) • East Canal at the confluence of Bridge Creek	Develop additional parking areas at: • Bridge on Boat Landing Road • Airboat launch site (to ADA standards)
Cultural Resources			
Cultural Resource Management and Protection	Prohibit access to sensitive areas. Continue law enforcement patrols to monitor and protect cultural resources. Continue cultural resource surveys in advance of program projects where soil disturbance may occur. Coordinate with the Burns Paiute Tribe on cultural resource issues. No cultural resources management plans.	Same as Alternative 1 plus: • Develop and implement step down cultural resource management plans for historic sites and archaeological areas • Increase monitoring, inventory, and protection of cultural resources	
Opportunities for Native American Uses	Continue collection of plant materials for traditional uses using a Special Use Permit.	Expand opportunities for Native American uses by increasing the type and quantity of species of native plants used for traditional uses	
Cultural Resource Interpretation and Education	Limited interpretation and education using static interpretive panels, brochures, and refuge website.	• Expand interpretation to improve awareness and appreciation of refuge cultural resources • Develop and implement site specific interpretive plans for Sod House Ranch, P Ranch, Benson Pond and the Double-O Ranch	
Paleontological Resources			
Paleontological Resource Management and Protection	Prohibit access to sensitive areas. Continue law enforcement patrols to monitor and protect paleontological resources. No paleontological resources management plan.	Same as Alternative 1 plus develop and implement a paleontological resources management plan.	
Paleontological Resource Interpretation and Education	No interpretation or educational opportunities.	Provide interpretation to instill appreciation for the Refuge's paleontological resources and the valuable information they can yield about past environments.	

2.9 Goals, Objectives, and Strategies

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to refuge purposes, Service policy, and the Refuge System mission.

A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects the refuge purposes, the Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Goals then define general targets in support of the vision, followed by objectives that direct effort into incremental and measurable steps toward achieving those goals. Finally, strategies identify specific tools and actions to accomplish objectives (USFWS 2002).

In the development of this CCP, the Service has prepared an EIS. The EIS evaluates alternative sets of management actions derived from a variety of management goals, objectives, and implementation strategies.

The goals for Malheur Refuge over the next 15 years under the CCP are presented on the following pages. Each goal is followed by the objectives that pertain to that goal.

The goal order does not imply any priority in this CCP. Priorities are described in the alternatives narratives above and further developed in Appendix C.

Readers, please note the following:

- Not all objectives or strategies are included in all alternatives. If an objective is not part of a particular alternative, a blank is used to indicate that this objective is not addressed in that alternative.
- Below each objective statement are the management strategies that could be employed in order to accomplish it. If a strategy is present under an alternative, a "✓" is used.
- Ranges in habitat acres capture the geographical extent of habitat types and not the quality of habitats, which is influenced by varying climatic conditions (e.g., low to high water years). Such variations do not typically cause dramatic shifts between habitats but do affect the plant communities found within the habitat types. Malheur Lake is an exception because widely fluctuating water levels do cause dramatic shifts in habitat types (i.e., salt desert scrub to lacustrine).

GOAL 1. Enhance aquatic health and habitat conditions essential to the conservation of the flora and fauna that depend on Malheur Lake and associated water bodies.

Objective 1a. Lacustrine (Malheur and Mud lakes)
Throughout the life of the CCP, enhance and maintain the lake basin health and associated terrestrial successional cycles of the lake systems on Malheur Refuge. American white pelican (*Pelecanus erythrorhynchos*), northern shoveler (*Anas clypeata*), canvasback (*Aythya valisineria*), and tui chub (*Gila bicolor*) will be used to evaluate habitat conditions that indicate ecosystem health for this unique marsh system. Desirable characteristics of Malheur and Mud lakes include:

- Emergent vegetation is mainly hardstem bulrush (*Scirpus acuta*), bur-reed (*Sparganium eurycarpum*), cattail (*Typha* spp.), and Baltic rush (*Juncus balticus*) and will vary in abundance depending on lake level, topography, water chemistry, wind/wave action, etc. The western portion of Malheur Lake (west of Graves Point) has the greatest opportunity to achieve hemi-marsh conditions (approximately half marsh and half open water).

- >40% cover of submergents (e.g., sago pondweed (*Stuckenia pectinata*)), associated with low turbid water conditions and maximum depth distribution in areas protected from extensive wave action.
- Russian olive (*Elaeagnus angustifolia L.*) and salt cedar (*Tamarix ramosissima*) will be absent around lakeshore or in adjacent habitats.
- Less than 100 pounds of carp per acre. This overall threshold is influenced by a multitude of factors (water quality, response of aquatic life, water depth, etc.) and may be adjusted as monitoring and inventory activities continue over time (Bajer et al. 2009).
- Provide habitat conducive to supporting viable populations of fishes such as redband trout, bridgelip suckers (*Catostomus columbianus*), and tui chubs.
- Diverse invertebrate community, including crustaceans, midges, aquatic worms, dragonflies, snails, mussels and water beetles.
- <10% cover of established noxious weed species (e.g., perennial pepperweed) per designated management area.

Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually	500-110,000	500-110,000	500-110,000
Strategies Applied to Achieve Objective			
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Continue to use opportunistic approaches (i.e., the use of piscicide rotenone at low lake levels) to rapidly lower carp populations.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, lake levels, and habitat/migratory bird responses in lakes.	✓	✓	✓
Develop a model to predict habitat response based upon changes in biotic and abiotic factors in the lakes.		✓	✓
Investigate and implement aggressive control strategies appropriate to the Refuge, based on assessment and research findings. Control strategies could include, but not be limited to, the application of piscicide, chemo-attractants, chemo-repellants, barriers, commercial harvest, angling, and water manipulation.		✓	✓

Consider the need for continued amendments to and the construction of additional strategically placed in-stream structures (i.e., traps, screens, and fish wheels) that address native fish passage issues and the prohibition of carp movement through the system.		✓	✓
Develop partnerships to address water quality, vegetation, and carp control issues within the Harney Basin.	✓	✓	✓
Enhance emergent vegetation within the lake system via carp exclosures, wind breaks, etc.		✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓

Rationale:

Common carp were introduced into the Silvies River watershed in the early 1920s. The Silvies River has intermittent connectivity with Malheur Lake. During times of connectivity, carp and other fish species have free passage to the lake. Prior to carp infestation, a diversity of submerged and emergent vegetation was abundant. By 1952, carp activity had created such turbidity that desirable submerged aquatic plants were nearly eliminated. In 1955 the carp population was controlled with rotenone, a fish toxicant or piscicide. It is estimated that 1.5 million carp, averaging 20 to 25 inches in length, were killed. The beneficial effect was demonstrated the next year, when sago pondweed showed an immediate response to improved growing conditions and covered 15,000 acres. Intensive efforts to control carp using rotenone continued in subsequent decades and realized similarly positive, yet fleeting, responses.

Over time, however, responses to carp control became less dramatic as the lake experienced a significant reduction in emergent vegetation and a dramatic overall decrease in bird use. A combination of prolonged negative carp impacts, high water depths, and associated ice shearing during the 1980s, followed by severe drought cycles, and possible changes in water chemistry are believed to have led to the lake's dramatically declining habitat conditions. Although emergent wetlands have persisted on the southern side and isolated patches remain primarily on the western half of the lake (Bat House Island, etc.), many large areas show little to no evidence of recovery.

Bajer et al. (2009) examined changing carp densities in a recently restored 300-hectare (ha) Midwestern lake, and found that although a carp biomass of 30 kg/ha (approximately 30 lb/acre) had no discernible effects on vegetative cover (which exceeded 90%) or waterfowl (which exceeded 150,000 individuals during fall censuses), the increase in carp biomass to 100 kg/ha (100 lb/acre) was associated with a 50% decrease in both vegetative cover and waterfowl. A further increase in carp biomass to over 250 kg/ha (250 lb/acre) coincided with a decrease in the vegetative cover to 17% of the lake's surface and a decline in waterfowl use to 10% of its value when carp were absent. Overall, the increase in carp biomass could explain 93% of the variation in waterfowl abundance decline during the 4 years studied. Although the lake studied is significantly smaller than Malheur Lake, the threshold value is the only known threshold from a field study correlating carp biomass, vegetative response, and waterfowl use.

The selection of White pelican, Northern shoveler, Canvasback, and Tui chub as focal species for this goal define the mix of open water, island, hemi-marsh, and submergent plant habitat conditions essential to restoring the diversity and abundance of wildlife that historically used this area. Pelicans used open water segments for foraging and low-lying islands for breeding. Open water areas are also used by canvasbacks for loafing during migration and submergent beds such as sago pondweed for foraging. Northern shoveler depicts the interspersion of open shallow water with stands of submernent and emergent vegetation for foraging as well as associated grasslands and rangelands for nesting needed by a variety of wildlife species. This same general habitat type is used by Tui chub for

spawning and foraging with a heavier vegetation component. The chub is an essential foodbase for waterbirds, one of the primary guilds of birds intended to be preserved in the lake's acquisition.
It is not known at this time if historic levels of hemi-marsh and submergent plant communities can be attained if carp control thresholds are successfully reached and maintained. Through the life of this CCP, a comprehensive, science-based approach to carp control will be initiated to reduce the carp population to the targeted threshold of 100 pounds of carp per acre. Lake rehabilitation efforts will involve the assessment of current water quality and habitat conditions, site potential, and vegetative trends, and these efforts will seek to increase our understanding of common carp's biotic potential, carrying capacity, density-dependent factors, distribution, and susceptibilities within the lake and connected aquatic systems. The understanding gained through these efforts will assist refuge staff and partners in increasing the productivity of Malheur Lake, once a significant resource in the Pacific Flyway. Increased partnerships with subject-matter experts and funding agencies will be the key to this effort's success.

GOAL 2. Monitor, protect, maintain, and/or rehabilitate riverine habitats to conditions essential for the conservation of native fish and wildlife species.

Objective 2a. Riverine (rivers and associated tributaries terminating on the Refuge): Develop an Integrated Wetland/River Rehabilitation Plan and Associated NEPA Document with Partners

Throughout the life of the CCP, necessary information will be gathered to develop a comprehensive rehabilitation plan for targeted river systems[3] and floodplain habitats. Information concerning biological, physical, and management attributes of these habitats will be gathered through specific assessments, pilot projects, and modeling (see Objectives 13b and 13c). This information will contribute to developing a decision support system that will allow comparisons among various alternatives in achieving management objectives and establish tools necessary to support development of a comprehensive riverine/wetland rehabilitation plan.
Pending the above approach for gaining understanding of pertinent riverine systems, desirable characteristics of riverine habitats for redband trout, other fish species, and native wildlife within the Refuge include:

- Water quality (e.g., maximum water temperature of <20°C, dissolved oxygen, turbidity, etc. within Oregon standards or exhibit no additional degradation attributable to refuge management actions)
- Native fish habitat (i.e., redband trout): stream shading (>80%); bank cover (no bare soil); bank stability (<5% eroding); channel stability (<1% channel movement); fine sediment <2 mm (<10%); cover (>50% of channel [Zoellick and Cade 2006]); percent late summer pools (25%-75%); and mean annual base flow (>45% of annual flow) (Raleigh et al. 1984)
- Connectivity among habitats (i.e., unimpeded passage within channels, floodplain regularly flooded, continuous site-appropriate vegetation along riparian zones)
- Channel form and substrate composition consistent with geomorphic and hydrologic setting

[3] Refuge riverine systems include the Blitzen, Silver Creek, and Silvies watersheds.

Alternatives	Alt 1	Alt 2	Alt 3
Strategies Applied to Achieve Objective			
Initiate process necessary to complete wetland/riverine strategicplan and associated NEPA documentation.		✓	
Complete wetland/riverine strategic plan and associated NEPA documentation.			✓

Rationale:

Utilizing information and research gleaned from assessments and pilot projects (see Objectives 13b and 13c), an integrated wetland/riverine strategicplan will be pursued to consider if rehabilitation is needed and various alternatives for river restoration; weigh the biological, cultural, economic, and social benefits and costs; and determine a future course of action supporting desired ecological outcomes. A three-tiered process will be required to develop the management plan: (1) identification of management objectives and assessment of hydrologic, geomorphic, and biologic features associated with target riverine systems (e.g., Blitzen River) and associated wetlands; (2) implementation of riverine pilot projects to evaluate biological and physical responses to management action and assess management objectives; and (3) development of a decision support system to support an integrated wetland/river rehabilitation plan and associated NEPA process (and resulting documentation) with partners.

Redband trout is designated as the focal species for riverine habitat. Redband need a stable free flowing stream with a mix of channels, riffles and pools as well as shading along various river reaches to support the year round requirements of this species as well as a variety of other native fish and wildlife. This will provide the corner stone for the three-tiered assessment process used in development of a wetland/river rehabilitation plan.

Alternative 3 provides a timeline for completing the above process for completing a strategicplan. The first seven years would be spent collecting necessary information (geomorphological, hydrological, and biological assessments). The next five years would be used for implementing and monitoring pilot projects to gain a better understanding of system response to enhancement activities. Using results from the pilot projects, a comprehensive plan would be crafted to begin implementation of rehabilitation efforts if deemed necessary.

Alternative 3 elevates river evaluation/ rehabilitation as co-equal to aquatic health on Malheur Lake (e.g., carp control) and would likely compete for limited refuge staff time, as well as grant opportunities and partnership involvement. Such an approach would be analogous to fighting a war on two fronts, possibly compromising the success of both efforts. To mitigate against this, Alternative 2 was formulated to emphasize carp control while moving forward strategically with the riverine effort.

Alternative 3 provides a timeline for completing the above process for completing a comprehensive river plan. The first seven years would be spent collecting necessary information (geomorphological, hydrological, and biological assessments). The next five years would be used for implementing and monitoring pilot projects to gain a better understanding of system response to enhancement activities. Alternative 3 would include a five-year period of conducting pilot studies, representing the minimum amount of time to understand how the riverine system and adjacent habitats may respond to larger-scale changes. Using results from pilot projects, a comprehensive plan would be crafted to begin implementation of a science based river strategy. Alternative 3 elevates a comprehensive river strategy as co-equal to aquatic health on Malheur Lake (e.g., carp control) and would likely compete for limited refuge staff time, as well as grant opportunities and partnership involvement. Such an approach would be analogous to fighting a war on two fronts, possibly compromising the success of both efforts.

To mitigate against this, Alternative 2 was formulated to emphasize carp control while moving forward strategically with the riverine strategy. Alternative 2 follows the same three-tiered process leading toward a strategic plan but allows for flexibility in the amount of progress that is made depending on

the availability of resources and success related to carp control on the Refuge. This alternative offers the advantage of using other available resources if they become available through agency funding, and partnerships. Another advantage of Alternative 2 is a greater understanding of the impacts on adjacent floodplain habitats will be gained over a longer study period enabling the development of site specific knowledge of how riverine, wet meadow and marsh communities would respond to hydrologic system changes. This alternative will also utilize a science based process to inform decisions regarding the river to determine existing biological conditions and site capability. The Refuge will work with the ecology working group and other stakeholders within the first 5 years of the current CCP to prioritize and refine a set of priority questions/objectives (see Objectives 13b and 13 c) creating a foundation to construct a comprehensive riverine strategy. Based on these questions/objectives the Refuge will take advantage of new resource opportunities to implement appropriate science based steps to continue the advancement of a comprehensive river strategy.

Objective 2b. Riverine

Throughout the life of the CCP, enhance and maintain the aquatic health of the riverine systems of Malheur Refuge for the benefit of redband trout and other priority resource species by doing inventory and monitoring of biotic and abiotic factors and conducting research pertaining to carp control.

Desired characteristics of Riverine include:

- Native and localized fish populations thriving and invasive carp population controlled
- Screened diversions and effluents pertaining to the river water delivery system
- Diverse invertebrate community, including crustaceans, midges, aquatic worms, dragonflies, snails, mussels and water beetles.

Alternatives	Alt 1	Alt 2	Alt 3
Strategies Applied to Achieve Objective			
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, water levels, and habitat/migratory bird responses in this habitat type.	✓	✓	✓

Rationale:

Yellow warblers, willow flycatchers, and associated benefitting species require dense thickets of deciduous riparian shrubs dominated by various willow species and occasionally interspersed with other shrubs and hardwood trees for feeding, reproduction and migration. With these species almost entirely restricted to river corridors in this arid region the condition of this habitat is vitally important.

The riverine system of the Malheur Refuge is an intergral part of the success or failure of many habitat types. For the life of this CCP, the focus will be on collecting data of biotic and abiotic parameters and finding ways to control carp. The recent addition of fish passage ladders, traps and screens on the Blitzen River have decreased thousand of acres that were availablfe for spawning and juvenile rearing

of common carp. In addition, this has decreased the number of redband trout and other species from entrainment in the irrigation system. The Silvies and Silver River health will be pursued by collaborating with land owner 's and other partners to focus on carp control.

GOAL 3. Protect, maintain, and rehabilitate riparian habitats to conditions essential for the conservation of wildlife species.

Objective 3a. Woody Riparian

Throughout the life of the CCP, enhance and maintain riparian shrub habitat on Malheur Refuge for the benefit of migratory land birds (e.g., yellow warbler (*Dendroica petechia*), willow flycatcher (*Empidonax traillii*)) and other wildlife. Desired characteristics of riparian shrub include:

- 40%-80% canopy cover of native shrub species (e.g., coyote willow (*Salix exigua Nutt.*), hawthorn (*Crataegus L.*), redosier dogwood (*Cornus sericea L.*), goose berry (*Ribes hirtellum*), Wood's rose (*Rosa woodsii*)) that are >3 feet tall in areas associated with flood irrigation or shallow water table
- >10% cover of understory native herbaceous species (e.g., sedges, rushes, spike bentgrass (*Agrostis exarata*), cinquefoil (*Potentilla L.*), false lupine (*Thermopsis villosa*))<5% cover of reed canarygrass and noxious species

Alternatives	Alt 1	Alt 2	Alt 3
Total acres annually managed as riparian shrub habitat	800-1,000	1,000-1,500	1,000-1,500
Strategies Applied to Achieve Objective			
Improve native plant cover and distribution by active planting or seeding appropriate native species.	✓	✓	✓
Exclude livestock from riparian habitats adjacent to meadow areas receiving grazing treatments (e.g., temporary or permanent fencing).	✓	✓	✓
Promote riparian shrub health (e.g., prescribed fire and mechanical removals to stimulate new growth and suckering), especially in decadent stands.	✓	✓	✓
Permanently exclude grazing from streamside corridors (Appendix K).	✓	✓	✓
Manipulate soil moisture in riparian areas outside of the naturally occurring floodplain (e.g., flood irrigation associated with meadow management).	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Yellow warblers, willow flycatchers, and associated benefitting species require dense thickets of

deciduous riparian shrubs for feeding and/or reproduction. This objective and associated strategies seek to maximize shrub density while managing for periodic disturbance to reinvigorate woody riparian stands. The greatest negative impact to riparian shrub habitat over the last century has been past grazing practices and the purposeful eradication of riparian habitats throughout the Blitzen Valley. In recent years, livestock grazing and other impacts to woody riparian communities have been significantly reduced. The result has been an increase in both the quantity and quality of this habitat type on the Refuge. In order to continue this upward trend, it will be necessary to protect these and additional potential woody riparian areas from unnecessary impacts. In target areas that are either disconnected from the floodplain, or lie outside of floodplain areas, supplemental soil moisture via flood irrigation will be used to sustain existing acres of this habitat and promote its expansion. Strategic planting will be used to increase shrub species diversity, particularly along waterways, and may include native shrubs such as various willows (e.g., beak, Drummond's, Geyer, Lemmon's Pacific, and yellow), black hawthorn, chokecherry, golden currant, Lewis' mock orange, redosier dogwood, Saskatoon serviceberry, silver buffaloberry, and water birch. Prescribed fire and mowing treatments will be infrequent and balanced by the need for older stands of dense, undisturbed willow/shrub areas according to focal species needs and designated acreages.

The vast majority of this habitat is located in the southern Blitzen Valley and extends northward along the Blitzen River and associated waterways and adjacent to impoundments. This habitat is not prolific in the Double-O Unit due to prevailing soil conditions (i.e., alkalinity) and only occurs there in isolated areas.

GOAL 4. Enhance, protect, and/or maintain primary habitats essential to the conservation of a diversity of aquatic and terrestrial wildlife species.

Objective 4a. Palustrine Emergent (seasonally flooded wet meadow)

Throughout the life of the CCP, enhance and maintain moist/wet meadow habitat on Malheur Refuge for the benefit of migratory birds (e.g., bobolink (*Dolichonyx oryzivorus*), sandhill crane, cinnamon teal (*Anas cyanoptera*)), and a diverse assemblage of other wildlife (e.g., Columbia spotted frog (*Rana luteiventris*)). Desired characteristics of moist/wet meadow habitat include:

- Irrigation depths ranging from 0 inches (subirrigation) to 5 inches of standing water
- >75% cover of perennial grasses, rushes, and sedges
- 15%-20% cover of forbs such as lupine, clover, and cinquefoils
- <20% cover of reed canarygrass
- <5% cover of noxious weeds (e.g., perennial pepperweed and Canada thistle)
- Grass height of treated acres <6 inches by October 1
- Maintain site vigor (i.e., prevent excessive litter accumulation from hindering diversity and expression of plant species)
- >50% of stems in a vertical or semivertical position for nesting waterfowl and other wildlife
- No willows
- Intake and effluent water screened or manipulated to stop influx of carp during spawning and juvenile rearing

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	20,000-25,000	22,000-27,000	22,000-27,000
Strategies Applied to Achieve Objective			
Maintain/enhance management units within this habitat type through the use of prescribed fire, haying, rake-bunch grazing, and rest from defoliation.	✓	✓	✓
Maintain/enhance management units within this habitat type through the use of active successional vegetation management (e.g., seeding, disking, grazing, grain farming, etc.).		✓	✓
Use tolerance thresholds specific to each plant community as determined through the Malheur Refuge State-and-Transition Model (Appendix L) to influence management prescriptions to meet annual and long-term wet meadow habitat objectives.		✓	✓
Use both winter and summer water rights in flood irrigation. Commencement and duration will depend on site-specific objectives.	✓	✓	✓
Modify dikes, ditches, and other infrastructure as needed to reclaim acres lost to cattail encroachment (e.g., Northwest Big Sagebrush field).		✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, water levels, and habitat/migratory bird responses in this habitat type.	✓	✓	✓
Develop a model to predict habitat response based upon changes in biotic and abiotic factors in the habitat type.	✓	✓	✓
Enhance water control structures to stop the influx of spawning carp and juvenile rearing	✓	✓	✓
Rationale: Cinnamon teal, greater sandhill crane, and bobolink have been designated as focal species for palustrine emergent temporarily flooded wet meadows. Cinnamon teal nest near water in rushes, sedges and grasses or occasionally over water in dense bulrush and cattails and move to nearby large wetlands			

for molting and brood development. The sandhill crane nests in isolated emergent vegetation within expanses of wet marshy meadows and forage in these same locations. The bobolink uses irrigated lowland wet meadows within the refuge landscape. They prefer transitional areas between wetter and drier sites dominated by dense stands of vegetation with a high percentage grass and moderate percentage of forbs and good litter density.

The Refuge provides much needed wetland habitat within the Pacific Flyway. Refuge wetlands have long been managed under prescriptions necessary to meet the needs of migrating and reproducing waterbirds and waterfowl. Unfortunately, these same prescriptions can cause undesirable plant community transitions. This dilemma creates a need for a creative and flexible new management paradigm. For example, warm-season cattail treatments may need to take place in areas experiencing encroachment of meadows by cattail (e.g., the lower Buena Vista Unit). Although extended irrigation schedules encourage this problem in some areas, they also play a significant role in meeting critical needs during various stages of wildlife reproduction and development. Therefore, the cessation of such a practice may not be desirable.

The CCP will begin with a 60:40 ratio of treated to untreated meadow, which was arrived at by examining past and current management practices (Blitzen Valley and Double-O Management Plans), consulting with former refuge biologists and flyway experts, and carefully examining life stage requirements for various wildlife species that use this habitat throughout the year (see Appendix K). It represents a starting point to test the efficacy of the haying and grazing program to achieve wet meadow objectives. This ratio is relevant only when considering all wet meadows within the Refuge and differs across fields and area-specific management units. The needs of focal species, the suite of wildlife they represent, and the nature of habitats they depend on determines the use and extent of these tools in realizing or maintaining attributes identified under this objective. This ratio provides an understanding of the overall use of haying and grazing but does not address the specific needs of wildlife in specific areas. These tools will be carefully evaluated on an annual basis by the science advisory team and adjusted relative to its efficacy in terms of achieving refuge objectives. The 60:40 ratio is meant to be illustrative, not definitive. Key to this approach is a recognition that haying and grazing is a tool to achieve desired habitat conditions as opposed to an objective unto itself. To ensure long-term habitat integrity of at-risk wet meadows, a combination of irrigation schedule adjustments, the designation of alternative suitable acres to meet irrigation prescriptions, or warm-season treatments may be used. Associated changes in water management that make these areas less susceptible to cattail expansion will be sought if alternative suitable acres are available to meet irrigation prescriptions. Treatments may include the use of livestock on reed canarygrass monocultures or the use of a marsh master (i.e., mowing), aerial application of appropriate pesticide, among other methods to set back cattail stands.

Mesic wet meadow areas may be placed on a rest-rotation schedule and forego defoliating treatment for periods suitable to site-specific conditions and associated wildlife habitat objectives (>50% vertical stems, etc.). Although most dense vegetative nesting is encouraged in marsh or dry meadow/sagebrush lowland/salt desert scrub sites, wet meadow areas less prone to flooding after the initiation of nesting activities can provide valuable breeding habitat for a variety of avian species.

In many refuge management units, topographic heterogeneity plays a significant role in providing for the habitat needs of a diversity of wildlife species. Variations in depth to water table allow for a variety of plant assemblages to be expressed across the landscape. Extra care is needed in areas where gradients in elevation occur with less frequency. In the former situation, prolonged irrigation may meet nesting and foraging needs of waterfowl and cranes without crossing thresholds that lead to significant decreases in forb and grass species and susceptibility to cattail and reed canarygrass invasion. In the latter situation, irrigation can strongly influence the long-term viability of the site for wildlife use.

In many areas, topographic diversity has been greatly reduced by past farming practices involving disking, plowing, and other ground-leveling disturbances. This is why it is important to remain cognizant of hydrological gradients that can drive plant community expression and subsequent habitat quality and availability for a number of target wildlife species. Sandhill cranes and bobolinks were both

selected as focal species for this habitat type because they tend to prefer conditions on opposite ends of the moist-to-wet meadow gradient that exists for this habitat type. It is important to establish irrigation prescriptions that accommodate the habitat needs of both species. By carefully identifying priority areas for both focal species and regarding the larger plant successional characteristics that are involved in meadow management to meet prescriptions long-term, dynamic management will seek to maintain or enhance the integrity of this habitat type in areas where dynamic, yet subtle shifts in topography have been compromised or an unacceptable percentage of plant assemblages is shifting toward undesirable species such as reed canarygrass or hybrid/common cattail.

Treatments may be applied during the growing or dormant season, depending on a science-based rationale. Due consideration will be given for late nesting requirements. Grazing may take the form of rake-bunching for litter management and to provide for migrants and early arriving wildlife. The use of livestock may be prescribed during the growing season in designated areas to influence plant community succession (see Appendix K).

Grain farming may be used as a tool to facilitate a significant successional shift toward more desirable plant communities. This approach is appropriate when conditions merit the manipulation of the existing soil propagule bank (e.g., seeds, tubers, rhizomes). The intensive annual management needed for grain production can drive undesirable plant species from the treatment area and allow a transition to more favorable species. Under this type of strategy, the cessation of farming will coincide with assisted/controlled colonization of desirable species.

Enhancement of water control structures on the intake and outflow of this habitat is an integral way to control spawning and rearing of juvenile common carp. By installing/maintaining fish screens or modifying the current water control structures the acres inhabitated by carp will sharply decrease and the food source for birds will increase.

Objective 4b. Palustrine Emergent (seasonally flooded marsh associated with wet meadow)

Throughout the life of the CCP, enhance and/or maintain 15,000 to 16,000 acres of emergent marsh on Malheur Refuge (excluding marshes associated with Malheur Lake) for the benefit of migratory birds (e.g., yellow-headed blackbird, sandhill crane, redhead, bittern, mallard) and a diverse assemblage of other wetland-dependent wildlife (beaver, muskrat, native amphibians, and reptiles). Emergent marsh generally occurs within a mosaic of moist/wet meadows. Desired characteristics of emergent marsh within this habitat complex include:

- Dominated by emergents (favoring hardstem bulrush and burreed while de-emphasizing cattails)
- Water depths ranging from 6 inches to 3 feet
- Irrigated in concert with associated wet meadows. Typically flooded by mid-March for breeding/nesting migratory birds and inundated until at least July 1
- 20%-40% open water for foraging wetland birds in areas of continuous marsh >10 acres in size
- Open water areas host submergents (e.g., sago pondweed)
- No carp or Eurasian water milfoil (Myriophyllum spicatum L.)
- Intake and effluent water screened or manipulated to stop influx of carp during spawning and juvenile rearing
- <20% cover invasive plants (e.g., reed canarygrass, common reed (*phragmites* spp., hybrid cattail)
- Diverse invertebrate community, including crustaceans, midges, aquatic worms, dragonflies, snails, mussels and water beetles.

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	17,000-18,000	15,000-16,000	15,000-16,000
Strategies Applied to Achieve Objective			
Reduce extensive emergent cover using prescribed fire, disking, herbicides, and mowing.	✓	✓	✓
Facilitate treatment of extensive emergents and/or carp control using periodic drawdowns.	✓	✓	✓
Ensure water delivery and management through maintenance or enhancement of infrastructure (e.g., delivery ditches, water control structure).	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, water levels, and habitat/migratory bird responses in this habitat type.	✓	✓	✓
Develop a model to predict habitat response based upon changes in biotic and abiotic factors in the habitat type.	✓	✓	✓
Enhance water control structures to stop the influx of spawning carp and juvenile rearing	✓	✓	✓
Rationale: Palustrine emergent seasonally flooded marsh associated with wet meadow is usually found immediately adjacent to our irrigated meadow system. Sandhill crane and yellow-headed blackbird, focal species for this habitat, require nesting sites over or near water in dense emergent stands of cattail, bulrush or reeds which predominate on these sites. They forage on the abundance of insects, macro-invertebrates, and other small wildlife species found in this environment during brood rearing. The adjacent meadows are used later in the year for summer foraging and staging for the fall migration. This blend of habits is central to the success of these birds and other associated wildlife species. Managing toward 20%-40% open water in emergent stands associated with wet meadows provides optimum conditions for the greatest diversity of dependent species. Diverging from this range in either direction decreases overall wildlife diversity and abundance; however, it may not be practical to meet this prescription for every acre across this habitat type due to its quantity and the limited availability of resources. Priority will be given to areas directly adjacent to the most productive wet meadows. Seasonal marshes should be irrigated simultaneously with wet meadows since the two are generally connected hydrologically, as well as biologically in terms of wildlife use. The above-mentioned strategies (mowing, grazing, burning, deep flooding, prescribed drought,			

plowing, herbicides, etc.) can generally reduce the density of emergent vegetation in direct relation to the intensity of the treatment. The plant species composition of specific target areas will determine appropriate management actions because some species are preferred over others (e.g., bulrush at the expense of cattail), and species such as burreed are more sensitive to disturbance than others.
The reduction of approximately 2,000 acres in this habitat type coincides with an equivalent increase in semiflooded seasonal wet meadows. This projected shift would not lead to a decrease in quality marsh habitat because the specified acreages address areas of meadow that have been invaded by cattails. Enhancement of water control structures on the intake and outflow of this habitat is an integral way to control spawning and rearing of juvenile common carp. By installing/maintainingfish screens or modifying the current water control structures the acres inhabitated by carp will sharply decrease and the food source for birds will increase.

Objective 4c. Palustrine Open Water/Emergent (semipermanently flooded wetland impoundment)

Throughout the life of the CCP, protect and maintain semipermanently flooded wetland impoundments on Malheur Refuge for the benefit of migratory birds (e.g., trumpeter swans, sandhill crane, redheads, mallards, soras, Virginia rails, colonial waterbirds) and other wetland-dependent species (beaver, muskrat, native amphibians and reptiles). The desired characteristics sought for this habitat type include:

- Between 40:60 and 60:40 ratio of open water to emergent plant cover in individual units (with the exception of Boca Lake, which will be managed for <20% emergent marsh cover, and West Knox Pond, which will be managed primarily as a moist soil unit)
- Emergent species include bulrush (predominantly hardstem), burreed, and cattail (predominantly common)
- Water depths ranging from 6 inches to 3 feet
- Permanently flooded with drawdowns every three to seven years (with the exception of West Knox Pond, which will be managed primarily as a seasonal wetland [i.e., moist soil unit] and Boca Lake, where water levels will fluctuate more frequently to meet annual seed production goals and carp control)
- >40% cover of submergents (e.g., sago pondweed) within open water
- No carp or Eurasian water milfoil (Myriophyllum spicatum L.)
- <10% cover invasive plants (e.g., reed canarygrass, phragmites, hybrid cattail)
- Diverse invertebrate community, including crustaceans, midges, aquatic worms, dragonflies, snails, mussels and water beetles.

Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually:	2,200-2,800	2,200-2,800	2,200-2,800
Strategies Applied to Achieve Objective			
Deliver and manage water through maintenance or enhancement of infrastructure (e.g., delivery ditches, water control structure). Address needs associated with spotted frog refugia in identified areas (e.g., East Canal, Five Mile Spring within West Canal, etc.).	✓	✓	✓
Use prescribed fire to remove extensive emergent cover.	✓	✓	✓

Use disking to remove extensive emergent cover.		✓	✓
Use mowing to remove extensive emergent cover.	✓	✓	✓
Apply herbicide(s) to control emergents.	✓	✓	✓
Experiment with grazing as a tool in monotypic stands of emergent cover to set back succession.		✓	✓
Manage water levels by flooding up and drawing down for habitat and carp management.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, water levels, and habitat/migratory bird responses in this habitat type.	✓	✓	✓
Develop a model to predict habitat response based upon changes in biotic and abiotic factors in the habitat type.	✓	✓	✓
Enhance water control structures to stop the influx of spawning carp and juvenile rearing	✓	✓	✓

Rationale:

Palustrine open water/emergent (semi-permanently flooded wetland impoundments) are vital to migratory waterfowl and other water birds. The focal species eared grebe, redhead, and ruddy duck express the range of habitat requirements used by the wide diversity of wildlife species benefiting from this habitat. All three prefer large permanently or semi-permanently wetlands or impoundments where open water areas are interspersed with emergent and submergent vegetation tracts. Water depth is the critical factor separating how our focal species and other associated wildlife species use the habitat. The eared grebe favor abundant submergent aquatic beds linked to open water areas up to 10 feet deep to nest and forage in. The ruddy duck prefers interspersed open water and vegetation areas from 1 to 3 feet deep while redheads can be found in the same environments with water depths from a few inches to 3 feet. It should be remembered that these wetlands are critical brooding and rearing areas for the very large portion of the diversity of birds using the refuge.

This wetland habitat will be managed for moist soil vegetation or to provide optimum food production in the form of submergent aquatic plants and aquatic invertebrates. For shorebirds, shallow water drawdowns will provide important feeding opportunities. Emergent vegetation in marshes provides nesting cover for overwater nesters (e.g., sandhill crane, trumpeter swan, rail, redhead, bittern, canvasback, mallard, and diving ducks) and escape cover for broods of numerous species, particularly late-season nesters such as gadwall, redhead, and grebes.

Periodic drawdowns and deep flooding are important tools in management of pond vegetation. A gradation of water depths from mud flats to deep water pools will encourage use by a wide variety of wildlife.

Enhancement of water control structures on the intake and outflow of this habitat is an integral way to control spawning and rearing of juvenile common carp. By installing/maintainingfish screens or modifying the current water control structures the acres inhabitated by carp will sharply decrease and the food source for birds will increase.

Objective 4d. Dry Meadow

Throughout the life of the CCP, enhance or maintain 4,500-5,000 acres of dry meadows on Malheur Refuge for the benefit of nesting migratory birds (e.g., cinnamon teal, northern pintail, savannah sparrow) and a diverse assemblage of other species (e.g., small mammals). The desired characteristics of dry meadow habitat include:

- 50%-70% cover of live native grasses (e.g., creeping wildrye)
- At least 20% cover of plant litter (residual)
- <10% cover of invasive plants (e.g., Russian knapweed (*Acroptilon repens*), pepperweed, whitetop (*Cardaria* spp.))
- Disturbance regime on five- to 10-year intervals to rejuvenate nesting cover (see Appendix B, Grazing and Haying Compatibility Determination, for potential uses)

Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually:	4,500-5,500	4,500-5,500	4,500-5,500
Strategies Applied to Achieve Objective			
Use agricultural practices (e.g., haying, grazing) to maintain/enhance fields to meet the habitat objective. Treatments may be applied during the growing season or dormancy, depending on a science-based rationale.	✓	✓	✓
Use burning regimes where feasible.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Western meadowlark is the focal species for this habitat and its' habitat requirements provide the many of the key needs for the diversity of other wildlife using this environment. Meadowlark favor open country meadows, fields or desert grasslands with good grass and litter cover with little or no woody layer.

Manipulation of vegetation via mowing, burning, or grazing would be used to stimulate vertical nesting structure (Cornely et al. 1983) and deter successional shifts away from desirable conditions (i.e., shrub encroachment could be controlled through the use of prescribed fire). Prescribed fire is the preferred tool for stimulating this habitat type because it is also the most effective tool for controlling sagebrush encroachment from adjacent upland habitats and has the highest potential for stimulating a favorable forb response. If perennial pepperweed and/or other noxious species pose a threat to areas needing treatment, then mowing will be the preferred tool. Mechanical treatments can be advantageous on weed-prone sites because the amount of resources (e.g., nutrients) released by this management action is less than that released by prescribed fire. If mowing is not feasible due to the presence of rocks, shrub stumps, or other obstacles, then late-season grazing may be implemented.

Warm-season grazing or other manipulations as directed by the Malheur Refuge State-and-Transition Model (see Appendix L) and associated collaborative process may be merited in specific situations where target plant community characteristics are at risk or are no longer present (e.g., increasing dominance of Russian knapweed). When desirable characteristics for this habitat type are achieved, site productivity and plant species composition will determine the frequency and specific type of disturbance on a field-by-field basis. Treatments should be infrequent because many avian species prefer to nest in dry meadows consisting of dense residual vegetation.

Objective 4e. Salt Desert Scrub

Throughout the life of the CCP, protect and maintain salt desert scrub for the benefit of breeding migratory birds (e.g., sage thrasher, sage sparrow) and other native wildlife species (e.g., kangaroo rats (*Sorex preblei*), grasshopper mouse (*Onychomys leucogaster*)) on Malheur Refuge. The desired characteristics of desert salt scrub and greasewood habitat include:

- <15% cover of scattered patches of shrubs (e.g., greasewood)
- <20% cover of native herbaceous species
- >20% cover bare ground
- Microbiotic crust present
- <10% cover of invasive plants
- Minimal human disturbance

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	40,000	40,000	40,000
Strategies Applied to Achieve Objective			
Protect existing sensitive sites with microbiotic crusts.	✓	✓	✓
Use prescribed fire depending on site-specific factors.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Aside from periodic weed control and prescribed fire, this habitat type does not receive a significant amount of active management.

The habitat preferences of loggerhead shrike of open terrain with low density of shrubs mixed with low or sparse grasses characterize the needs of other wildlife species typically found in the settings.

Objective 4f. Sagebrush Lowland

Throughout the life of the CCP, protect and maintain lowland big sagebrush habitats (e.g., basin big sagebrush, Wyoming big sagebrush, basin wildrye, Indian ricegrass, Sandberg's bluegrass, bottlebrush squirreltail, etc.) for the benefit of ground nesting migratory birds (e.g., gadwall, short-eared owl, meadowlark) and a diverse assemblage of native species (e.g., small mammals). At any time, 40% of the sagebrush lowland habitat on the Refuge is characterized by the following attributes:

- 0%-12% canopy cover of dominant and subdominant brush species (e.g., basin big sagebrush, Wyoming big sagebrush, greasewood, rabbit brush, horse brush)
- 10%-25% cover of native bunchgrasses (e.g., great basin wildrye, Sandberg's bluegrass, etc.) and forbs
- >5% cover of residual bunchgrasses
- <10% cover invasive plants (e.g., pepperweed, knapweeds)

Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually:	4,300-4,500	4,300-4,500	4,300-4,500
Strategies Applied to Achieve Objective			
Use prescribed fire.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Mallard and gadwall are focal species for sagebrush lowland and in this region prefer islands of brushy shrubland mixed with clumps of native bunchgrasses in the vicinity of water.
Aside from periodic weed control and prescribed fire, this habitat type does not require a significant amount of active management.

Objective 4g. Sagebrush Steppe

Throughout the life of the CCP, protect and maintain sagebrush steppe upland habitat on Malheur Refuge for the benefit of migratory landbirds (e.g., sage sparrow, brewer sparrow, sage thrasher) and a diverse assemblage of other sagebrush-obligate species (e.g., jackrabbit, mule deer). Desired characteristics of sagebrush steppe habitat to achieve include:

- 0%-20% canopy cover of sagebrush species (e.g., Wyoming sagebrush, rabbit brush, bitterbrush)
- >5% cover of bunchgrasses (e.g., Idaho, fescue, Sandberg's bluegrass, bluebunch wheatgrass)
- 3%-5% cover of native forbs (e.g., western yarrow, arrowleaf balsam root, lupine)
- No medusahead or young juniper present
- 5% cover of cheatgrass
- <5% cover of other invasive plants

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	15,500	15,500	15,500
Strategies Applied to Achieve Objective			
Add diversity to crested wheatgrass monocultures using best science practices (i.e., Krumbo research project)		✓	✓
Mimic natural disturbance process in sagebrush communities using mechanical and chemical methods to promote bunchgrasses and forbs.		✓	✓
Seed desirable grasses and forbs.		✓	✓
Use prescribed fire, where appropriate, and based upon site-specific conditions.		✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Wildlife use in this sagebrush landscape is dominated by rangeland passerine birds with the sage thrasher designated as the focal species. The thrasher favors large contiguous tracts of open terrain covered with high density of shrubs with a scattered herbaceous layer. These habitat elements also support a number of mammals such as the pronghorn antelope as well as other wildlife species.

Aside from periodic weed control and limited prescribed disturbance, this habitat type does not require a significant amount of active management. Research is currently being conducted on the Refuge to address the lack of species diversity in areas that were historically seeded into crested wheatgrass following wildfire. Depending on research results, some successional management may occur on these sites, but wetland habitat management will continue to receive highest management priority.

Objective 4h. Dune

Throughout the life of the CCP, protect and maintain dune habitat on Malheur Refuge. Desired characteristics of dune habitats include:

- Open sand dunes hosting widely spaced shrubs (e.g., shortspine horsebrush, fourwing saltbush, bud sagebrush, green and gray rabbitbrush, greasewood, and Basin big sagebrush), grasses (e.g., Indian ricegrass, needle-and-thread, bottlebrush squirreltail, alkali sacaton), and forbs (e.g., tufted evening primrose, Paiute suncup, Geyer's milkvetch, sharpleaf penstemon, various lupines)
- Soil formation by lacustrine sands is neutral to moderately alkaline (8.2); moist in the winter and spring and usually dry June through October
- Host rare and unique invertebrates

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	6,300	6,300	6,300

Strategies Applied to Achieve Objective			
Protect dune areas from disturbance (e.g., well-maintained boundary fences).	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

The sage sparrow has been defined as the focal species for this environment. The habitat needs of this bird as well as associated wildlife species readily describe the landscape. It prefers tracts of widely spaced shrubs surrounded with open patches of bare soil or sand and lightly scattered grasses and forbs. Aside from periodic weed control, this habitat type does not require a significant amount of active management.

Objective 4i. Playa

Throughout the life of the CCP, protect and maintain playas on Malheur Refuge for the benefit of migratory birds (e.g., snowy plover) and associated guilds. The desired characteristics of playa habitats include:

- Retention of hypersaline conditions where appropriate (avoid dilution caused by freshwater irrigation)
- Water depth ranges from hydrated soils to 3-4 feet
- Bare ground with little vegetation (e.g., saltgrass, shrub, herbaceous cover)
- Recharge through springs or natural overland flow
- High populations of brine flies and brine shrimp
- Retention of fringe habitats consisting of dunes, salt desert scrub, and mudflat habitats
- No salt cedar present

Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually:	29,000	29,000	29,000
Strategies Applied to Achieve Objective			
Prevent freshwater irrigation from negatively impacting water chemistry.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

This unique environment is well defined by the habitat needs of its focal species the snowy plover. This bird favors barren sparsely vegetated alkaline flats usually with an adjacent very shallow gloss of water within a mile

Aside from periodic weed control around perimeters, this habitat type does not require a significant amount of active management.

Objective 4j. Provide Agricultural Crops for Migratory Waterfowl and Sandhill Cranes			
Throughout the life of the CCP, annually provide approximately 80-1,000 acres of small grains (e.g., wheat, barley) as forage for migrating aquatic birds (e.g., waterfowl, sandhill crane) and other resident wildlife. The desired characteristics of agricultural lands cropped in small grains include: • Fall harvesting completed by October • ≤1,000 acres as short-stature small grains available during mid-fall to mid-winter • Limited presence of invasive plants			
Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
Total acreage managed annually:	80	≤1,000	≤1,000
Strategies Applied to Achieve Objective			
Use traditional agricultural practices (cultivating, seeding, fertilizing) to produce grain crops.	✓	✓	✓
Conduct cropland management through cooperative farming agreement and/or refuge staff.	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓

Rationale:

Grain farming in the Blitzen Valley is essential to meeting Refuge objectives for fall maintenance of greater sandhill cranes. Grain crops on the Refuge and adjacent private lands provide for a large population of staging and migrating cranes in fall, and are recommended under the Greater Sandhill Crane (Central Valley Population) Pacific Flyway Plan (Pacific Flyway Council 1997). Analysis has determined that 190 tons of grain is required to meet 225,000 crane use-days (Rule et al. 1990). This is the target number of crane use-days, based on historical crane use on the Refuge. The average yield per acre in the Blitzen Valley is 1 ton per acre. Currently the acres farmed on the Refuge have the potential to meet about half this target, but the force-account (Refuge staff conducts farming) method of grain production results in the grain availability being less consistent. In addition, there is no guarantee that the adjacent private lands will continue to be farmed in the future.

Under the CCP, the Service attempts to resolve these issues by doubling the target level of grain produced on Refuge lands, and by modifying the program to a cooperative farming model. Under this model, Refuge lands are used for growing crops but the labor is provided by a private farmer. The farmer would be compensated for his/her efforts by being permitted to take an 80% share of the crop. The remaining 20% would be left in the field for wildlife. Although such a model will provide more consistency in the grain production for the benefit of cranes, it also requires a larger land base for crop production. Under this scenario, approximately 950 acres of grain farming would be needed.

GOAL 5. Enhance and maintain rare and unique habitats.

Objective 5a. Cold and Hot Springs

Throughout the life of the CCP, protect and maintain cold and hot springs, associated pools, and vegetative habitats on Malheur Refuge for the benefit of a diverse assemblage of native plants, fish, and wildlife species (e.g., Columbia spotted frog, endemic invertebrates). The desired characteristics of cold and hot springs include:

- Water table and springhead integrity maintained
- Diversity of native macroinvertebrates
- Breeding, feeding, and winter refugia for native amphibians
- Dominant substrate vegetation, with boulders, fines, cobble, or gravel
- Vegetation varies depending upon soil type
- No turbidity
- No carp or bullfrogs present

Alternatives	Alt 1	Alt 2	Alt 3
Total acreage managed annually:	230-250	230-250	230-250
Strategies Applied to Achieve Objective			
Secure/adjudicate groundwater rights to protect cold and hot springs.		✓	✓
Protect spring habitat to provide a stable permanent water source for Columbian spotted frogs.		✓	✓
Protect spring habitat areas from undesirable, preventable disturbance (i.e., livestock grazing, traffic, etc.).	✓	✓	✓
Use IPM strategies including chemical, mechanical, horticultural, and biological control agents to control/eradicate invasive plants (see Appendix G).	✓	✓	✓
Conduct baseline inventories of fish, wildlife, and vegetation to guide future management actions.	✓	✓	✓
Conduct surveys, inventories, and assessments of pre- and post-carp control effects on aquatic habitats.	✓	✓	✓
Conduct research to understand carp population dynamics and seasonal movements.	✓	✓	✓
Conduct research to understand relationships among water chemistry, water levels, and habitat/migratory bird responses in this habitat type.	✓	✓	✓
Develop a model to predict habitat response based upon changes in biotic and abiotic factors in the habitat type.	✓	✓	✓

Rationale:

Springs provide a stable, permanent source of water for spotted frog breeding, feeding, and winter refugia. Current refuge distribution of the spotted frog is believed to be associated with spring-fed water bodies. Invasive species in these habitats may compete for habitat and food, carry diseases, or be predators upon these amphibians.

Objective 5b. Cliffs, Rimrock, and Lava Flows

Throughout the life of the CCP, protect and annually maintain cliff, rimrock, and lava flow habitats for the benefit of migratory birds (e.g., golden eagle, prairie falcon) and a diverse assemblage of native, cliff/canyon-dependent wildlife (e.g., bat species, marmot) on Malheur Refuge. The desired characteristics of cliffs, rimrock, and lava flow habitats include:

- Well-sheltered crevices, cavities, bluffs, high walls, or rocky ledges overlooking valleys within range of open grasslands, wet meadows, and shrub-steppe deserts
- Largely unvegetated
- Minimal human disturbance, especially in proximity to nesting birds

Strategies Applied to Achieve Objective	Alt 1	Alt 2	Alt 3
Prohibit mining and rock removal, except by the Refuge and according to valid permits for use of existing gravel/rock pits.	✓	✓	✓
Prohibit rock climbing.		✓	✓

Rationale:

This habitat type is not actively managed. These areas will be protected from disturbance (rock mining, climbing, etc.) due to their high value for nesting birds as well as reptiles, mammals, and other wildlife.

Public Use Goals

The following goals and objectives cover facilities and programs associated with wildlife-dependent recreational uses (the "Big Six"): wildlife observation, wildlife/nature photography, interpretation, environmental education, hunting, and fishing. Objectives for related activities, including welcome and orientation, volunteers, partnerships, law enforcement, and transportation, are also included.

Although all of the wildlife-dependent recreational uses would be provided on the Refuge, the cornerstone of the program would be providing quality wildlife observation and wildlife/nature photography opportunities. Interpretation and welcome and orientation features are also high priorities. These programs would be focused on enhancing visitor experiences and promoting the key values and features unique to the Refuge: a renowned diversity of wildlife, signs of earlier inhabitants, remoteness, and solitude. Environmental education, hunting, and fishing would also be provided, but with less commitment of refuge staff time than the other programs. However, additional areas would be opened to enhance opportunities for hunting and fishing. Each of these programs would be supported with the help of volunteers and partnerships.

Quality will be emphasized for each use and program. The definition of "quality" for wildlife-dependent recreational uses is defined in refuge policy by several elements (605 FW 1):

- Promotes safety of participants, other visitors, and facilities;
- Promotes responsible behaviors and compliance with applicable laws and regulations;
- Minimizes or eliminates conflicts with fish and wildlife population or habitat goals or objectives;
- Minimizes or eliminates conflict with other compatible wildlife-dependent recreation;
- Minimizes conflicts with neighboring landowners;
- Promotes accessibility and availability to a broad spectrum of the public;
- Promotes resources stewardship and conservation;
- Promotes public understanding and increases public appreciation of natural resources and the Refuge's and National Wildlife Refuge System's roles in managing and protecting these resources;
- Provides reliable, reasonable opportunities to experience wildlife;
- Uses facilities that are accessible and blend into the natural setting; and
- Uses visitor satisfaction to help define and evaluate programs.

GOAL 6. Welcome visitors and offer them a safe experience of the Refuge's outstanding features: diversity of wildlife, signs of earlier inhabitants, scenic landscapes, and solitude. As a result, visitors will leave the Refuge with a memorable experience that fosters a connection between themselves and nature, and with an appreciation of Malheur Refuge's unique resources.

Objective 6a. Provide Welcome and Orientation to Visitors
Provide an integrated set of welcome and orientation features for visitors to: • Feel welcomed • Easily find accurate, timely, and appropriate orientation materials and information • Be aware of their options (available activities and experiences, where and when to go, how to get there, etc.) • Safely pursue self-guided activities. Welcome and orientation features shall be characterized as follows: • Both modern and traditional media will be used to reach and orient visitors to the Refuge • Entrance signage welcoming visitors to Malheur Refuge will be located at all seven refuge entrances and road junctions at Refuge Headquarters, Malheur Field Station, both access points at Buena Vista, Krumbo Lane, P Lane, and Double-O • Directional signs that alert visitors to the presence of nearby attractions (such as "Krumbo Reservoir – Fishing", "Visitor Center" or "Contact Station") will be posted on State Highway 205 and along the auto tour route (Center Patrol Road) in appropriate locations • Outdoor welcome and orientation panels will be provided at four to eight locations to direct and guide visitors • Maps, brochures, regulations, and additional information on the outdoor welcome and orientation panels will be positively worded and available at attractive and visible structures, such as masonry work, near main refuge entrances and at areas where visitors tend to congregate, especially at the Narrows Pull-out, Buena Vista, Krumbo Reservoir, P Ranch, and Frenchglen • Five to 10 clean, well maintained, and accessible developed sites with visitor amenities, such as picnic tables, shelters, and vault toilets will be provided in logical and appropriate locations

in the Blitzen Valley and at Double-O
- Structures and developed sites will be built to blend in with the surrounding features and habitat
- Daily opportunities for personal contact with refuge staff and volunteers at Refuge Headquarters and P Ranch contact station will be provided

Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	Some features	All added features	Some added features
Strategies Applied to Achieve Objective			
Continue to maintain and update existing modern and traditional media (website, brochures, Flickr account, etc.) to reach and orient visitors. Use other modern media as appropriate.	✓	✓	✓
Develop step-down plans for outdoor panels, facilities, and signs.		✓	✓
Continue to maintain and update four existing outdoor panels to welcome and orient visitors at locations indicated in Alternative 1. Develop additional outdoor welcome and orientation panels as shown.	• Narrows Pull-Out • Refuge Headquarters • Buena Vista • Frenchglen	Same as Alt 1, plus: • Krumbo Reservoir • P Ranch • Harney Lake • Double-O	Same as Alt 1, plus: • Krumbo Reservoir • P Ranch • Harney Lake
Maintain existing developed sites with visitor amenities such as picnic tables, shelters, and vault toilets as indicated by Alternative 1. Provide additional developed sites as shown.	• Refuge Headquarters • Buena Vista • Krumbo Reservoir • P Ranch	**Complete Developed Sites** • Double-O **Vault Toilet Only** • Sod House Ranch **Picnic Tables and Shelters Only** • Refuge Headquarters (ADA-compliant) • Buena Vista Overlook • P Ranch	**Picnic Tables and Shelters Only** • Refuge Headquarters (ADA-compliant) • P Ranch
Build an enlarged visitor contact station and gift shop at Refuge Headquarters.		✓	✓

Enhance George Benson Memorial Museum to meet ADA standards and meet preservation standards to protect specimens.		✓	✓
Establish a seasonal contact station at P Ranch, and provide volunteer staffing as available during spring, summer, and fall.	✓	✓	✓
Continue to consider/participate in discussions for an interagency visitor facility off-refuge.	✓	✓	✓

Rationale:

A high number of visitors to the Refuge are new to the area and benefit from direction and guidance especially at refuge entrances and road junctions. The strategies focus on providing quality customer service and improving information and orientation availability. Utilizing modern and traditional media, and providing outdoor welcome and orientation panels and developed sites that are clean, well maintained, and accessible, while also not detracting from the surroundings, will be emphasized. This objective and its strategies are aimed at ensuring that information provided to visitors is clear so visitors can easily determine where they can go, what they can do, and how to safely and ethically engage in wildlife-dependent recreational uses.

Objective 6b. Address Transportation Issues and Concerns

Develop a transportation plan for existing and needed roads, bridges, pull-outs, access points, parking areas, trails, and other elements of transportation infrastructure that support public uses and refuge management needs as identified within other CCP objectives. The transportation plan will:

- Develop strategies for maintaining three to six public roads, parking areas and several vehicle pull-offs, to minimum public safety standards
- Consider provisions, according to management and public use needs, for vehicles, farming equipment, bicycles, school buses or other larger vehicles, and pedestrians
- Include ancillary facilities, such as interpretive signage, environmental education shelters, restrooms, parking areas, boat launches, etc.
- Address potential impacts to wildlife and associated habitats
- Include a safety audit of all transportation facilities identified above
- Include a prioritized list of construction and improvement items
- Implement as funds become available to bring all facilities up to approved Service standards

Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	Some features	All added features	Some added features
Strategies Applied to Achieve Objective			
Continue to maintain existing refuge public roads as indicated in Alternative 1. Enhance one to four refuge public roads as shown.	• 42-mile Blitzen Valley auto tour route (Center Patrol Road)	• Boating Landing Road • East Canal Road to the confluence	• Boat Landing Road • Saddle Butte hunt access

	• Krumbo Reservoir • P Lane	of Bridge Creek • Double-O • Saddle Butte hunt access	
Continue to maintain a variety of vehicle pull-offs (one or two vehicle lengths) on the 42-mile Blitzen Valley auto tour route (Center Patrol Road) and develop additional vehicle pull-offs to assist with wildlife observation and wildlife/nature photography, hunting and fishing programs as shown.	✓	• Boating Landing Road • East Canal Road to the confluence of Bridge Creek	• Boat Landing Road
Redesign two or three year-round smaller auto tour routes on Center Patrol Road in the Buena Vista and P Ranch units.			✓
Maintain existing parking areas and develop two or three parking areas to assist with wildlife observation and wildlife/nature photography, hunting and fishing programs as shown.		• Bridge on Boat Landing Road • Airboat launch site (to ADA standards) • East Canal at the confluence of Bridge Creek	• Bridge on Boat Landing Road • Airboat launch site (to ADA standards)
Work with local and State governments to identify alternative funding sources and cost-sharing opportunities for maintenance of and improvements to the transportation system to and through the Refuge.	✓	✓	✓
Partner with the Federal Highway Administration, ODOT, local county road departments, and others to develop the transportation plan and safety audit.		✓	✓
Rationale: A comprehensive transportation plan and safety audit is needed to ensure the safest and most efficient access for visitors, cooperative ranchers, and others who need to access the Refuge. A transportation plan will also assist the Refuge in obtaining funds available under Federal and State transportation authorities for project implementation.			

GOAL 7. Connect the hearts and minds of visitors with the places and resources the Refuge protects, and enlighten visitors' experiences with an understanding of, appreciation for, and knowledge about historic and natural resources, and the importance of conservation and stewardship.

Objective 7a. Provide Wildlife Observation and Wildlife/Nature Photography Opportunities to the Casual Visitor and Beginning to Moderate Birders

Provide casual visitors and beginning to moderate birders with a variety of structured opportunities to view wildlife, observe nature, and photograph wildlife and the surrounding landscape. The program shall:

- Provide docent-led tours, approximately monthly, at different locations on the Refuge, including into areas that are normally closed to the public
- Provide occasional opportunities to experience Malheur Lake with docent-led kayaking and canoeing tours
- Integrate the interpretive program with observation and photography opportunities so that visitors can make their own discoveries (see Objective 7c)
- Provide a variety of vehicle pull-offs on the 42-mile Blitzen Valley auto tour route (Center Patrol Road) at key locations to enhance the birding experience
- Provide an opportunity for exercise and enhanced opportunities for solitude as part of the recreational experience by providing two to four loop trails (≥1 mile)
- Provide at least five or six spur trails to good birding sites, with some trails meeting ADA standards
- Include trail signs (e.g., trail access information (TAI) signs) posted at all trailheads (see photo).
- Provide access to five to seven developed viewing facilities, such as overlooks and platforms at key locations for viewing wildlife and landscapes
- Provide opportunities for quality photography in three first-come/first-served permanent, ADA-compliant photography blinds or temporary, day-to-day basis photography blinds

Objective is Part of the Following Alternatives	Alt 1	Alt 2	Alt 3
	Some features	All added features	Some added features
Strategies Applied to Achieve Objective			
Docent-led Tours			
Continue to provide docent-led tours in conjunction with the annual John Scharff Migratory Bird Festival.	✓	✓	✓
Advertise and provide docent-led tours, approximately monthly, to a variety of audiences for the purposes of viewing wildlife and habitats at different locations on the Refuge. Tours may include kayaking		✓	✓

or canoeing on Malheur Lake. Encourage advanced birders to volunteer to lead docent-led tours for the public and groups.			
Auto Tour Route and Vehicular Access			
Continue to maintain existing refuge public roads on the 42-mile auto tour route (Center Patrol Road), Krumbo Reservoir, and P Lane. Provide additional vehicle access year-round as shown, except when road conditions are hazardous.	✓	Same as Alt 1, plus: • Boat Landing Road • Krumbo Reservoir • East Canal Road to confluence of Bridge Creek	Same as Alt 1, plus: • Boat Landing Road
Seasonally close portion of the 42-mile auto tour route (Center Patrol Road) to vehicle traffic to develop two or three year-round smaller auto tour routes, and allow walk-in, free-roam access along the auto tour route (Center Patrol Road) and dike tops in the Buena Vista and P Ranch units.			**Buena Vista Unit** • Free roam open August 15-fourth Friday of October **P Ranch Unit** • Free roam open August 15-March 1
Participate in Basin and Range Birding Trail on-refuge with Harney County Chamber of Commerce and other partners.		✓	✓
Trails			
Provide trails as shown. Mark all existing and new trailheads with trail signs (e.g., TAI).	• Headquarters Overlook • Buena Vista Overlook • Crane Pond Overlook • Krumbo Reservoir • Benson Pond Trail • Bridge Creek Trail • River Trail	**Spur Trail** • Frenchglen to Barnes Springs Footpath **Loop Trails (≥1 mile)** • Refuge Headquarters along the Blitzen River and Display Pond (Headquarters	**Loop Trails (≥1 mile)** • Refuge Headquarters along the Blitzen River and Display Pond (Headquarters Loop Trail) **ADA-compliant Trails** • Sections of

	• East Canal Trail • Barnes Springs Footpath • Desert Trail	Loop Trail) • Connect Bridge Creek Trail, River Trail, and East Canal Trail with pedestrian crossings and boardwalks **ADA-compliant Trails** • Sections of Headquarters Loop Trail • Sod House Ranch (upgrade to ADA standards) • Benson Pond • P Ranch	Headquarters Loop Trail • Sod House Ranch (upgrade to ADA standards) • P Ranch
Propose alternative route to enhance the Desert Trail and post appropriate Desert Trail signs at logical locations.		✓	✓
Observation and Photography Features			
Provide viewing features as shown and develop step down plans for viewing overlooks and platforms.	• Headquarters Overlook • Buena Vista Overlook (upgrade to ADA standards)	**Viewing Overlooks** • Krumbo Reservoir (ADA-compliant) **Elevated Viewing Platforms** • Historic CCC lookout tower at Refuge Headquarters • Malheur Lake at airboat launch site	**Elevated Viewing Platforms** • Malheur Lake at airboat launch site • Harney Lake

		• Harney Lake • Double-O	
Restore historic Audubon photography blind at Refuge Headquarters Display Pond.		✓	✓
Provide two ADA-compliant, first-come/first-served permanent photography blinds for high-quality wildlife photography at appropriate locations.		✓	
Allow temporary photography blinds to be erected on day-to-day basis when free-roam areas are open.			✓
Allow boating use (nonmotorized or electric boats, kayaks, canoes, etc.) that is not directly supporting fishing at Krumbo Reservoir year-round, except when reservoir begins to ice over.		✓	✓ (With seasonal drive-in and walk in access)
Require a yearly special use permit for for-profit commercial wildlife guiding and commercial photography uses on the Refuge.		✓	✓

Rationale:

During scoping, casual visitors and beginning to moderate birders expressed a need for increased access, vehicle pull-offs near a variety of trails, viewing and photography facilities, and other opportunities for this user group. Wildlife observation is the primary visitor activity that occurs on the Refuge, but visitors also come to enjoy the area's wide open spaces, geology, and historic resources. The Refuge provides docent-led tours during the John Scharff Migratory Bird festival to closed areas of the Refuge; visitors respond enthusiastically to these tours. An expanded use of docent-led tours will promote relationship-building between the Refuge and visitors, create greater awareness of the values of Malheur Refuge, and allow occasional access to areas that are normally closed to refuge visitors, in a manner that minimizes conflicts with fish and wildlife population or habitat goals.

Connecting people to nature is a national initiative that the Refuge will contribute to via the strategies described above. Providing docent-led tours on Malheur Lake by kayak and canoe will enhance the opportunity for freedom and experience of one of the Refuge's most well-known landmarks, and provide an opportunity to educate visitors about the management challenges posed by invasive common carp and the degradation of important habitat on the lake.

Continuing to provide an auto tour route, while enhancing the experience by providing additional areas for vehicle access and pull-offs, providing longer trails, and providing additional viewing and photography facilities, will also help to meet a visitor need to connect with the larger landscape and resources.

Objective 7b. Provide Opportunities to View Rare and Incidental Species to Advanced Birders

Provide advanced birders with continued opportunities to enjoy sightings of rare and incidental birds, particularly passerines. The Refuge will:

- Maintain four to six sites (approximately 300 acres) of habitats characterized by cottonwood trees, other non-endemic trees, and shrubs associated with historic landscapes

Objective is Part of the Following Alternatives	Alt 1	Alt 2	Alt 3
	Some features	All added features	Some added features
Strategies Applied to Achieve Objective			
Participate in and promote real-time rare bird alerts utilizing modern media.		✓	✓
Prepare and implement a site plan for Refuge Headquarters that incorporates birders' concerns, such as maintaining cottonwood trees, other non-endemic trees, and shrubs.		✓	✓
Prepare and implement site plans to maintain cottonwood trees, other non-endemic trees, and shrubs as shown.		• Sod House Ranch • Benson Pond • Witzel Field • Barnyard Springs • P Ranch	• Sod House Ranch • Benson Pond • P Ranch
Conduct vegetation management of invasive species in ways that do not interfere with the ability of the identified sites to host rare and incidental species.		✓	✓
Integrate vegetation management and access at the identified sites with appropriate cultural resource protection and interpretation (see Goal 10).		✓	✓
Continue to maintain seasonal closure at Sod House Ranch to protect heron rookery.	✓	✓	✓
Rationale: Advanced birders are a small but important component of the visitor base at the Refuge. Some of the trees that host the rare and vagrant species are not native to the area but were brought in deliberately by early settlers for shade. Because these special birding sites are located at sites of historic significance, maintaining a component of tall shade trees meets both the objective of providing habitat for rare and incidental species, and the purpose of providing a continued "look and feel" characteristic to these historic landscapes. In addition to these reasons, these sites occupy a small percentage of the overall refuge landscape and also provide values to native wildlife, including a heron rookery at Sod House Ranch; therefore, we consider it acceptable to maintain and promote this non-native vegetative component.			

Objective 7c. Provide Interpretive Opportunities of Key Resources and Issues
Provide a variety of interpretive opportunities to connect refuge visitors and the local community with historic and natural resources. Interpretive features shall be characterized as follows: • Enhance uses of modern media to convey information to visitors and enhance opportunities for

self-guided or multisensory experiences
- Provide a range of traditional interpretive materials and programs, including indoor and outdoor interpretive panels, approximately monthly presentations, and four to seven local events
- Provide well-marked outdoor interpretive panels that include "attractants" to slow and encourage visitation, such as masonry work

Using various methods, advance visitor understanding of the following key themes:
- Historical and current significance of the Refuge to breeding and migratory birds
- Precontact and post-contact history (see Goal 10)
- CCC work in the area (see Goal 10)
- Wilderness
- Geology and paleontology
- Aquatic health
- Water's importance, hydrology, and movement across the landscape
- Primary refuge wildlife, habitat, and resources management objectives and management challenges, and methods
- Role and importance of the National Wildlife Refuge System
- An understanding of visitors' relationships to, and impacts on, natural and cultural resources to encourage and inspire them to become stewards of the lands

Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	Some features	All added features	Some added features
Strategies Applied to Achieve Objective			
Regularly maintain and update information on the key interpretive themes via a variety of media.	• Website • Brochures	Same as Alt 1, plus make greater use of modern media, such as CDs, podcasts, social media, etc.	
Provide new interior panels in the George Benson Memorial Museum to connect visitors with places and the resources the Refuge protects.		✓	✓
Continue to maintain five existing outdoor interpretive panels as indicated by Alternative 1. Provide additional outdoor interpretive panels at key field sites to appropriately implement key interpretive themes, and focus on aquatic health and associated management activities and weaving historic events and ecology of the Refuge.	• Narrows Pull-out • Refuge Headquarters • Sod House Ranch • Buena Vista Overlook • P Ranch	✓	✓
Participate in local events, on- and off-refuge, providing docent-led activities and visits to specified sites with booths and	• John Scharff Migratory Bird Festival	Same as Alt 1, plus: • International Migratory Bird	

educational materials as appropriate.	(April) • Free Fishing Day (June) • Invasive Carp Awareness (August) • Harney County Fair (September)	Day (May) • Ranching Heritage Day combined with Invasive Carp Awareness (August) • National Wildlife Refuge Week (October)
Continue to provide public presentations by refuge staff and volunteers. Advertise and share presentations by utilizing modern media.	Upon request	At least monthly
Rationale: Interpretive features and programs emphasizing key interpretive themes relevant to the Refuge can greatly assist visitors in discovering the resources and understanding the role and relevance of the Refuge. The visiting public has expressed a need for a stronger emphasis on connecting visitors with places and resources the Refuge protects, and enlightening visitors' experiences through interpretive panels, docent-led tours, special events, and group presentations. Investing in such programs and facilities is consistent with the Refuge System mission and would expand refuge support and relationships.		

Objective 7d. Support and Provide Environmental Education Programs			
In partnership, implement environmental education programs that: • Emphasize enjoyable, hands-on, outdoor learning • Integrate key interpretive themes (see Objective 7c) • Promote discovery and wildlife awareness • Build understanding and appreciation of the Refuge's historic and natural resources • Promote conservation and stewardship The program shall be characterized as follows: • Facilitate on- and off-refuge education for all ages for ≥500 students annually, with a target audience of local first and third graders • Partner with other environmental education initiatives to promote assistance with programs, activities, and exhibits • Support local, state, and national education standards and other curricula • Serve formal educators (i.e., teachers) and informal educators (i.e., Scouting group leaders) • Use various refuge resources to assist with environmental education activities, and use refuge facilities, including wildlife observation structures, interpretive panels, trails, etc. • Coordinate and assist with other environmental education initiatives			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	Some features	All added features	Some added features

Strategies Applied to Achieve Objective			
Continue to conduct existing environmental education program and ongoing collaboration with environmental education initiatives.	✓	✓	✓
When refuge staff and volunteers are available, use and implement existing curricula, and national and regional environmental education modules, such as Junior Duck Stamp Program, International Migratory Bird Day, etc., on- and off-refuge.		✓	✓
Coordinate and assist with local environmental education initiatives upon request.	✓	✓	✓
Review and revise as needed the Cooperative Agreement between the Great Basin Society/Malheur Field Station and the Refuge.		✓	✓
Build an outdoor shelter at Refuge Headquarters where environmental education activities can be conducted during periods of inclement weather.		✓	✓
Provide an outdoor learning area at Refuge Headquarters to assist with existing environmental education program and efforts with other environmental education initiatives.		✓	✓
Require a yearly special use permit for non-profit groups and educational institutions engaging in EE programs on the Refuge.		✓	✓
Rationale: The Refuge has an opportunity to support and provide environmental education programs for local schools, universities, and other educational or community groups, in partnership with other local environmental education initiatives. Utilizing and enhancing partnerships with established programs like these, and using ready-made national curricula would provide greater efficiency for the Refuge and build community relationships. The existing environmental education program would remain, and when staff and volunteers are available existing curricula and national and regional environmental education modules would be used and implemented. Provision of specified outdoor learning facilities will promote enjoyable and hands-on learning and an integrated curriculum at key target sites, while mitigating demands on the Refuge's indoor spaces.			

GOAL 8. Provide reasonable challenges and opportunities, and provide uncrowded conditions for the hunting and fishing public.

Objective 8a. Provide Hunting Opportunities for Upland Game
Provide high-quality hunting opportunities for upland game hunting in the Malheur Lake, Buena Vista, and Boundary hunt units, for the species, seasons, and other details described in the Hunt Plan (Appendix P). The program shall be managed such that: • Youth are provided added emphasis • Conditions are uncrowded, with abundant opportunities for solitude over 58,000 allowable hunting acres • The hunt is safe and managed to minimize conflicts with wildlife and other priority wildlife-dependent recreational uses • Access is provided on suitable all-weather access roads • Game are wild or naturalized (not stocked) • Most hunters reach their quota each day • Refuge staff engages in close cooperation and coordination with State fish and wildlife management agencies for management of hunting opportunities on the Refuge and in setting population management goals and objectives • Hunt is consistent with State fish and wildlife laws, regulations, and management plans

Strategies Applied to Achieve Objective	Alt 1	Alt 2	Alt 3
Continue to allow upland game hunting in the Malheur Lake, Buena Vista, and Boundary hunt units under regulations currently in place and specified.	✓		
Update existing hunting brochure and website to explain upland game hunting opportunities and regulations; update Code of Federal Regulations [CFRs] per revised Hunt Plan (Appendix P).		✓	✓
Malheur Lake Hunt Unit			
Maintain hunt program under current regulations, except drop rabbit from the list of allowable species. Improve Saddle Butte access on north side of Malheur Lake Hunt Unit (see Appendix P).		✓	✓
Buena Vista Hunt Unit			
Maintain hunt program under current regulations, except drop rabbit from the list of allowable species and extend season opener from the fourth Saturday of October to the end of the State pheasant season (see Appendix P).		✓	✓

Boundary Hunt Unit			
Manage hunt program as described in Hunt Plan (Appendix P).		✓	✓

Rationale:

The most substantial modification suggested for the upland game hunt on the Refuge under Alternatives 2 and 3 is the season extension proposed for the Buena Vista Unit; this would provide greater hunting opportunity. The hunt openers have been designed to minimize disturbance to staging sandhill cranes, which do not use the northern part of the Malheur Lake Hunt Unit; hence, this unit will remain open at the same time as the regular State season, thus spreading out the openers across two weekends and reducing crowding.

Greater vehicular access for the Buena Vista Unit was considered but rejected because many believe the free-roaming, off-road nature of the hunt is one of its key assets. The P Ranch Unit was also considered but was rejected due to conflicts with wintering waterfowl, which use the P Ranch Unit more heavily than other units because of the access to open water, which is limited during winter on the Refuge.

Rabbit is proposed to be dropped from the Malheur Lake and Buena Vista hunt units because this species may be taken at any time of day or night, and this presents a conflict with the hunts as designed for these units.

Objective 8b. Provide Hunting Opportunities for Waterfowl

Provide high-quality waterfowl hunting opportunities in the Malheur Lake, Buena Vista, and Boundary hunt units, for the species, seasons, and other details described in the Hunt Plan (Appendix P).
The program shall be managed in such that:

- Youth are provided added emphasis
- Conditions are uncrowded with abundant opportunities for solitude over 63,000 allowable hunting acres
- The hunt is safe and managed to minimize conflicts with wildlife and other priority wildlife-dependent recreational uses
- Access is provided on suitable all-weather roads
- Hunters can enjoy a range of waterfowl hunting experiences, ranging from traditional setup with decoys and dogs to jump-shooting
- Parking areas are adequate, with parking at three existing locations and one new parking area and boat launch at the airboat launch site to access a new hunt opportunity on the southern side of Malheur Lake
- Most hunters reach their quota each day
- Refuge staff engages in close cooperation and coordination with State fish and wildlife management agencies for management of hunting opportunities on the Refuge and in setting population management goals and objectives
- Hunt is consistent with State fish and wildlife laws, regulations, and management plans

Strategies Applied to Achieve Objective	**Alt 1**	**Alt 2**	**Alt 3**
Continue to allow waterfowl hunting in the Malheur Lake and Boundary hunt units under regulations currently in place and specified.	✓		

Update existing hunting brochure, website, and CFRs to explain waterfowl hunting opportunities and regulations.		✓	✓
Malheur Lake Hunt Unit			
Manage the waterfowl/migratory bird hunt on Malheur Lake Unit as described in Appendix P.		✓	✓
Promote waterfowl youth hunt opportunity on State-designated weekend in the northern Malheur Lake Hunt Unit.		✓	✓
Improve Saddle Butte access on north side of Malheur Lake Hunt Unit.		✓	✓
Expand allowable boundary to include south-central area of Malheur Lake with special date regulations of the fourth Saturday of October to the end of the State waterfowl season.		✓	✓
Open new boat access for nonmotorized or electric boats on Malheur Lake at the airboat launch site near Refuge Headquarters with expanded parking and a boat launch (ADA standards). Opening date for the access would be the on the fourth Saturday of October to the end of the State waterfowl season.		✓	✓
At low water (<10,000 acres), close Malheur Lake to waterfowl hunting.	✓	✓	✓
The new Caspian tern island in the South Malheur Lake Unit will be permanently closed to hunting.	✓	✓	✓
Buena Vista Hunt Unit			
Open Buena Vista Hunt Unit to waterfowl hunting with special date regulations, from the fourth Saturday of October to the end of the State pheasant season. Boats will not be permitted. See Appendix P for details.		✓	
Support reasonable waterfowl hunting opportunities that comply with the ADA in partnerships with potential users.		✓	
Boundary Hunt Unit			
Continue to allow waterfowl/migratory bird hunting in the Boundary Hunt Unit under existing regulations (see Appendix P).		✓	✓

Double-O Unit			
Explore a youth hunt opportunity on State-designated weekend in designated areas.			✓

Rationale:

Although historically Malheur Lake was renowned for its waterfowl hunting opportunities, currently the waterfowl hunt is perceived as poor quality. The key issue preventing greater success is seen as the plenitude of invasive common carp in the lake. Access is also poor from the existing access points; lake fluctuations often preclude opportunities to provide easy drive-in access to reliable boat launches on most parts of the lake. Hence, at the present time, few hunters hunt the lake and those who do rarely use boats to access the lake. Providing a fourth access point at the more reliable airboat launch site on the Blitzen River delta near Refuge Headquarters would allow hunters to access a larger portion of the lake by boat and provide additional opportunities for hunting. As aquatic health improves (see Objective 1a), waterfowl hunting opportunities on the lake should improve.

Opening the Buena Vista Hunt Unit will provide a quality experience in a large additional area with good access. This unit has some wetlands and the mainstem of the Blitzen River. Hunters may walk in and set up decoys on some of the wetlands or jump-shoot as opportunities present themselves. Although the small size of ponds and wetlands could pose competition and disturbance issues, the limited number of hunters past opening weekend will likely mitigate against these concerns. Safety issues along the auto tour route (Center Patrol Road) will also be mitigated as visitor use is expected to be light during the hunting season.

Other areas considered for waterfowl hunting included the P Ranch and Double-O units. With the change in water rights, there could be a potential opportunity to flood up additional areas for hunting in the Blitzen Valley. However, most of the additional water will arrive early in the spring, so it will not be available during prime waterfowl hunting time. In addition, the P Ranch Unit was also rejected as a hunt unit due to conflicts with wintering waterfowl, which use the P Ranch Unit more heavily than other units because open water is more concentrated in the P Ranch Unit during winter. The Double-O Unit is considered more sensitive to biological and cultural resource disturbances, but a weekend youth hunt may be possible while limiting the amount of disturbance.

Objective 8c. Provide Stream Fisheries Aimed at Experienced Fly-fishers and Other Anglers

Provide a high-quality, challenging, semiprimitive fishing opportunity aimed at experienced fly-fishers and non-bait anglers along the upper Blitzen River, a portion of the East Canal, and tributaries (collectively known as the South Fishing Loop), and along a new fishing opportunity near Refuge Headquarters. The program shall be managed such that:

- Drive-in access is available in close proximity on approximately 3 miles of the stream opportunity, with pedestrian crossings for walk-in access to 7 miles of fishable area west of the East Canal to the confluence of Bridge Creek at the Blitzen River
- Conditions are uncrowded, with abundant opportunities for solitude over 11 miles of river
- Minimal facilities are present for a more undeveloped experience
- Maps, brochures, regulations, and additional information are positively worded on panels and available at attractive and visible structures, such as wooden kiosks, at all five fishing entrances;
- Redband trout and other native fish are present
- Conflicts with wildlife and other priority wildlife-dependent recreational uses are minimized;
- Refuge staff engages in close cooperation and coordination with State fish and wildlife management agencies for fisheries management
- Fishing is consistent with State fish and wildlife laws, regulations, and management plans

Strategies Applied to Achieve Objective	Alt 1	Alt 2	Alt 3
Continue to allow fishing opportunities in the areas identified in this objective's other strategies and under regulations currently in place and specified.	✓	✓	✓
Allow drive-in access on East Canal Road to the confluence of Bridge Creek with access to Granddad Reservoir (BLM), except when road conditions are hazardous.		✓	
Build a new pedestrian crossing and boardwalks at Bridge Creek to access a portion of the fishable area west of East Canal to its confluence of Bridge Creek with the Blitzen River.		✓	
Open new seasonal bank fishing opportunity from Sodhouse Lane to the bridge on the Boat Landing Road, part of the Headquarters Loop Trail. Dates for fishing access would be August 1 to September 15.		✓	✓
Develop 5 outdoor panels with brochures, maps, regulations, and other information at main entrance points, such as the East Canal, P Ranch, Bridge Creek, Sodhouse Lane, and the bridge on the Boat Landing Road, and provide additional signing.		✓	✓
Rationale: The fishery as currently managed offers a semideveloped experience with greater challenge than the Krumbo Reservoir fishery. Re-opening the East Canal Road to Bridge Creek to vehicles under Alternative 2 will provide greater access, including access to Granddad Reservoir (BLM). Currently, members of the fishing public either cannot or do not wish to walk long distances. Opening a new seasonal bank fishing opportunity from Sodhouse Lane to the bridge on the Boat Landing Road near Refuge Headquarters will also provide additional fishing opportunity.			

Objective 8d. Provide a Reservoir Fishery Aimed at Successful Take for Casual Anglers
Provide a quality year-round fishing opportunity at Krumbo Reservoir aimed at providing successful trout and bass fishing for beginning, casual, and local anglers. The program shall be managed such that: • Visitors can drive in and walk short distances • Anglers may fish from the shoreline, on the accessible fishing dock, or by boat • Access for visitors with disabilities is available • Clean and maintained facilities, including vault toilets, picnic tables, and shelters, are available • Maps, brochures, regulations, and additional information will be positively worded and available at one attractive and visible structure, such as a wooden kiosk at the main parking area • Numerous catchable fish are present • Managed to minimize conflicts with wildlife and other priority wildlife-dependent recreational uses

- Refuge staff engages in close cooperation and coordination with State Fish and Wildlife management agencies for stocking of fish and fisheries management
- Fishing is consistent with State fish and wildlife laws, regulations, and management plans

Strategies Applied to Achieve Objective	Alt 1	Alt 2	Alt 3
Continue to allow fishing opportunities under regulations currently in place from the fourth Saturday of April through October 31.	✓		
Develop fishing brochure to explain fishing opportunities and regulations, and update existing website.		✓	✓
Continue coordination with ODFW and stocking of Krumbo Reservoir with triploid rainbow trout with steps to undertake genetic introgression study on redband trout (See Objective 13d).	✓	✓	✓
Open Krumbo Reservoir to fishing year-round with drive-in access, except when road conditions are hazardous. For safety reasons, ice fishing or nonmotorized or electric boats will not be permitted when the reservoir begins to ice over.		✓	
Open Krumbo Reservoir to fishing year-round with seasonal drive-in and walk-in access as described in Alternative 3. For safety reasons, ice fishing or nonmotorized or electric boats will not be permitted when the reservoir begins to ice over.			**Drive-in Access** • Open to vehicular traffic from the fourth Saturday of April-October 31 **Walk-in Access** • Open to walk-in access from November 1-fourth Friday of April
Develop one panel with maps, brochures, regulations, and additional information at the main parking area.		✓	✓

Rationale:

Providing access for fishing (and other uses) year-round is a way to provide greater opportunity for this use and to avoid the opening day rush and overcrowding that currently occurs in the spring. As noted in a strategy under Objective 7a, it would also allow use of the area during fall, winter, and spring for wildlife observation and hikers. Some wintering use by diving ducks, swans, and other wintering

waterfowl occurs on the reservoir, but since wintertime visitor use is expected to be light, any disturbance that may occur is not expected to significantly impact these species. Wildlife surveys will be underway in the winter of 2010-2011 to evaluate the extent of wildlife use and to estimate future wildlife disturbance. Camping was requested by several members of the public during scoping and was considered for Krumbo Reservoir to support the fishing experience; it was determined that it is unnecessary to provide camping in the area because of the availability of nearby camping opportunities on BLM and at the Narrows, and because of the demands camping would place upon refuge staff and law enforcement.

The CCP team recommends continuing the current practice of stocking the reservoir with triploid rainbow trout, a non-native fish. Transitioning the fishery to a native redband trout fishery was considered but a variety of steps would need to be undertaken (public review, genetic introgression study, and regulation change). If the fishery was transitioned to a native fishery, it would likely require a regulation change to catch-and-release or two-fish limit. Although the stocking of non-native species is discouraged under refuge policy (601 FW 3), in this case it is justified because of the importance of this recreational opportunity to local and nonlocal visitors. There are only a few other such opportunities for year-round fishing in southeast Oregon.

GOAL 9. Enhance Refuge Programs, Partnerships and Public Outreach

Objective 9a. Enhance Refuge Programs, Partnerships and Public Outreach with Volunteer Opportunities

Build a volunteer program and partnerships to help the Refuge achieve its mission and goals. The programs shall:

- Identify ways the Malheur Wildlife Associates can best support the Refuge
- Provide volunteer opportunities that allow the public to maximize their interaction with refuge facilities and staff
- Focus on priority projects that will enhance the wildlife and habitat on the Refuge, and support a variety of projects and programs
- Focus on building partnerships and public outreach
- Increase recruitment, retention, and a volunteer return rate of ≥50%

Strategies Applied to Achieve Objective	Alt 1	Alt 2	Alt 3
Continue to conduct existing volunteer program and ongoing collaboration with Malheur Wildlife Associates, including assisting with building their capacity.	✓	✓	✓
Establish a full-time volunteer coordinator position that would focus specifically on improving the volunteer program, such as by increasing recruitment, retention, and return rate of volunteers and expanding the program for efficient use of facilities and Refuge staff. The position would also focus on building partnerships and increasing public outreach.		✓	✓

Rationale:

Although the Refuge is remote, current capacity for supporting volunteers is relatively high. The Refuge has six RV pads with full hookups; in addition, two bunkhouses with 11 bedrooms provide the

potential to support up to 15 volunteers at any one time. Typically 50 volunteers are on-site between March and October, each serving approximately two months. Over 5,000 hours are contributed annually with a return rate of at least 50%. However, to increase the volunteer program without additional assistance would be difficult. Establishing a full-time volunteer coordinator position would enable desired improvements to the program, efficient use of facilities, and more use of volunteers by Refuge staff.

Objective 9b. Maintain an Effective Law Enforcement Presence			
Establish and maintain an effective, professional, and courteous law enforcement presence to discourage unauthorized uses and maintain reported incidents at a flat or declining trend over a 15- year period.			
Strategies Applied to Achieve Objective	**Alt 1**	**Alt 2**	**Alt 3**
In connection with Objective 6a, improve posting of regulations at key welcome and orientation sites, as well as locations where fishing and hunting uses predominate (Krumbo Reservoir, Malheur Lake, Buena Vista Unit, etc.).		✓	✓
Maintain current law enforcement staffing (one dedicated law enforcement officer).	✓	✓	✓
Continue cooperative relationships and agreements with Oregon State Police and Harney County Sheriff's office.	✓	✓	✓
Continue to emphasize information, education, and a friendly presence in the field during key seasons.	✓	✓	✓
Improve fencing in certain refuge boundary areas to minimize trespass cattle.		✓	✓
Rationale: Enforcement of Federal wildlife laws, regulations specific to the Refuge System, and State laws is an essential component of refuge operations; enforcement ensures that natural and cultural resources are protected and that visitors have a safe environment. Fortunately, law enforcement incidents at the Refuge are relatively few compared to other refuges. The predominant law enforcement concerns center on cultural resource protection, trespass cattle, and fishing and hunting compliance. Cooperative relationships with other law enforcement organizations improve effectiveness.			

Objective 9c. Engage Partners and Stakeholders in Adaptive Management			
Continue to work with partners and stakeholders in the pursuit of the best available science to further our understanding of the effects of implementing management activities, evaluating methods and techniques, and initiating adaptive management to address needed changes.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	limited	✓	✓

Strategies Applied to Achieve Objective			
Via the Ecology Working Group, develop the Malheur Refuge State-and-Transition Model (STM) (see Appendix L).	✓	✓	✓
Implement use of the Malheur Refuge STM.		✓	✓
Use the Malheur Refuge STM as a framework for presenting results of management activities to partners and stakeholders.		✓	✓
Via the Aquatic Health Coalition's workgroups (control, assessment, and partnership and funding) develop grant proposals and conduct research to adaptively manage aquatic health. Communicate via the Aquatic Health Coalition list serve.	✓	✓	✓
Rationale: The benefits of the STM concept for Malheur Refuge are greater than the ecological understanding of refuge habitat it promotes. The STM is a living model that is continually transformed as new information is gleaned over time and because of this, it introduces an amplified dependence on actualized adaptive management. It also provides a framework for organizing results and reporting them to the interested public. The STM and the Aquatic Health Coalition provide transparency, heightened and continued interaction with partnering agencies/organizations, and accountability for continued monitoring of management actions. The desired outcome is to work collaboratively with others to address habitat management and aquatic health needs using the best available science, innovative methods and techniques, and transparency. The Refuge is committed to keeping our partners engaged as we move forward with adaptive management activities.			

GOAL 10. Manage prehistoric and historic cultural resources for their educational, scientific, and cultural values for the benefit of present and future generations of refuge users and for the communities that are connected to these resources.

Objective 10a. Identify and Protect Prehistoric and Historic Archaeological Resources			
Increase monitoring and protection of all cultural resources, prehistoric and historic, on the Refuge while increasing public and staff support and appreciation.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	limited	✓	✓
Strategies Applied to Achieve Objective			
Continue to identify archaeological sites and historic structures that coincide with existing and planned roads, facilities, public use areas, habitat restoration, and research projects. Prepare and implement activities to mitigate impacts to sites as necessary.	✓	✓	✓

Implement a program to evaluate eligibility for listing on the NRHP for those archaeological sites and historic structures that may be impacted by Service undertakings, management activities, erosion, or neglect.	limited	✓	✓
Develop a historical buildings management plan with list of maintenance and restoration needs by structure. Prioritize the list by structure and include estimated repair costs. Actively seek funding and develop partnerships to maintain and protect structures.		✓	✓
Coordinate with the Tribe on cultural resources inventory, evaluation, and project monitoring, consistent with the regulations of the NHPA. Protect all identifiable archaeological sites by avoiding disturbance within the area.	✓	✓	✓
Develop and strengthen partnerships with educational and historic institutions for the interpretation and protection of cultural resources.	✓	✓	✓
Facilitate partnerships with other appropriate Federal and State agencies, professional archaeologists, descendants of early settlers, and the general public to aid in the management of cultural resources.	limited	✓	✓
Rationale: Various Federal historic preservation laws and regulations require the Service to implement the kind of program described under this objective. Providing adequate attention and resources to these responsibilities would identify areas to be avoided by disturbances associated with projects being implemented by Refuge staff as they focus on other land, habitat, and wildlife management efforts.			

Objective 10b. Provide Interpretation of Cultural Resources			
Increase awareness of and appreciation for the Refuge's cultural resources among refuge users, the community, and staff.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	limited	✓	✓
Strategies Applied to Achieve Objective			
Prepare interpretive media (e.g., pamphlets, signs, exhibits) that communicate cultural resources information and Native American perspectives to visitors.	limited	✓	✓
Develop interpretive media (e.g., pamphlets, signs, exhibits) describing the history of Euro-American settlement and use of the Refuge.	limited	✓	✓
Prepare environmental/cultural education materials for use by local schools concerning cultural resources, the discipline of archaeology, the perspectives of Native Americans, the history of the area, and conservation of natural and cultural resources. These materials could include an artifact replica kit with hands-on activities and curriculum prepared in consultation with the local school district, the historical society, and the Tribe.		✓	✓
Consult with the Tribe and other preservation partners to identify the type of cultural resources information appropriate for public interpretation.	limited	✓	✓

Develop an outreach program and materials so that the cultural resource messages become part of cultural events in the area, including the State's Archaeology Month, National Wildlife Refuge Week, and local festivals (see Objective 7c).		✓	✓
Develop museum property inventory for the George Benson Memorial Museum. Create storage and use plans for museum property as part of the outreach program.		✓	✓
Promote reuse of existing historic structures (e.g., for environmental education, interpretive programs, storage).		✓	✓
Develop and implement interpretive plans for the Headquarters CCC site, Sod House Ranch, Benson Pond CCC site, P Ranch, and Double-O Ranch.		✓	✓
Continue working with the Tribe on the collection of native plant materials where compatible.	✓	✓	✓
Rationale: Cultural resources are not renewable. Interpretation of cultural resources can raise public interest and appreciation for the peoples who lived in earlier times. Ultimately, such appreciation can result in public support for conservation, maintenance, and protection of archaeological and historic sites.			

Objective 10c. Consultation on Cultural Resources			
Increase coordination and consultation with the Burns Paiute Tribe for prehistoric resources and important native plants and wildlife on the Refuge.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	limited	✓	✓
Strategies Applied to Achieve Objective			
Continue consulting and coordinating with the Tribe on refuge projects that may affect prehistoric sites, native plants, or wildlife important to the Tribe. Meet with the Tribal Council at least three times a year to review upcoming refuge projects.	✓	✓	✓
Continue working with the Burns Paiute Tribe on the collection of native plant materials where compatible and the inclusion of important traditional plants in riparian or other habitat restoration projects.	✓	✓	✓
Rationale: Federal historic preservation laws and regulations require the Service to consult with Native American Tribes concerning projects which may affect archaeological sites. Collaborating with the Tribe on the inclusion of important traditional plants in refuge restoration projects ensures greater communication with the Tribe.			

Objective 10d. Establish Site Significance Factors			
Identify criteria that allow us to determine what cultural resource sites, site types, and data from sites are important and need preservation or analysis to address specific research questions.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
		✓	✓
Strategies Applied to Achieve Objective			
Develop a model identifying the sensitivity of various habitat types for the presence of cultural resources. Link these to specific layers in a GIS database.		✓	✓
Perform an archaeological analysis of the Refuge and the surrounding area to formulate a short list of information and research needs for cultural resources and their management.		✓	✓
Rationale: Implementation of this objective would streamline the process used to identify cultural resources that may be impacted by refuge projects or public uses.			

GOAL 11. Identify and protect prehistoric and historic resources on the Refuge that are eligible for or listed on the National Register of Historic Places.

Objective 11a. Increase Management Efforts for Historic Sites Listed on or Eligible for Listing on the NRHP			
Identify, stabilize, and restore eligible historic resources from the homestead, ranching, and CCC eras.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	limited	✓	✓
Strategies Applied to Achieve Objective			
Perform an inventory and assessment of historic sites to determine NRHP eligibility. As part of this inventory, identify specific stabilization and restoration costs. This should include prioritization of the most critical needs for each site and structure.	limited	✓	✓
Develop partnerships (University of Oregon, National Park Service, etc.) to assist in the stabilization and restoration of historic sites and structures.	limited	✓	✓
Rationale: Federal historic preservation laws and regulations require a determination of eligibility for the NRHP for sites 50 years or older, and preservation of historic resources determined to be eligible for listing.			

Objective 11b. Increase Management Efforts for Prehistoric Sites Listed on or Eligible for Listing on the NRHP			
Identify and protect prehistoric archaeological sites listed on or eligible for listing on the NRHP.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
	✓	✓	✓
Strategies Applied to Achieve Objective			
Identify archaeological sites that coincide with existing and planned roads, facilities, public use areas, and habitat projects. Evaluate threatened and impacted sites for eligibility to the NRHP. Prepare and implement activities to mitigate impacts to sites as necessary.	✓	✓	✓
Implement a program to evaluate eligibility to the NRHP for those archaeological sites that may be impacted by Service undertakings, management activities, erosion, or neglect.	limited	✓	✓
Develop a GIS layer for cultural resources that can be used with other GIS layers for the Refuge yet contains appropriate locks to protect sensitive information.	limited	✓	✓
Rationale: Federal historic preservation laws and regulations require a determination of eligibility for the NRHP for archaeological sites 50 years or older.			

GOAL 12. Manage the Refuge's paleontological resources for their educational and scientific values for the benefit of present and future generations of refuge users.

Objective 12a. Protect Paleontological Resources			
Increase monitoring and protection of paleontological resources on the Refuge.			
Objective is Part of the Following Alternatives	**Alt 1**	**Alt 2**	**Alt 3**
		✓	✓
Strategies Applied to Achieve Objective			
Continue to identify paleontological sites that coincide with existing and planned roads, facilities, public use areas, habitat restoration, and research projects. Prepare and implement activities to mitigate impacts to sites as necessary.		✓	✓
Rationale: Paleontological resources are not renewable. Federal laws and regulations mandate protection of this resource on Federal lands.			

Objective 12b. Provide Interpretation of Paleontological Resources
Provide interpretation to instill appreciation for the Refuge's paleontological resources and the valuable information they can yield about past environments.

Objective is Part of the Following Alternatives	Alt 1	Alt 2	Alt 3
		✓	✓
Strategies Applied to Achieve Objective			
Provide interpretation of paleontological resources at Refuge Headquarters using static displays, brochures, etc.		✓	✓
Partner with National Park Service staff from the John Day Fossil Beds National Monument on the development of interpretive and educational materials about the Refuge's paleontological resources.		✓	✓
Rationale: Interpretation of paleontological resources can raise public interest and appreciation of the scientific information that can be gained from studies of fossil fauna and flora and how this information relates to past environments in the Great Basin. Ultimately, such appreciation can result in public support for conservation, maintenance, and protection of paleontological resources.			

GOAL 13. Gather scientific information (surveys, research, and assessments) to support adaptive management decisions.

Objective 13a. Inventory and Monitoring (Surveys)
Throughout the life of the CCP, conduct high-priority inventory and monitoring (survey) activities that evaluate resource management and public use activities to facilitate adaptive management. Surveys should contribute to the enhancement, protection, use, preservation, and management of wildlife populations and their habitats on and off refuge lands. Additionally, surveys can be used to evaluate achievement of resource management objectives identified in the CCP. These surveys have the following attributes: • Data collection techniques should result in minimal animal mortality or disturbance, and minimal habitat destruction • The minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet statistical analysis requirements would be collected for identification and/or experimentation in order to minimize long-term or cumulative impacts • All common carp would be lethally sampled unless the survey pertains to telemetry or mark and recapture. • Proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary, would minimize the potential spread or introduction of invasive species • Projects would adhere to scientifically defensible protocols for data collection, where available and applicable.
Strategies Applied to Achieve Objective **The following is a list of survey activities to support resource management decisions on the Refuge.**
Aquatic inventory and monitoring associated with highest priority habitat objectives.
Terrestrial inventory and monitoring associated with highest priority habitat objectives.
Wildlife inventory and monitoring associated with highest priority habitat objectives.
Habitat inventory and monitoring associated with highest priority habitat objectives.

Rationale: National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. 668dd-ee) requires the Service to "monitor the status and trends of fish, wildlife, and plants in each refuge." Surveys would be used primarily to evaluate resource response to assess progress toward achieving refuge management objectives (under Goals 1-4 in this CCP) derived from the NWRS mission, refuge purpose(s), and maintenance of biological integrity, diversity, and environmental health (601 FW 3). Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on Department of Interior lands as required by policy (522 DM 1). Specifically, results of the surveys would be used to refine management strategies, where necessary, over time in order to achieve resource objectives. Surveys would provide the best available scientific information to promote transparent decision-making processes for resource management over time on refuge lands.

Objective 13b. Assessment of Hydrological Features Associated with Riverine Systems and Associated Wetlands (i.e., Blitzen River)
Conduct geomorphological, hydrological, and biological assessments that will provide current baseline information about the ecological status of riverine systems (i.e., Blitzen River and tributaries) and associated wetlands.
Strategies Applied to Achieve Objective
Historic channel/floodplain geometry (e.g., historic aerial photo analysis, transport measurements).
Sediment flux (sediment/hydraulic modeling).
Water allocation (water budget, habitat use, and availability surveys).
Life history/habitat needs of aquatic species (population modeling, literature review, aerial photos).
Bank erosion and incision rates (e.g., erosion pins, channel surveys).
Channel morphology surveys (e.g., sediment budget).
Sediment transport measurements (e.g., channel change).
Continued gauging of flows (water supply, potential climate change, channel and floodplain change).
Ongoing aerial photo collection and analysis (bank erosion rates, extent of floodplain inundation).
Riparian plant surveys (composition/distribution of riparian vegetation).
Habitat availability surveys for focal species (condition of in-stream habitat).
Habitat use surveys for focal/invasive species (physical factors affecting aquatic species).
Investigate bed erosion associated with in-stream structures.
Rationale: See Objective 2a.

Objective 13c. Implement Riverine Pilot Projects to Assess River and Wetland Response to Rehabilitation Efforts
Utilizing information gleaned from assessment results, identify and implement two to five pilot projects to gain greater understanding of plant community and physical responses to rehabilitation efforts of the Blitzen River and associated tributaries, wetlands, and meadows.

Strategies Applied to Achieve Objective
Study response of wetland habitats to the cessation of flood irrigation.
Initiate small in-stream rehabilitation pilot projects in tributaries or reaches of the Blitzen River in response to assessment results.
Rationale: See Objective 2a.The necessity of this objective is dependant upon the outcomes of objectives 13a and b.

Objective 13d. Research
Throughout the life of the CCP, conduct high-priority research projects that provide the best science for habitat and wildlife management on and off the Refuge. Scientific findings gained through these projects would expand knowledge regarding life-history needs of species and species groups as well as identify or refine habitat and wildlife management actions. Research also will reduce uncertainty regarding wildlife and habitat responses to refuge management actions in order to achieve desired outcomes reflected in resource management objectives and to facilitate adaptive management. These research projects should exhibit the following attributes: • Projects would adhere to scientifically defensible protocols for data collection, where available and applicable, in order to develop the best science for resource management • Data collection techniques should cause minimal animal mortality (except for invasive species) or disturbance and temporary habitat damage • Investigators should collect the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet statistical analysis requirements for identification and/or experimentation in order to minimize long-term or cumulative impacts • All common carp would be lethally sampled unless the research pertains to telemetry or mark and recapture • Investigator equipment and clothing would be properly cleaned or quarantined, where necessary, to minimize the potential spread or introduction of invasive species • Permitted research should result in peer-reviewed articles in scientific journals and publications and/or symposiums
The following is a prioritized list of research projects to support resource management decisions on the Refuge.
Conduct research to gather scientific data to further carp control efforts.
Determine management action responses by native fish and wildlife resources.
Identify methods for restoration of crested wheatgrass plantings and cheatgrass-dominated areas to native sagebrush steppe communities.
Monitor the effect of seasonal water table depths on plant communities along hydrological gradients in emergent marsh and wet and dry meadow habitats in select areas.
Identify strategies for diversifying plant communities (e.g., reed canarygrass and other introduced grass monocultures) where appropriate.
Rationale: Research projects on refuge lands would address a wide range of natural and cultural resource as well as public-use management issues. Examples of research projects include habitat use and life-history requirements for specific species/species groups, practical methods for habitat management and restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest

species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, wilderness character, modeling of wildlife populations, and assessment of responses of habitat/wildlife to disturbance from public uses. Projects may be species-specific or refuge-specific, or they may evaluate the relative contribution of the Refuge to issues and trends at larger landscape level (e.g., ecoregion, region, and flyway, national, international). Like monitoring, results of research projects would expand the best available scientific information and potentially reduce uncertainties to promote transparent decision-making processes for resource management over time on refuge lands. In combination with results of surveys, research would promote adaptive management on refuge lands. Scientific publications resulting from research on refuge lands will help increase the visibility of the NWRS as a leader in the development of the best science for resource conservation and management.

Objective 13e. Scientific Assessments

Throughout the life of the CCP, conduct scientific assessments to provide baseline information to expand knowledge regarding the status of refuge resources to make better resource management decisions. These scientific assessments will contribute to the development of refuge resource objectives and they will also be used to facilitate habitat restoration through selection of appropriate habitat management strategies based upon site-specific conditions. These scientific assessments should exhibit the following attributes:

- Use of accepted standards, where available, for completion of assessments
- Scale and accuracy of assessments where appropriate for development and implementation of refuge habitat and wildlife management actions

Alternatives	Alt 1	Alt 2	Alt 3
The following is a prioritized list of scientific assessments to support resource management decisions on the Refuge.			
Conduct aquatic health assessment of Malheur Lake pertaining to fish, macroinvertebrates, water, and plants.	✓	✓	✓
Assess avian predation on carp.		✓	
Assess carp control study areas before and after treatment.	✓	✓	✓
Conduct assessment on hydrogeological modifications.			✓

Rationale:

In accordance with policy for implementing adaptive management on refuge lands (522 DM 1), appropriate and applicable environmental assessments are necessary to determine resource status, promote learning, and evaluate progress toward achieving objectives whenever using adaptive management. These assessments would provide fundamental information about biotic (e.g., vegetation data layer) as well as abiotic processes and conditions (e.g., soils, topography) that are necessary to ensure that implementation of on-the-ground resource management achieve resource management objectives identified under Goals 1-4.

Objective 13f. Monitor Public Use Programs

Monitor public use programs to meet the needs and desires of refuge visitors, and to ensure visitor satisfaction with wildlife-dependent recreational opportunities. The program will use visitor satisfaction surveys or other instruments to help define and evaluate wildlife-dependent recreational opportunities.

Objective is Part of the Following Alternatives			Alt 1	Alt 2	Alt 3
			Some occurs	✓	✓
Program	**Indicator**	**Method**	**Frequency**	**Locations**	**Partners**
Overall use	Visitation numbers	Traffic counters	Checked monthly	Entrances at Headquarters parking area and P Lane	Volunteers
Site visits	Number of visitors at key sites	Door counter, head count and self-registration	Checked monthly	Visitor Center, trail heads, and fishing areas	Volunteers
Facility conditions	Conditions	Visual/site condition form	Checked quarterly	Signs, trails, interpretive panels, etc.	Volunteers
Welcome and orientation	Number of users and user satisfaction	Comment cards	Checked monthly	Visitor Center and key sites	Volunteers
Wildlife observation	Number of users and user satisfaction	Self-registration	Checked monthly	Visitor Center and key sites	Volunteers
Wildlife/ nature photography	Number of users and user satisfaction	Self-registration	Checked monthly	Visitor Center and key sites	Volunteers
Interpretation	Number of users and user satisfaction	Self-registration	Checked monthly	Visitor Center and key sites	Volunteers
Environmental education	Number of users and user satisfaction	Feedback forms	Per scheduled programs	All scheduled programs	
Hunting	Number of users and user satisfaction	Verbal communication	During hunting seasons	All hunt units	
Fishing	Number of users and user satisfaction	Self-registration	Checked monthly	Entrances to fishing areas	Volunteers
Volunteers and partnerships	Number of users and user satisfaction	Feedback forms and verbal communication	End of volunteer tour of duty or opportunity	All volunteers; partners at bi-annual intervals	
Rationale: Monitoring public use, including the level of visitation, facility condition, and visitor experience, assists in maintaining a quality public use program. Monitoring will provide a tool to evaluate the public use program and assist the Refuge with making needed improvements.					

GOAL 14. Integrate our conservation-based mission with the best available science and become a leader in advancing best practices for the design and management of innovative, sustainable refuge and community development opportunities.

Objective 14a. By 2020, Achieve Carbon Neutrality (striving for carbon negative), Meeting and Exceeding All Energy and Material Efficiency and Effectiveness as Defined by 565 FW 1 and Executive Order 13514 for All Facets of Refuge Management and Operations

Objective is Part of the Following Alternatives	Alt 1	Alt 2	Alt 3
Strategies Applied to Achieve Objective			
Establish performance benchmarks within Environmental Management System (515 DM 4) as the critical first step, then create metrics and benchmarks for all other sustainability-based practices (environmental, social, economic, and community).	✓	✓	✓
Complete audits for energy and material use, carbon footprint, and biomass-based carbon sequestration.	✓	✓	✓
Integrate sustainability-based approaches into partnerships, contracts, and other external stakeholder efforts.	✓	✓	✓
Provide staff and external stakeholder training for sustainability-based principles and practices, social justice/equity, community development, and partnership performance standards.	✓	✓	✓
Develop projects to refit and right-size facilities, infrastructure, and vehicle fleet to maximize energy efficiency and production. Seek funding through Refuge Operations Needs and Deferred Maintenance databases, and other opportunistic and entrepreneurial funding sources.	✓	✓	✓

Rationale:

The word "sustainability" came into common use only in the past 25 years, most formally in 1987 when the Brundtland Commission defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

This widely published definition says much about the ethics and responsibility of one generation to the next. Sustainability is how we commonly think in terms of leaving the nation and world a better place for our children and grandchildren, whether in regards to family, land, and finances, or in terms of public land and resources. As such, it is a reinforcement of traditional American values: protection of our natural and cultural resources, self-sufficiency, self-determination, ingenuity, and responsibility. Sustainability-based planning, design, and management practices are essential to the conservation of biodiversity as well as, if not synonymous with, the longevity and resilience of surrounding local communities and landowners, who are possible partners in Refuge sustainability initiatives.

There are numerous policy statements and initiatives that call for integrating sustainability-based principles and practices within the CCP.

- USFWS Strategic Plan for Climate Change, which calls for the Service to become carbon neutral by 2020
- 515 DM 4, Environmental Management System (EMS), which gives facilities a systematic way to identify environmental impacts from operational activities and to set facility-specific goals and targets for sustainability; Malheur Refuge is one of 17 USFWS facilities chosen to implement EMS
- Executive Order 13514, Federal Leadership in Environment, Energy, and Economic Performance
- Executive Order 13423, Federal Environmental, Energy, and Transportation Management (codified by Section 748 of the Omnibus Appropriations Act of 2009 (P.L. 111-8)), and Instructions for Implementing the Order)
- Secretary of Interior Salazar's speech at the UN Conference on Climate Change in Copenhagen, entitled "New Energy Future: The Role of Public Lands in Clean Energy Production and Carbon Capture"

As such, in the interest of contributing to national security and economic competitiveness through our mission, the Refuge must do its part in producing more energy than it consumes, storing more carbon than it produces, proactively adapting to climate change, and maximizing the delivery of all other ecological services, especially biodiversity and clean water.
The Refuge is taking the approach of the old adage that if we are not part of the solution, then we are part of the problem. If we are part of the problem, then we risk being irrelevant, if not disposable, in the eyes of the general public. Our intent is to lead.

2.10 References

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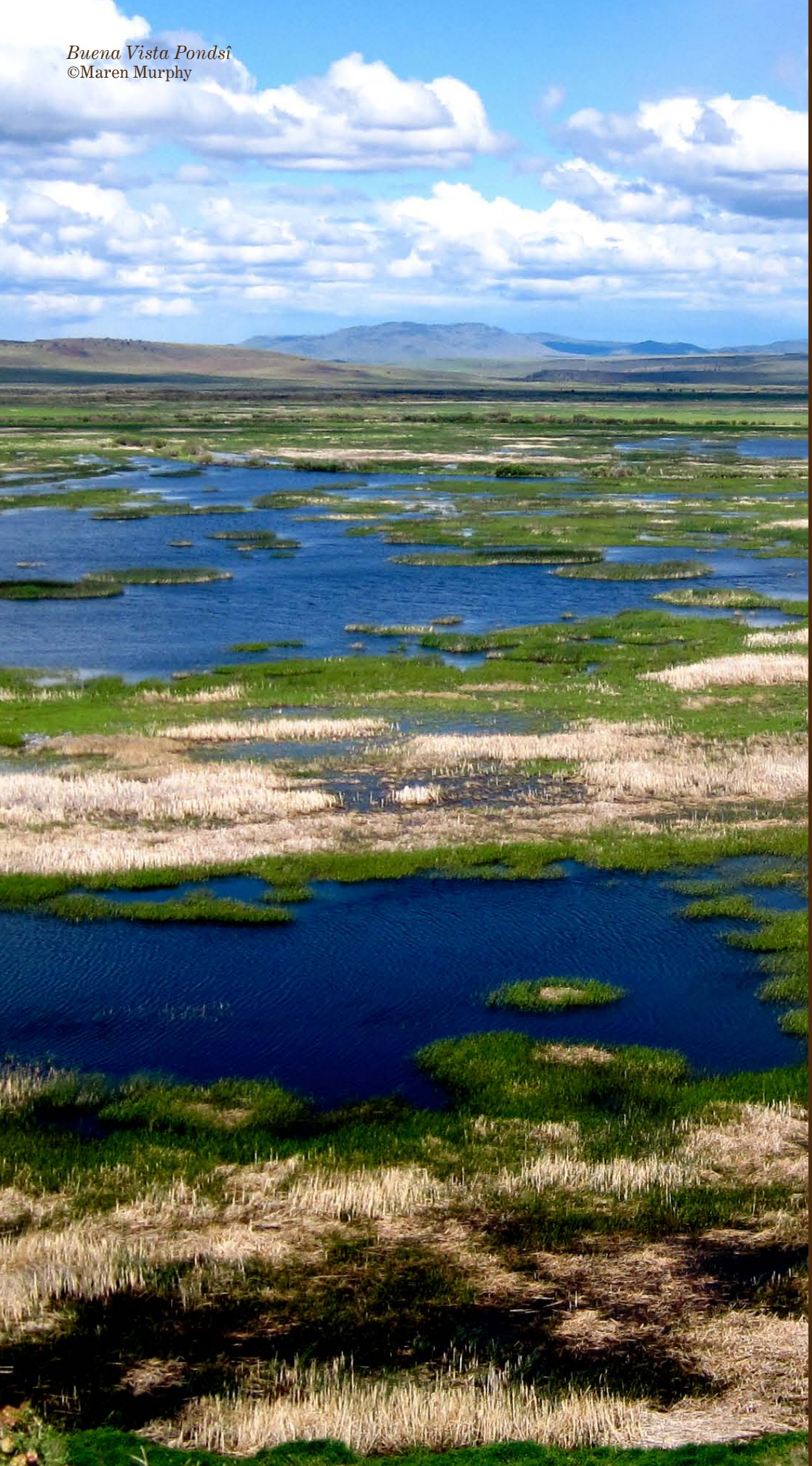

Buena Vista Pondsî
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Chapter 3 Physical Environment

3.1 Major Landforms

Situated in the wide open spaces of the Harney Basin physiographic area, on the northern edge of the Great Basin, the Refuge centers on three shallow playa lakes, Malheur, Mud, and Harney. These lakes are located in the lowest portion of the Harney Basin and receive life-producing water from the surrounding hills and mountains. Most of the water reaching the lakes arrives in the spring as snow melts and flows southward down the Silvies River, northward in the Donner und Blitzen River (Blitzen River), and through the Silver Creek drainage from the northwest. With an average annual rain/snow fall of only 9 inches, a drought year can result in extremely dry conditions; the lakes can be reduced to a mere fraction of their former size or become alkali-covered playas. The area surrounding the lakes is relatively flat, so a 1-inch rise in the water level will put almost 3 square miles of adjacent land underwater. A year of extremely abundant rain and snow can force water to rise beyond the boundaries of the Refuge to cover surrounding lands, doubling or tripling the size of the marsh. In the mid-1980s three years of above-normal snow forced Malheur Lake beyond the refuge boundary; the lake grew from 67 square miles to more than 160 square miles. The reverse is also possible: in 1992 Malheur Lake was reduced to 500 acres with a depth of 2 inches (USFWS 1992).

Malheur Refuge lies in the Harney Basin in southeastern Oregon. The basin is in a hydrographically closed watershed on the northern reaches of the Great Basin. It lies mainly within the High Lava Plains physiographic province and is characterized as alluvial lowlands and surrounding volcanic rock uplands.

3.2 Climate

3.2.1 Current Climate

Climate Patterns

In winter, air masses moving inland from the Pacific Ocean to the North American continent pick up unlimited moisture from the ocean. The Cascade Range, some 100 miles west of the Refuge, forces this moisture-laden marine air from the Pacific Ocean to rise as it moves eastward. The resultant cooling and condensation produces heavy winter moisture on the western side of the Cascades and a rain shadow effect that extends across eastern Oregon. This produces a semiarid steppe climate for the Harney Basin, with relatively low rainfall in the lowland areas. Higher elevation areas in the basin, including Steens Mountain, are cooler and much wetter than the valley floors. The distribution of vegetation communities, which is strongly controlled by temperature and precipitation gradients, reflects this difference. Vegetation in these higher elevation areas includes western juniper and quaking aspen as well as mountain sagebrush, grasses, and other low-growing shrubs. These areas are very important to refuge water resources because the river systems that supply the Refuge are mainly sourced from higher-elevation areas. In particular, the Blitzen River, which flows through the Blitzen Valley before emptying into Malheur Lake, originates on the western side of Steens Mountain. Because of the importance of the Blitzen River to refuge water resources, the following climate discussion includes the Blitzen watershed, upstream of the Refuge, as well as the valley floor and the Refuge.

Local Temperature and Rainfall Sources 1975-2009

There are several sources of historic climate data for the Refuge. The main data source used here is the Parameter-elevation Regressions on Independent Slopes Model (PRISM) (Daly 2002; Daly et al. 2008). PRISM provides a complete record (i.e., no missing data) of temperature and precipitation data at 4-km resolution for the United States. Monthly minimum and maximum temperature and monthly precipitation PRISM data from 1950 to 2009 was used. A Geographic Information System was used to delineate two areas, the area encompassed by the refuge boundary and the Blitzen watershed upstream of the Refuge and Page Springs. This was then used to intersect the 4-km gridded PRISM data and queried temperature and precipitation for all grid points within the boundaries of these two areas at each monthly time step, so that an average monthly temperature and total monthly precipitation could be calculated for both the Refuge and the Blitzen watershed for every month from 1950 to 2009.

A second source of daily and monthly climate data is the individual weather stations in the area. These include Burns Municipal Airport, four National Weather Service/National Oceanic and Atmospheric Administration (NWS/NOAA) government weather stations on the Refuge (Buena Vista Station, P Ranch Substation, Double-O Station and Refuge Headquarters), and the United States Historical Climatology Network (USHCN) Malheur Refuge Headquarters station (Station No. 355162). Data from the USHCN station data was the main source of data because this station provides a complete record of high-quality climate data (Menne et al. 2009). The PRISM method described above likely used data from all these local stations, as well as snowpack telemetry (SNOTEL) station data described below, to develop the interpolated dataset for the area.

A third source of climate data is two Natural Resources Conservation Service (NRCS) SNOTEL sites, Silvies SNOTEL (Site No. 759) and the Fish Creek SNOTEL (Site No. 477), located on Steens Mountain within the Blitzen watershed (NRCS 2011). The Silvies site is slightly lower (6,990 feet) than the Fish Creek site (7,660 feet) but both sites are at high elevations for SNOTEL sites in Oregon. These sites have April 1 snow water equivalent measurements (SWE) from 1939 to the present, with daily SWE, precipitation, and air temperature measurements beginning in 1984.

Average temperature, precipitation, and April 1 SWE were calculated from the PRISM data or the SNOTEL data using the period 1975 to 2009. Summary statistics (average, maximum, and minimum) for the shorter, more recent period will be more representative of average climate in the area today. Data from the longer period (from 1950 to 2009) were used to evaluate long-term trends in the monthly temperature and precipitation PRISM data and the April 1 SWE data. Temperature or precipitation trends observed in the PRISM dataset were compared to data from the USHCN station. A Mann Kendall test, a nonparametric trend test that is less sensitive to outliers than linear regression, was used for trend testing. Because the trend is less sensitive to outliers, the test results can be thought of as more conservative—meaning it will be more difficult to detect statistically significant trends in the data.

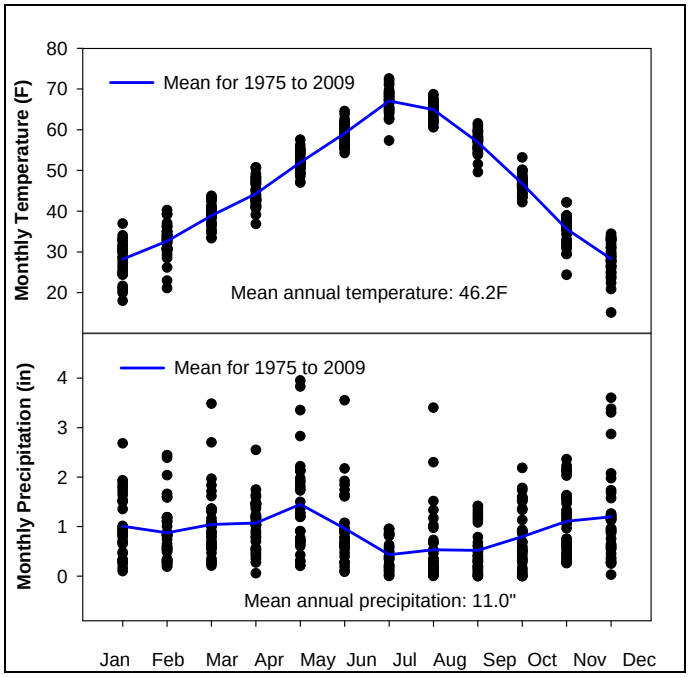
Refuge Temperature and Precipitation Averages 1975-2009

Temperature: The mean annual temperature for the Refuge is 46.3°F for the period 1975 to 2009 (Figure 3-1). July is the warmest month, with an average monthly maximum temperature of 84.9°F. January is the coldest month, with an average monthly minimum temperature of 18.4°F. Average

All references to elevations in this document are at the National Geodetic Vertical Datum of 1929 (NGVD29), to the best of our knowledge.

monthly minimum temperatures are below 32°F from November through April. The USHCN station (elevation 4,118 feet) at Malheur Refuge Headquarters has recorded an average of 18 days a year with temperatures of 90°F or greater, and an average of 182 days a year with temperatures of 32°F or less.

Precipitation: Average annual precipitation for the Refuge is 11.0 inches for the water year (October-September), with most of that total (9.5 inches) falling from October to June (Figure 3-1). The summer months, July through September, are typically very dry, although August has been wet in some years because of thunderstorm activity. Thunderstorms accompanied by lightning are common during the late summer and influence the frequency of wildland fires on and around the Refuge.



Source: PRISM 4-km gridded data.

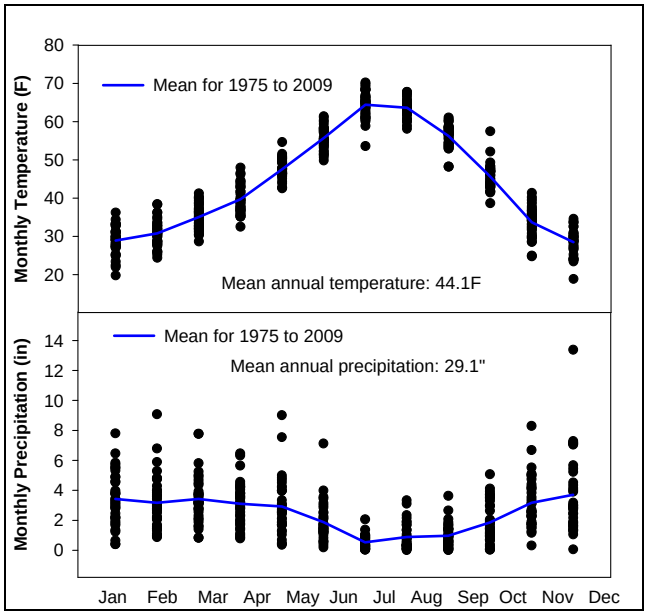
Figure 3-1. Mean and distribution of monthly temperature and precipitation for the area encompassed by Malheur Refuge for the period 1975 to 2009.

Wind: Winds are common in the area with an annual average speed of 6.7 miles per hour (MPH) and gusts over 25 MPH. In general, winds are westerly but switch to the north and east during the winter. Severe wind conditions are usually associated with the onset of late summer thunderstorm activity.

Blitzen Watershed Temperature and Precipitation (Off-refuge)

The Blitzen watershed upstream of the Refuge and Page Springs is higher in elevation than the Refuge (average elevation is 6,200 feet compared with the valley floor elevation of 4,150 feet). Average temperatures are not very different from the valley floor of the Refuge, but precipitation is much greater on the mountain. Over the period from 1975 to 2009, the mean annual temperature for the Blitzen watershed measured 44.1°F (Figure 3-2), with an average monthly maximum temperature of 78.2°F in July and an average monthly minimum temperature of 20.1°F in December, the coldest month.

Average annual precipitation in the watershed is 29.1 inches, almost three times the amount on the Refuge, with most of that (26.7 inches) occurring October through June (Figure 3-2). Much of the winter precipitation in the area falls as snow. April 1 SWE at the two Steens Mountain SNOTEL sites averages 17.6 inches (range 0 to 40.8 inches) at Silvies and 29.0 inches (range 9 to 49.8 inches) at Fish Creek for the period 1975 to 2009. The Fish Creek site receives more snow because of its higher elevation. As in many areas of the West, the spring snowpack represents an accumulated reservoir of water that is released slowly from April through June and sustains streams through the typically dry summers of the region.



Source: PRISM 4-km gridded data.

Figure 3-2. Mean and distribution of monthly temperature and precipitation in the Blitzen River watershed above Page Springs for the period 1975 to 2009.

Climate Variability

Pacific Northwest climate variability is strongly shaped by two large-scale patterns: the El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Each ENSO phase (El Nino or La Nina) typically lasts six to 18 months, while, during most of the 20th century, each PDO phase has typically lasted for 20 to 30 years. These climate drivers can act separately or in concert in creating patterns of warm/dry or cool/wet winters. Via their influence over both winter temperature and winter precipitation, these natural climate patterns exert significant influence on snowpack and hydrology.

Although both ENSO and the PDO have been shown to affect climate in the Pacific Northwest (Cayan et al. 1999; Mantua and Hare 2002; McCabe and Dettinger 2002), neither is significantly correlated with precipitation or temperature at the Refuge or in the Blitzen watershed. The lack of any relationship may be due to the fact that the Refuge is located at the intersection of two geographic regions, the Pacific Northwest and the Great Basin, with contrasting responses to ENSO and the PDO.

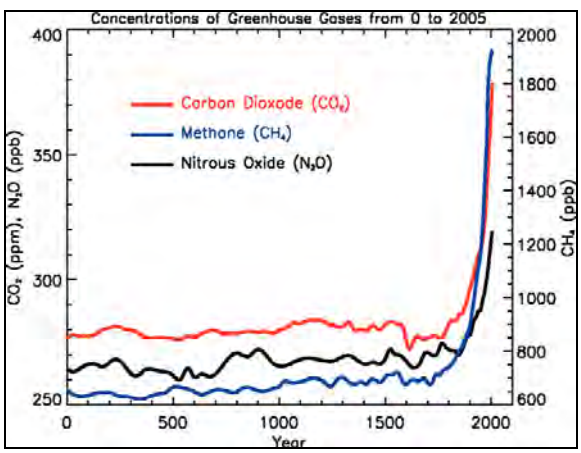
3.2.2 Climate Change

As required by DOI Secretarial Order 3226, issued in 2001, the Service requires consideration and analysis of climate change in long-range planning. Detailed information about climate change is contained in Appendix M. Relevant data that apply to the Refuge have been taken from this appendix and are presented below.

Global Greenhouse Gases

The greenhouse effect is a natural phenomenon that assists in regulating and warming the temperature of our planet. Just as a glass ceiling traps heat inside a greenhouse, certain gases in the atmosphere, called greenhouse gases, absorb heat from sunlight, trapping heat in the atmosphere and warming the planet. The primary greenhouse gases occurring in the atmosphere include carbon dioxide (CO_2), water vapor, methane, and nitrous oxide. CO_2 is produced in the largest quantities, accounting for more than half of the current impact on the earth's climate.

A growing body of scientific evidence from basic theory, climate model simulations, and observations has emerged to support the idea that humans are changing the earth's climate (IPCC 2007; NAS 2008; USGCRP 2009). The concentrations of heat-trapping greenhouse gases have increased significantly over the last several hundred years due to human activities such as deforestation and the burning of fossil fuels (Figure 3-3).

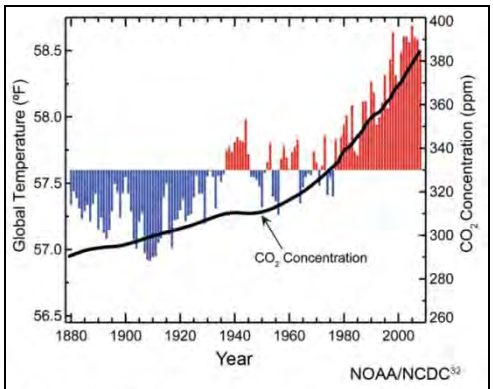


Source: IPCC 2007.

Figure 3-3. Concentrations of important heat-trapping greenhouse gases over the last 2,000 years.

Global Temperature in Relationship to Greenhouse Gases

There is a direct correlation between greenhouse gas concentrations and the temperature of the earth's surface. Global surface temperatures have increased about 1.3°F since the late 19th century (USGCRP 2009), and the rate of temperature increase has risen in more recent years (Figure 3-4). The Intergovernmental Panel on Climate Change (IPCC), a large group of scientists created by the United Nations to evaluate the risk of climate change caused by human activities, reported in 2007 that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (IPCC 2007).



Global annual average temperature (as measured over both land and oceans). Red bars indicate temperatures above and blue bars indicate temperatures below the average temperature for the period 1901-2000. The black line shows atmospheric carbon dioxide (CO_2) concentration in parts per million (ppm). While there is a clear long-term global warming trend, each individual year does not show a temperature increase relative to the previous year, and some years show greater changes than others.[33] These year-to-year fluctuations in temperature are due to natural processes, such as the effects of El Niños, La Niñas, and the eruption of large volcanoes.

Source: USGCRP 2009.

Figure 3-4. Global average temperature and CO_2 concentrations from 1880 to 2008.

In the northern hemisphere, recent decades appear to be the warmest since about A.D. 1000, and warming since the late 19th century is unprecedented over the last 1,000 years. Globally, 2010 and 2005 tie as the warmest years in the instrumental record (1880 to the present), while 2009 was only a fraction of a degree cooler, matching 1998, 2002, 2003, 2006, and 2007 for the second warmest on record, according to independent analyses by NOAA and the National Aeronautics and Space Administration (NASA). The new 2010 record is particularly noteworthy because it occurred in the presence of a La Niña and a period of low solar activity, two factors that have a cooling influence on the planet. However, in general, decadal trends are far more important than any particular year's ranking.

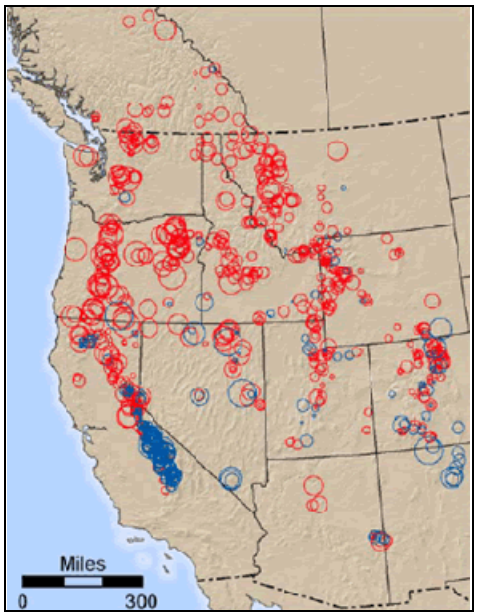
Pacific Northwest Climate Indicators and Trends

From a climate change perspective, the Refuge is more closely aligned with changes that have occurred in the Pacific Northwest than those in the desert regions of the Southwest. In the Pacific Northwest, regionally averaged temperature rose 1.5°F between 1920 and 2000, slightly more than the global average. Warming was largest for the winter months of January through March. Minimum daily temperatures have increased faster than maximum daily temperatures. Longer-term precipitation trends in the Pacific Northwest are more variable and vary with the period of record analyzed (Mote et al. 2005). Looking at the period 1920 to 2000, precipitation has increased almost everywhere in the region. Most of that increase occurred during the first part of the record.

In the Pacific Northwest, increased greenhouse gases and warmer temperatures have resulted in a number of physical and chemical impacts to the region. These include changes in snowpack,

streamflow timing and volume, flooding and landslides, sea levels, ocean temperatures and acidity, and disturbance regimes like wildfires and outbreaks of insects and diseases (USGCRP 2009).

Snowpack Changes: One of the most important responses to warmer winter temperatures in the Pacific Northwest has been the loss of spring snowpack (Mote et al. 2005). As temperatures rise, the likelihood of winter precipitation falling as rain rather than snow increases. This is especially true in the Pacific Northwest where mountainous areas of snow accumulation are at relatively low elevations and winter temperatures are near freezing. Small increases in average winter temperatures can lead to increased rains, reduced snowpack, and earlier snowmelt. The loss of spring snowpack in the Pacific Northwest has been significant, with most of the stations showing, on average, a decrease (Figure 3-5). Data recorded each April 1 show that snowpacks have declined 25 percent over the past 40 to 70 years (Mote et al. 2005). The fact that the declines are greatest at low-elevation sites and that the trend has occurred in the absence of significant decreases in winter precipitation implicates temperatures rather than precipitation as the cause of the trend.



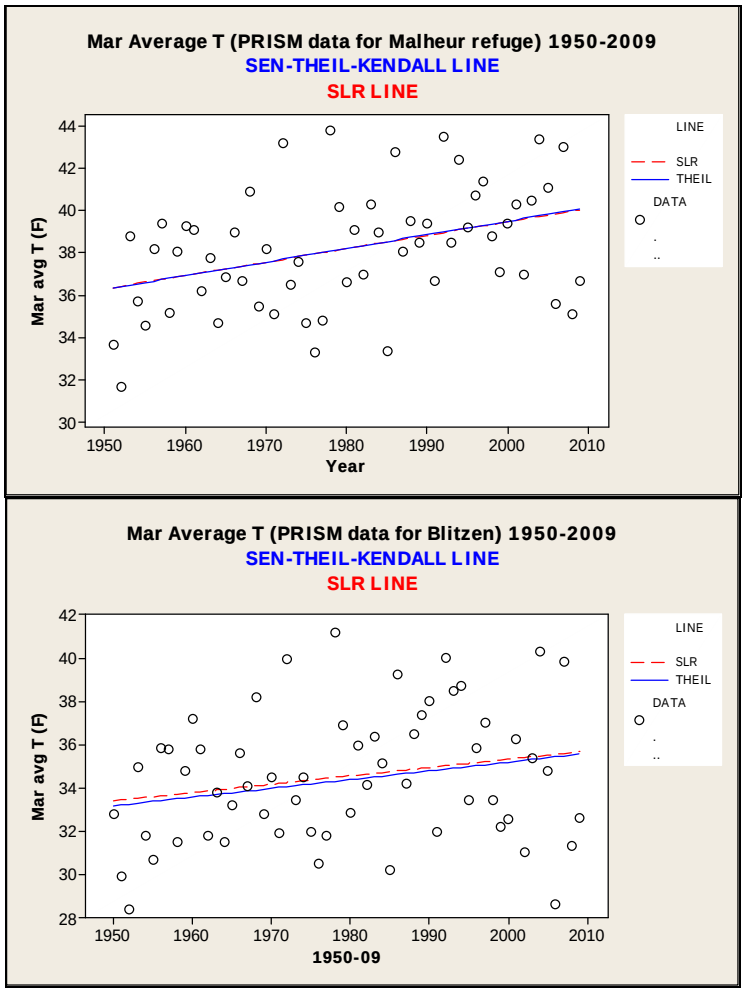
Source: Mote et al. 2005.
Red (blue) circles indicate decreasing (increasing) snow water equivalent (SWE), with the size of the symbol indicating the magnitude of the trend

Figure 3-5. Trends in April 1 snow water equivalent in the western United States from 1950 to 1997.

Streamflow changes: The decrease in spring snowpack and earlier snowmelt has led to a change in streamflow in many systems, including earlier spring runoff peaks, increased winter streamflow, and reduced summer and fall streamflows. Stewart et al. (2005) examined 302 streamflow gages in the western United States and reported that the timing of winter runoff and annual streamflow had advanced by one to four weeks from 1948 to 2002. The degree of change depends on the location and elevation of the specific river basin. Basins located significantly above freezing levels have been much less affected by warmer temperatures than those located at lower elevations. River basins whose average daily winter temperatures are close to freezing are the most sensitive to climate change, as is apparent from the dramatic shifts in streamflow timing that have resulted from relatively small increases in wintertime temperatures.

Climate Change Indicators and Historical Trends at Malheur Refuge

An analysis of historic PRISM data between 1950 and 2009 for both the refuge area and the Blitzen watershed revealed a statistically significant trend in March monthly temperatures, showing a 3.5°F increase over the period measured (0.6°F per decade; see Figure 3-6). The USHCN data from the Malheur Refuge Headquarters station validate this (data not shown). The USHCN station data also show statistically significant increases in several other months.



Source: PRISM data.

Figure 3-6. Trend in March monthly temperature for the Refuge and the Blitzen from 1950 to 2009.

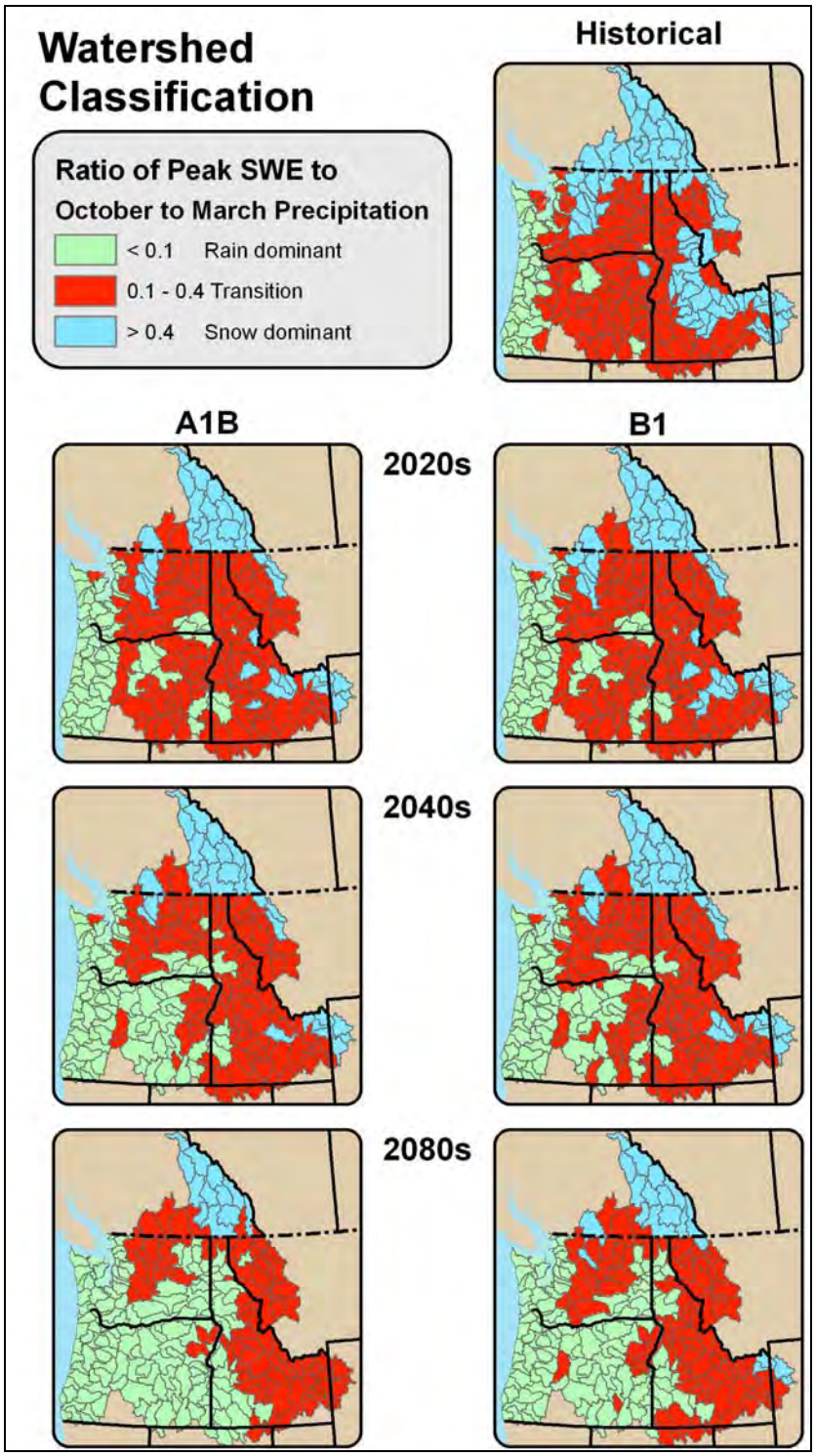
Precipitation data from PRISM and USHCN show opposite trends (one increasing and one decreasing) from 1950 to 2009 but neither trend is statistically significant. As discussed above, winter temperatures, particularly in January and March, have been shown by other studies to be increasing in the West (Hamlet and Lettenmaier 2007; Knowles et al. 2006). The increases can cause more precipitation to fall as rain versus snow, resulting in reduced April 1 SWE, earlier snowmelt, and changes in streamflow.

The SNOTEL data from Steens Mountain suggest that warmer March temperatures may have impacted snowpack at least at lower elevations in the Blitzen watershed. There is a statistically significant decreasing trend (-5 percent per decade or -34 percent) from 1950 to 2009 in the April 1 SWE at the Silvies SNOTEL, the lower-elevation site. April 1 SWE at Fish Creek, the higher-elevation site, shows a very slight decrease from 1950 to 2009, but the trend is not statistically significant. Note that the Blitzen PRISM dataset shows an increase in precipitation over the same period. The fact that precipitation in the Blitzen watershed has increased or at least not changed while SWE at the lower-elevation site has decreased significantly indicates that the decreasing trend at the Silvies SNOTEL site is most likely related to warmer temperatures. Because of the relatively high elevation and cold climate of the Blitzen watershed and the Steens Mountain area, snowpack has not been affected by warming temperatures to the degree it has in other lower-elevation areas around the Pacific Northwest. However, as temperatures continue to warm, snowpack will likely continue to decline.

One of the expected impacts of declining snowpacks and earlier snowmelt is a change in streamflow timing and volume, specifically higher winter flows, an earlier snowmelt runoff peak, and reduced late season baseflows. Because the USGS Blitzen River stream gage has a long period of record (continuous measurements from 1939 on) and is upstream of any significant diversions or regulation, it provides an excellent record of the river's response to climate. To date, few climate change impacts can be observed in the Blitzen River streamflow record, in contrast to other stream systems in the Pacific Northwest. There is no trend in the annual streamflow centroid (the date on which approximately half of the annual volume of streamflow occurs for the water year) or the annual minimum seven-day average flow. There has been no change in the percentage of monthly flows to total annual flow for March through September over the same period (data not shown). There has been a slight decrease in the ratio of June-to-May flows, as might be expected with earlier runoff, and an increase in the annual maximum daily flow, as might be expected with more winter/spring rains, but the statistical significance of both of these trends is weak ($p=0.14$).

In addition to changes in the amount of precipitation, a major concern in the Pacific Northwest is the change in the form of winter precipitation expected due to warmer temperatures. The Climate Information Group at the University of Washington (CIG) has modeled changes in the current and future peak SWE versus October-March precipitation (O-M pcp) for fourth-level hydrologic unit code (HUC) watersheds in the Columbia Basin area, including the Blitzen watershed. CIG has classified watersheds into three categories to reflect projections of the dominant precipitation regime: snow (peak SWE/O-M pcp > 0.4), transition (peak SWE/O-M pcp = 0.1 to 0.4), and rain (peak SWE/O-M pcp < 0.1). Generally, there is a large shift in the Pacific Northwest from snow and transition basins to rain basins. In basins where these changes occur, there will likely be a tendency for higher winter flows and possibly an increased risk of flooding, earlier snowmelt and runoff peaks, and lower summer streamflows (Figure 3-7).

The Blitzen watershed is currently classified as a transition basin and is projected to remain that way until the 2080s under the A1B scenario and through the 2080s under the B1 scenario (see Appendix M), when it will become a rain basin. This shift to a rain basin occurs more slowly than in many of the surrounding basins in the Pacific Northwest and the Blitzen watershed appears to be more resilient to climate change, probably because of the higher elevation and cooler climate in the Steens Mountain area.



Source: CIG 2010. The Blitzen watershed is not identified in this figure; however, it is the small, isolated basin in southeastern Oregon shown in red in the lowest right figure

Figure 3-7. Ratio of April 1 SWE to total October-March precipitation for the historical period (1916-2006), for the A1B scenario (left panel), and for the B1 scenario (right panel) at three future time periods (2020s, 2040s, 2080s).

Observed and Predicted Ecological Response to Climate Change in the Region

An emerging body of literature indicates that over the past three decades, the changes in the climate system, including the human-caused component of warming, have resulted in physical and biological changes in a variety of ecosystems (IPCC 2007; Parmesan 2006; Root et al. 2003) that are discernable at the global scale. Climate change has and will continue to combine with other nonclimate stressors to impact ecosystems and threaten biodiversity. In the Great Basin, climate change, invasive species, habitat fragmentation, and rangeland and riparian degradation have placed numerous species at risk, including sage-grouse and redband trout (Chambers and Pellant 2008).

Disturbances, both natural and human-induced, shape ecosystems by influencing their composition, structure, and function. One observed response to climate change in the Pacific Northwest is the change in disturbance regimes like fire and outbreaks of insects and diseases. Increased spring and summer temperatures, earlier snowmelt, and prolonged drought have contributed to longer fire seasons and an increase in wildfire activity in the Pacific Northwest. Westerling et al. (2006) evaluated the effects of both land-use histories and climate on wildfire and concluded that the increase in fire frequency in the past two to three decades has been driven primarily by recent changes in climate. Areas in southern Oregon, northern California, and the northern Rockies have been especially vulnerable to these changes.

Interactions between climate change and non-native invasive species may combine to increase invasion risk to ecosystems. Bradley (2009) showed that the potential area for cheatgrass invasion, which is sensitive to precipitation and temperature, increased up to 45 percent in the western U.S. with decreasing summer precipitation and warmer winter temperatures. Cheatgrass invasion also interacts with climate change to alter fire regimes. Frequent fires promote invasive grasses like cheatgrass, and large grassland fires are more likely in a warmer, drier climate with exotic grasses present. The cheatgrass-fire cycle has been a major factor in the decline of sagebrush-steppe ecosystems, and climate change is likely to exacerbate this decline (Chambers and Pellant 2008).

Climate change is also expected to cause major changes in grassland and sagebrush distribution across the landscape (Bachelet et al. 2001). Range expansions of woody species are predicted to continue, particularly the expansion of pinyon-juniper into sagebrush steppe and grasslands (Rowland et al. 2008), resulting in a decrease in sagebrush and an increase in woodlands across the West. More frequent wildfires may favor non-native invasive species and exacerbate the loss of big sagebrush, a keystone species that is not very fire tolerant. In the Great Basin, current sagebrush habitat is predicted to decrease 12 percent for each 1.8°F (1°C) increase in temperature, partly because of these factors (Chambers and Pellant 2008). However, more frequent fires might also limit juniper expansion.

Climate change has a large potential to impact aquatic ecosystems in the Pacific Northwest. Although there have been few climate change impacts on Blitzen streamflow to date, aquatic habitats at the Refuge, including rivers, streams, springs, wetlands, and wet meadows, face future threats from climate change. River and stream temperatures may increase with warmer air temperatures and longer growing seasons, threatening redband trout. Water temperatures in the Blitzen River are already quite warm; seven-day average maximum temperatures are frequently near 77°F (25°C) in the summer (Mayer et al. 2007). Even at the upstream end, where the river enters the Refuge from the canyon, water temperatures exceeded the State standard of 68°F (20°C) for an average of 64 days during the summers of 2003 and 2005 (Mayer et al. 2007).

Evaporative and seepage losses in wetlands and wet meadows may increase due to warmer temperatures, longer growing seasons, drier soils, and lower water tables, potentially limiting the available habitat that can be sustained for migratory waterfowl. Changes in transpiration are uncertain. There may be less transpiration because of greater photosynthetic efficiency from higher CO_2 concentrations in the atmosphere, but higher CO_2 concentrations could also mean more plant growth, plant leaf area, and increased transpiration. Earlier runoff and higher evaporation losses could cause a decrease in wetland acreage that can be maintained on the Refuge given the refuge water supply.

Climate Change Adaptation Strategies

The slower response and apparent resilience of the Blitzen watershed to climate change may provide the Refuge with an opportunity to develop and implement climate change adaptation strategies (or adjustments in management). The goal of adaptation is to reduce the risk of adverse environmental outcomes through activities that increase the resilience of ecosystems to climate change and other stressors (USCCSP 2008). *Resilience* is defined as the amount of change or disturbance a system can absorb without undergoing a fundamental shift to a different set of processes and/or structures. One of the most effective means of increasing resilience is to reduce or eliminate nonclimate stressors.

Climate change will combine with other nonclimate stressors to exacerbate existing problems with water supply, aquatic resources, invasive weeds, and ecosystem function on the Refuge. Even now, there are difficulties balancing the needs of water management for wetlands with the needs of in-stream flows for fish. Wetland irrigation and water management on the Refuge decrease river flows, exacerbate high water temperatures, and reduce dissolved oxygen concentrations in the river (Mayer et al. 2007). River temperatures are already at or near the limit of tolerance for redband trout on most of the Refuge. The river was channelized in the 1910s to facilitate drainage and water delivery. Riparian vegetation is limited and the river habitat is degraded, with little complexity. Wetland and wet meadow habitats on the Refuge are threatened by several non-native invasive plant species including perennial pepperweed, Russian olive, and reed canarygrass. Aquatic and riverine habitats are threatened by non-native invasive carp.

Reducing nonclimate stressors means controlling invasive species and could include restoring the river, rehabilitating riparian vegetation, re-establishing where possible the natural sinuosity of the channel, and reconnecting where viable valley wetlands and floodplains with the river channel. Reducing the impacts of current stressors is a “no regrets” adaptation strategy that could be used to enhance ecosystem resilience to climate change. These activities would require time. Fortunately, the fact that climate change impacts are slower to manifest themselves here compared with other areas would allow more time to implement these restoration activities.

Key to the successful implementation of these adaptation and restoration strategies will be the monitoring of results. The NWS weather stations, the USGS Blitzen river gage, and the two NRCS SNOTEL sites on Steens Mountain will continue to provide very valuable climate and streamflow information on the local impacts of climate change. It is in the Refuge’s best interest to see that these sites are maintained and monitored in the future. The Water Resources Branch of the Service monitors streamflows and diversions at several sites on the Refuge; this should be continued as well. The branch also monitored water temperatures in the river during the summers of 2002, 2003, and 2005. This seasonal water temperature monitoring should be continued in the future. Finally, ongoing efforts to monitor and contain invasive species will be important for providing information on the status of nonclimate stressors.

Monitoring may provide information that will require modification of adaptation strategies or point to new restoration needs. One method for integrating new information into resource management decisions given uncertainty is adaptive management. Adaptive management is a process that promotes flexible decision making so that adjustments are made in decisions as outcomes from management actions and other events are better understood. This method supports managers in taking action today using the best available information while also providing the possibility of ongoing future refinements through an iterative learning process.

3.3 Hydrology

This section first describes the hydrologic units within which the Refuge is located. The rivers, streams, and lakes of the Refuge are then explored in detail. Finally, groundwater sources are discussed, followed by water rights.

3.3.1 Hydrologic Units

The USGS maps the river basins and nested sub-basins, watersheds, of the United States using a system of nested hydrologic units. Each region is divided and subdivided into successively smaller hydrologic units. Hydrologic units are identified by a unique code (i.e., an HUC) consisting of two to eight digits. The number of digits indicates the scale: the grossest level of classification receives two digits while the finest based on the four levels of classification in the hydrologic unit system.

The Refuge, together with much of the surrounding area, is contained within USGS Accounting Unit 171200—Oregon closed basins. The area of this accounting unit is 17,300 square miles. Within this area are nine smaller hydrologic units (known as cataloguing units or watersheds). The Refuge includes portions of three of these hydrologic units:

- Unit 17120001—Harney-Malheur Lakes (area=1,420 square miles)
- Unit 17120003—Donner und Blitzen (area=765 square miles)
- Unit 17120004—Silver (area=1,670 square miles)

Although not identified as a USGS-delineated hydrologic unit, many people refer to the Harney Basin as a hydrologic entity. The Harney Basin is a hydrographically closed basin located largely in northern Harney County, bounded on the north by the southern end of the Blue Mountains. The ridge of Steens Mountain separates the basin from the watershed of the Alvord Desert to the southeast. No streams cross the volcanic plains that separate the basin from the watershed of the Klamath River to the southwest. The basin encompasses an area of 5,300 square miles in the watershed of Malheur Lake and Harney Lake. (Wikipedia 2011)

The basin coincides with a large down-warped and faulted structural basin that formed during the late Tertiary (65 to 2.6 million years ago) and Quaternary (2.5 million to 500,000 years ago) periods (McDowell 1992). The shallow playa lakes of the Refuge (Malheur, Mud, and Harney lakes) are located in the center of the basin.

Malheur-Harney Lakes Sub-basin

An assessment of the Harney-Malheur Lakes Sub-basin was prepared in 2001 by the Harney County Watershed Council (HCWC 2001) for future watershed management plans.

The Harney-Malheur Lakes Sub-basin is over 894,000 acres in size; 11.4 percent (101,555 acres) of this sub-basin is managed by Malheur Refuge. The groundwater system encompassed by the sub-basin receives discharge from the adjacent uplands and from stream seepage adjacent to the uplands. Although Silver Creek, the Silvies River, and the Blitzen River do not originate within the sub-basin, all eventually discharge into Malheur Lake or Harney Lake (HCWC 2001).

During the Pleistocene (2.6 million to 11,700 years ago) epoch, the levels of Malheur, Mud, and Harney lakes fluctuated widely with climatic conditions. When levels were high enough, water exited the basin through Virginia Valley via the Malheur River. A Pleistocene basalt flow in the vicinity of Princeton at Malheur Gap, which occurred around 32,000 years ago, prevents outflow from the basin except during very high water events. Lake levels must exceed 4,114 feet in elevation before water can flow over the lava flow at Malheur Gap.

Lake level fluctuations are characteristic of closed basins, and even today the level of Malheur Lake can fluctuate dramatically from year to year. Recent lake level fluctuations attest to the dynamic nature of Malheur Lake levels. Beginning in 1982 Malheur Lake began to rise as greater than normal precipitation occurred in the Harney Basin. By 1985, the lake level exceeded 4,102 feet, a rise of over 7.5 feet in just three years, and Malheur Lake reached 124,440 surface acres. At that time, the combined surface areas of Malheur, Mud, and Harney lakes exceeded 172,000 surface acres, or 279 square miles. The reverse is also common for the lakes: in 1992 Malheur Lake was reduced to 500 surface acres with a depth of 2 inches (USFWS 1992).

Donner und Blitzen Sub-basin

An assessment was prepared for the Donner und Blitzen Sub-Basin in 2003 (HCWC 2003). The Donner und Blitzen Sub-basin originates on the north slope of Steens Mountain and extends northward to the boundary of the Harney-Malheur Lakes Sub-basin. The sub-basin consists of over 505,100 acres, with just 64,652 acres, or 12.8 percent of the land, under refuge management. The Blitzen River is located within this sub-basin and, except during very high precipitation years when flows from the Silvies River reach Malheur Lake, provides the only water supporting Malheur Lake.

Silver Creek Sub-basin

An assessment of the Silver Creek Sub-basin was completed in 2000 (HCWC 2000). The Silver Creek Sub-basin is located in the northwest corner of Harney County with a very small portion extending into Lake County. It is contained in the Malheur Lake Basin. The sub-basin consists of over 1,075,748 acres, with just 20,574 acres, or 1.9 percent of the land, under refuge management in the Double-O Unit. The Silver Creek area in the northwestern part of the Malheur Lake basin comprises all drainage into Harney Lake west of the Narrows, an area of land separating Harney and Malheur lakes.

3.3.2 Rivers and Streams

Three major streams (the Silvies River, the Blitzen River, and Silver Creek) flow from the north, south, and west, respectively, and enter the Harney-Malheur Lakes Sub-basin and ultimately the Refuge. Water originates primarily from snowmelt and runoff from higher elevations; however, springs, especially in the Double-O Unit, also contribute to flows. As these watercourses enter the Harney-Malheur Lakes Sub-basin, flows decrease with irrigation withdrawals before reaching the

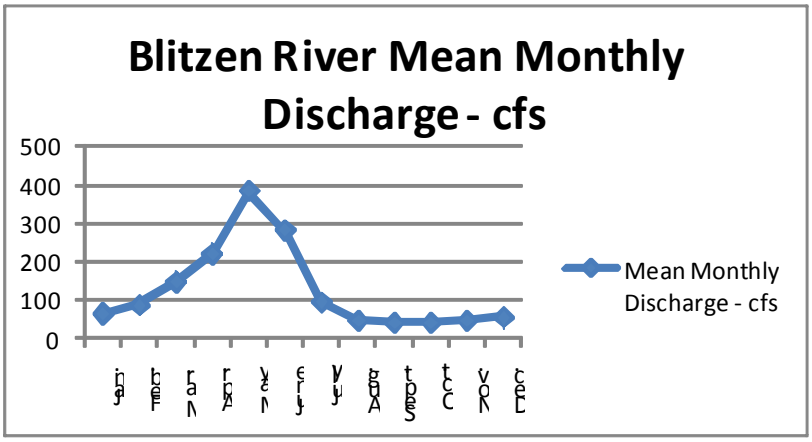
lakes. Two of the three waterways (Blitzen River and its tributary Bridge Creek) have USGS gage stations located just upstream of their entrances into the alluvial valley.

The Blitzen River

The largest watercourse influencing refuge lands is the Blitzen River. The Blitzen River drains the southern portion of the Donner und Blitzen Sub-basin and receives most of its volume from Steens Mountain as snowmelt. By the time the river enters Malheur Lake it has drained an area of 760 square miles (Hubbard 1975). It is joined by a number of tributaries, (Mud, Bridge, Krumbo, and McCoy creeks) as it continues downstream. The discharge of the Blitzen is reduced as it enters the valley because of irrigation withdrawals at four dams.

The maximum annual runoff, recorded at the USGS gaging station upstream of the Refuge from 1939 to 2004, was 198,000 acre-feet in 1984 and the minimum was 36,000 acre-feet in 1992. The mean annual discharge carried by the waterway is 91,000 acre-feet, and Mann-Kendall trend analysis showed no significant change to the mean annual discharge over the 67 year period (Mayer et al. 2007). However, by the time the river reaches the lake the mean annual flow is 60,000 acre-feet. This decrease in flow is the result of a system of dams and irrigation canals that divert water to meadows, marshes, and pools throughout the Blitzen Valley. Figure 3-8 shows the monthly mean discharge for the Blitzen River.

Streamflow on the Blitzen River is driven by snowmelt which contributes increased discharges to the Refuge beginning in early March and reaches a peak in May. The average May volume is 369 cfs, or 22,700 acre-feet for the month, representing 25 percent of the total annual runoff. Flows tend to decline in June with minimum levels attained in August or September averaging a discharge of 42 cfs, or 2,490 acre-feet for the month.



Source: USFWS, Region 1 Water Resources Division.

Figure 3-8. Monthly mean discharge for the Blitzen River.

Water Control and Distribution: A system of dikes, canals, drains, and water control structures were developed along the Blitzen River system beginning in the late 1800s, to facilitate the movement or diversion of portions of the river's discharge for the benefit of grazing and farming (Burnside 2008). Between 1907 and 1913, 17.5 miles of stream were channelized and straightened. Additional dikes, canals, and water control structures were added between 1935 and 1942 by the Civilian Conservation

Corps. More than 900 water control structures occur in the Blitzen Valley as part of the intensive water management system used by the Refuge to manage ponds, wetlands, and meadows. River water is pooled behind four dams before being diverted via canals and ditches to meadows, ponds, and wetlands. Flows return to the river by surface sheet flow, flow through ditches or pipes, and subsurface seepage (Mayer et al. 2007). Portions of the early water distribution system still exist but have been substantially modified as the Refuge has made changes to manage water in the Blitzen Valley.

Diversion of the Blitzen starts at the Page Springs Dam at the southern end of the Blitzen Valley and continues to be diverted at Grain Camp Dam, Busse Dam, and Sodhouse Dam. The diversion sites from upstream to downstream are as follows: Page Springs Dam, Old Buckaroo Dam, Grain Camp Dam, Busse Dam, Dunn Dam, and Sodhouse Dam. The Refuge maintains a minimum flow of 25 cfs in the river to benefit aquatic resources. Table 3-1 shows the diversion capacity in cfs for canals associated with the main structures used to divert water from the Blitzen River.

Table 3-1. Barrier Diversion Capacity for Structures on the Blitzen River

Structures	Number of Diversion Canals	Cubic Feet per Second
Page Springs	2	200
Old Buckaroo	1	10
Grain Camp	2	303
Busse	2	166
Dunn	2	84
Sodhouse	1	37

The water delivery system of the Refuge is complex and a summary of how this system works is difficult to describe.

Tributaries of the Blitzen River

Five major tributaries contribute water to the Blitzen River after it enters the Refuge (other upstream tributaries on Steens Mountain provide significant flows to the river before it enters the Refuge and are not discussed here). The tributaries are Mud Creek, Bridge Creek, Krumbo Creek, McCoy Creek, and the Diamond Drain, which incorporates water from Cucamunga and Kiger creeks. Mud Creek water flows directly into the East Canal. A portion of Bridge Creek contributes to flows in the East Canal, but most of the water meanders westward until it flows into the Blitzen River. Krumbo Creek flows into Krumbo Reservoir and then enters a series of ditches in the Krumbo Valley before reaching the Blitzen River. McCoy Creek skirts the southern edge of the Diamond Swamp where it becomes channelized in the Diamond Canal before entering the river north of Diamond Lane. The Diamond Drain moves water to the north along the edge of the valley before draining into the river via the Skunk Farm Canal.

The Silvies River

The other main water source for Malheur Lake is the Silvies River, which drains the north side of the Harney Basin. The river receives most of its volume from the Strawberry Mountains and the Aldrich Mountains as snowmelt. It flows through the Bear and Silvies valleys before entering the Harney Basin near the community of Burns. The watercourse drains a larger area than the Blitzen River but provides less inflow to the lake because of upstream diversions and withdrawals. The Silvies River enters the Refuge at two locations on the north side of Malheur Lake when sufficient flows are present. Currently, the Silvies River contributes water to Malheur Lake only when flows exceed upstream water right allocations, usually two to three times per decade.

Silver Creek

The northwestern portion of the Harney Basin and the Refuge is drained by Silver Creek, which flows southward before entering Harney Lake. This waterway drains an area of 544 square miles with most of the volume coming from the Snow Mountain area. The creek travels through the Warm Springs and Silver Creek valleys before entering Moon Reservoir. Shortly below Moon Reservoir, the creek channel turns into a complex series of irrigation ditches on private lands. The creek continues to flow through these ditches until it enters Refuge lands and flows into Harney Lake across a marsh delta and the channel transitions into a playa. Silver Creek contributes standing water over the surface of Harney Lake only during very high water years.

3.3.3 Malheur, Harney, and Mud Lakes

Malheur Lake

Malheur Lake is the highest and freshest of the three lakes. Because the lake depression is broad and shallow, a slight rise in water level results in a large expansion of lake or marsh surface area. Inundated areas typically range from 25,000 to 45,000 acres. During historic times, Malheur Lake surface acres have ranged from completely dry (1934) to 124,000 acres (1986). Water depth ranges from 1 to 6 feet with an extreme depth of 14 feet in 1986. Water quality is variable across the lake, with the freshest water found where the rivers empty into the lake.

Malheur Lake consists of three units that are ecologically and hydrologically distinct (Duebbert 1969). The western unit extends from the Narrows east to Graves Point, a discontinuous ridge, which runs north-south. The central unit extends from Graves Point to the remnants of Cole Island Dike, the dike is created from a discontinuous series of dune islands which trend north-south across the lake. The eastern unit extends from Cole Island Dike to the eastern edge of the lake east of the Pelican Islands. Under normal water levels, Malheur Lake consists of shallow marsh in the western third of the lake, shallow open water in the middle third of the lake, and shallow *Juncus* marsh or mud flats on the eastern third of the lake.

Discharge from the Blitzen and Silvies rivers enters the central portion of the lake, which contains the freshest water on the lake. The central unit also has the lowest point on the lake at 4,088 to 4089 feet above mean sea level (msl). When water entering the central unit reaches an elevation of 4,091 feet msl, the water spills into the eastern portion of the lake, which contains the most alkaline water in the entire lake. The east side of the lake functions as an overflow reservoir that receives water during wetter periods. The western side of the lake is better connected to the central basin but is hydrographically complex with a series of ponds separated by islands and peninsulas, with a number

of connections that are overtopped at different lake levels. Water starts to flood into the west side when lake elevations reach 4,092 feet msl, and when water elevations drop below 4,093.5 feet msl the surface area of this unit at the Narrows begins to decline (Hamilton et al. 1986).

Malheur Lake last went completely dry in 1934, and it reached its next lowest level in 1961, when the lake was reduced to 500 acres. The highest lake level was recorded in 1986 when the lake reached an elevation of 4,102.6 feet msl and an area of 124,000 surface acres.

Harney Lake

At the lowest elevations in the Harney Basin, Mud and Harney lakes act as a sump for the entire watershed. Harney Lake is a playa and receives water from Silver Creek and the Warm Springs Canal. Usually these flows do not sheet across the lake surface but are lost through infiltration into the permeable layer of the alluvial valley or by evapotranspiration as the water enters the west central portion of the lake. There are a few springs located along the south-central and east-central portions of the playa, but these do not contribute surface water to other portions of the lake.

Harney Lake is described as the most variable and unstable of the three lakes in the Harney Basin watershed and has varied during the historical period from completely dry to nearly 49,000 acres. Harney Lake itself is dry at about 4,079.7 feet msl, but after the dunes on the east side are breached, water quickly sheets over the surface area of the playa from 4,080 to 4,085 feet msl. The lake shoreline becomes relatively steep-sided from elevations of 4,085 to 4,100 feet msl, and under these conditions, the water overtops its defined margin and spreads over the lake plain on its western and northern sides (McDowell 1992). Only during the flood of the mid-1980s did it reach this height. Harney Lake dries up completely during dry periods, with the lake becoming salty as water levels decline and salts accumulate on the playa. When wet, the lake is primarily open water with little aquatic vegetation.

Mud Lake

Mud Lake is broad and shallow like Malheur Lake, and its surface area expands as water levels rise. Malheur Lake must reach a level of 4,093 feet msl before flows enter Mud Lake at the Narrows. Separated by a lunette dune, Harney and Mud lakes first begin to combine as water levels in Mud Lake rise and water begins to seep under the dune ridge between alternating silt and sand layers. A series of shallow ponds develop on Harney Lake parallel to the dune as water seeps under the dune ridge from Mud Lake.

At elevations above 4,097.3 feet msl, the lunette dune separating Mud and Harney lakes may be breached at the Sand Gap, and the three lakes may become connected (Hamilton et al. 1986). This connection is subject to modification by natural and human processes, so the elevation at which water spills from Mud Lake into Harney Lake has varied. For example, in 1972-1973 the water level of Malheur Lake varied between 4,090.8 and 4,094.6 feet msl. During this time period the gap was dammed by private landowners to store water for irrigation before it flowed into Harney Lake and became salty (Hubbard 1975).

3.3.4 Groundwater

Springs

In addition to the streams, a number of springs are located in the lowlands around the margins of Malheur and Harney lakes or make significant contributions to streamflows. Springs with less significant flows or which have outputs farther away generally support a marsh or pond that eventually drains into a channel or vanishes due to evapotranspiration losses.

Springs contributing flows to Malheur Lake from the Blitzen River are Knox (1.3 cfs), Hog Wallow (3.0 cfs), Page (11 cfs), Warm (2.5 cfs), Five Mile (0.5 cfs) and Sodhouse (8.6 cfs) springs. These freshwater springs are used by a variety of wildlife and support a diversity of aquatic species. The other significant springs contributing flow to Harney Lake include the Double-O Spring (14.7 cfs, composed of Ross and Hibbard springs) that joins the Silver Creek channel and empties into Harney Lake, as well as Hughett (12.5 cfs), Barnyard (6.0 cfs), Basque (2.5 cfs), Johnson (2.0 cfs), and Cold springs (0.8 cfs), all of which flow southeasterly before emptying into Harney Lake. Most of the springs in this stream are alkaline (Scharff and Davis 1962).

Aquifers

The groundwater system underlying the basin occurs at two distinct levels. There is a shallow unconfined aquifer that occurs in the upper alluvial fill, commonly within 20 feet of the surface. This is fed by infiltration of precipitation and streamflow on the valley floor. The water table fluctuates seasonally from 3 to 4 feet below the surface in the spring and 8 to 10 feet below the surface in the fall.

The second and deeper aquifer is confined and occurs in the lower part of the Quaternary fill and the underlying Tertiary rocks. Groundwater occurs in porous layers, such as gravel, sand, or porous rock, and is confined by impermeable clay in the upper part of the Quaternary fill. The confined aquifer is fed by infiltration of precipitation, streamflow in the uplands, and infiltration of streamflow where the waterways enter the alluvial basin floor. This is generally within 50 feet or less of the surface. Pressure in the deeper confined aquifer causes water to leak upward to the shallow aquifer. Groundwater withdrawal from wells throughout the basin appears to be lowering the water table in some locations within the Harney Basin (Leonard 1970).

The surfaces of both the confined and unconfined layers slope toward the center of the alluvial basin; interdicting groundwater is discharged through the surface at lower elevations. The piezometric layers under Malheur Lake slope away on the northern, southern, and western margins, indicating that infiltration from the lake is contributing to the groundwater. The relationship between the aquifer layers and Mud and Harney lakes is not documented.

3.3.5 Water Rights and Use

The right to use water on the Refuge is managed through the State of Oregon's Water Resources Department (OWRD). Water rights in Oregon are managed by two basic principles: beneficial use and first in time/first in right. All water use on the Refuge has some form of a State water right. The current exception is springwater in the Double-O Unit of the Refuge. Because these waters originate and terminate on the Refuge, they are exempt from a State-controlled surface water right.

The Service has adjudicated water rights on the Blitzen River and Silver Creek. In addition, the Refuge has 30 wells that have been permitted by the State for domestic, livestock, or irrigation uses. The Refuge has no water rights on the Silvies River and has not applied for any.

Pond/Storage Water Rights

The Refuge has 71 sites where water is stored to meet a variety of wildlife objectives. The majority of these sites are small, holding less than 100 acre-feet, but a limited number do store thousands of acre-feet, such as Derrick Lake and Krumbo Reservoir. Most of the storage sites are seasonally managed.

Blitzen River and Associated Tributaries Water Rights

The adjudicated water right for the Blitzen River and tributaries allows diversion of water between March 15 and October 1 for domestic, livestock, and irrigation purposes. The Service has an application before the State of Oregon to transfer the existing water right from the current use to a Wildlife Refuge Management use. The transfer will also allow the movement of water within the refuge boundaries of the Blitzen valley to meet wildlife management needs. The status of the transfer application is pending based on the outcome of affidavits of cancellation.

The Service has also received a permit for a Wildlife Refuge Management water right for the Blitzen River and tributaries that will allow for water diversion from March 1 through September 30. The ability to use water during this time period enables the Refuge to use runoff events to stimulate plant activity in wetland and meadow habitats. The current permit, which allows the Refuge to use water during this time frame, is conditioned with four primary conditions that the Refuge must address before OWRD will grant an actual water right. These conditions are 1) install water measurements devices with an appropriate reporting plan, 2) complete a water quality plan, 3) complete a bypass flow study, and 4) meet ODFW fish passage and screening requirements. The first two requirements are complete and the second two are near completion.

Through the combination of both existing and permitted water rights, the Refuge is limited to diverting no more than 145,000 acre-feet on an annual basis and no more than 820 ccfs at any one point in time.

Silver Creek and Spring Water Rights

The water right to Silver Creek (23,287 acre-feet) is from March 1 to October 1 and is for domestic, livestock, and irrigation use on the Double-O portion of the Refuge. A second important water source for this area is a series of springs that originate and remain on refuge lands. Water from these springs is used in the management of wetland/pond and meadow habitats. Even though these waters are exempt from any type of mandatory water right, the Refuge plans to file for a groundwater right for the springs in the Double-O Unit. Currently the groundwater sources providing water to these springs are potentially threatened by groundwater withdrawals outside of the Refuge. To protect the groundwater that creates unique habitats both within the springs and in associated habitats, a State groundwater right needs to be obtained.

3.4 Topography and Bathymetry

As described above, the Refuge occupies the central and lowest portion of the Harney Basin and contains portions of three delineated sub-basins. Bathymetry is described above in detail in Section 3.3.3. The lowest point of the Refuge is contained in Harney Lake (somewhere below 4,079 feet msl). The Refuge is generally flat with outcroppings of rock that reach 4,800 feet msl.

3.5 Geologic History and Features

The climatic and geologic conditions in this portion of Oregon have changed significantly over time. Nearly 10 million years ago, tectonic faults and regional uplifting began the formation of Steens Mountain on the south side of the Harney Basin. Eventually rising 9,700 feet above the surrounding valleys, Steens Mountain developed a vast ice field covering the upper reaches of the mountain around one million years ago. More recent glaciers carved the spectacular U-shaped gorges on the flanks of the mountain. As the glaciers slowly moved downhill, their weight and movement ground the rock below into a fine powder, or loess. This loess was captured in the numerous streams flowing from beneath the glaciers and carried down the Blitzen River and other creeks on the western flank of the mountain to be deposited on the floodplain of the Blitzen Valley. Turbulent downslope winds pushed these deposits of loess around the valley floor, eventually forming a series of low, vegetation-covered dunes at the south end of the river valley (Burnside 2008).

Corresponding with the cooler and moister conditions of the late Pleistocene epoch, 1.8 million to 11,550 years ago, vast amounts of water flowed into the lowest elevations of the basin; from there it drained down the Malheur River and then to the ocean. This connection to the ocean gave salmon and other fish species access to the basin. However, this continuous access to the ocean ended around 32,000 years ago, when basalt flows erupted in the southeast corner of the basin, blocking the outlet from the lake into the river. As climatic conditions varied over the centuries with shifts in seasonal rain fall and temperature, the right combination of conditions created an enormous lake covering the floor of the basin. At several different times, conditions were wet enough and water levels rose until the lake was over 25 feet deep; when this happened, the water was high enough to spill over the top of the blocked outlet and reconnect the basin to the ocean. Salmon bones discovered in spawning gravels near the connection between Malheur and Mud lakes attest to one of these overflow events around 22,000 years ago (Burnside 2008).

With the end of the cold conditions of the Pleistocene, subtle warming conditions combined with abundant rain fall transformed the lower elevations of the Harney Basin into an expansive pluvial lake. With no outlet to the ocean until the level of the lake crested at over 30 feet, a major portion of the Harney Basin was covered with water by 9,300 years ago. This rise in lake levels would combine Malheur, Mud, and Harney lakes into a deep lake at least four times over the next 9,000 years. A lush, narrow band of wetland vegetation bordered the edges of this lake. As the water expanded southward into the Blitzen Valley, shallower areas developed in to extensive cattail and tule marshes. Remnant shore lines of these pluvial lake occurrences are still evident along the south side of Harney and Mud lakes (see Map 10). Large gravel bars, formed under these large lakes, can be seen at various locations along the south side of the lakes and at the mouth of the Blitzen Valley (Burnside 2008).

These same climatic changes also had a profound influence on the Blitzen Valley. In times of plentiful snow on the upper elevations of Steens Mountain, the Blitzen River burst out of the narrow

canyon at the south end of the valley, depositing nutrient-loaded sand and silt on the floodplain. Water overflowing the banks of the river settled into old channels of the river, creating small, linear ponds and providing water for nearby native grass meadows. Creeks entering the valley from the east side funneled water across these grassy meadows, creating numerous stringers of lush riparian vegetation. As water decreased in the river in the late spring or during periods of lower snowfall, these creeks became increasingly important habitat for wildlife using the area (Burnside 2008).

The geological information presented here is excerpted from McDowell's geomorphic description of the Harney Basin (McDowell 1992). The geology of Harney Basin is characterized by an essentially continuous depositional sequence composed of volcanic and volcanic-derived sedimentary rock. The sequence includes a large number of different lithologies and ages. Faulting, uplifting, and tilting of fault blocks occurred during the Pliocene epoch (5.3 to 2.5 million years ago), creating a closed basin. Today these constructional volcanic features can be seen as faulted and weathered masses within fault-blocked uplands and include Steens Mountain, Wagontire Mountain, and Burns Butte.

The specific origins of the Harney Basin are not known, but the basin may have been partially defined by calderas that formed during the eruption of ash-flow tuffs. Three distinctive and very widespread ash-flow tuffs erupted from the calderas in Harney Basin. They are the Devine Canyon ash-flow tuff, covering three-quarters of the basin up to a maximum depth of 98 feet (30 meters); the Prater Creek ash-flow tuff, covering about a third of the basin to a similar depth; and the Rattlesnake ash-flow tuff, centered over western Harney Basin and covering 19,305 square miles (50,000 square kilometers) up to a maximum depth of 198 feet (60 meters). The fine-grained sedimentary rocks in the Harney Basin suggest a low-relief landscape with closed drainage basins.

A layer of volcanic and sedimentary rock flow was deposited over these ash-flows along the western and northwestern portions of the Harney Basin. This caused the formation of Wright's Point, which is sheltered by a resistant cap of basalt which covered weaker sedimentary rock. As subsequent erosion removed sedimentary rock from the surrounding area, Wright's Point remained. After this eruption, the central basin continued to be deeply eroded but was filled again during the Pleistocene epoch (2.5 million to 12,000 years ago).

Leonard (1970) reported that the Pleistocene fill in the Harney Basin is more than 300 feet thick near Lawen and the east-central portion of the basin. To accomplish this amount of erosion, the basin must have been connected to the Snake River System and externally drained. The external drainage to the basin was probably to the east, into Malheur River and the Snake River system. This is evidenced by the thickest fill occurring in the eastern part of the basin, near the former outlet. Much of the erosion and creation of the incised valleys of the Silvies and Blitzen rivers along with Silver Creek occurred during this period.

External drainage from the basin is controlled by geologic structures in the uplands east of the Harney Basin. The main structural features are north-trending faults. The outlet for Harney Basin and the headwaters for the Malheur River cut through this area at right angles to the fault features. After the early Pleistocene erosion, the basin filled with fluvial sand and gravel along its margins (from streams entering the basin) and lacustrine silt, clay, peat, and ash deposits in the central portion. Minor amounts of eolian deposits also occurred with sand dunes and lunettes on the basin floor and loess in the uplands.

Volcanic activity continued as basalt flows sealed the outlet to Malheur Lake at Malheur Gap, re-establishing a closed basin. Diamond Craters, the youngest geological feature in the Harney Basin,

began to develop during this time along the eastern edge of the Blitzen Valley. Following the initial extrusions of lava, a series of magma intrusions caused doming and cracking of the surface. Explosive eruptions formed craters and distributed tephra and bombs on the surface of the surrounding area, and minor basalt extrusions occurred.

3.6 Soils

The soils of Malheur Refuge have been defined and influenced by the geological actions outlined above. Other influences responsible for soil formation are climate, living organisms, time, and weathering.

Soils on the Refuge include the following orders:

- **Aridisols** are dry desert soils. The lack of moisture greatly restricts the intensity of the weathering process and limits most soil development processes to the upper part of the soil column. Aridisols often accumulate gypsum, salt, calcium carbonate, and other materials. These are commonly located in the sagebrush-steppe habitats on the Refuge.
- **Inceptisols** are soils of semiarid to humid environments which exhibit moderate degrees of soil weathering and development. These are located in the salt desert scrub in the lower Blitzen Valley and Double-O areas.
- **Entisols** are soils that show little or no evidence of pedogenic horizon development. These are areas of recently deposited parent material or areas where erosion or deposition rates are faster than the rate of soil development, such as dunes, steep slopes, and floodplains. An example of these would be the dunes between Harney and Mud lakes.
- **Mollisols** are relatively high in organic content and have a dark-colored surface horizon. These soils are quite rich and are characteristically formed under grass in climates that have moderate to pronounced seasonal moisture deficit.

The NRCS carried out a soil survey for Harney County (Keller and Horn 1997). The following information was compiled using data from that report.

The soils on the Harney, Mud, and Malheur lake beds and the terraces adjacent to them are classified as Lolak, Ausmus, Crowcamp, Poujade, and Lawen series. The very deep, clayey Lolak soils are in the lowest positions on the lake plains (Malheur Lake) and are poorly drained. They formed in lacustrine deposits from volcanic rock. Vegetation is sparse to fairly dense and consists mainly of black greasewood (*Sarcobatus* spp.), seepweed (*Sueda depressa*), saltgrass (*Distichlis spicata*), and rush (*Juncus* spp.). The Ausmus (Harney and Mud lakes area and lower Blitzen Valley) and Crowcamp (Double-O) soils are very deep and on slightly higher positions on the lake plains. They are somewhat poorly drained soils formed in alluvium and lacustrine deposits. Vegetation found in the Ausmus series is mainly of basin wildrye (*Leymus cinereus*), black greasewood, and saltgrass. On the Crowcamp series, native plants are mainly silver sagebrush (*Artemisia cana*), creeping wildrye (*Leymus triticoides*), Nevada bluegrass (*Poa nevadensis*), and mat muhly (*Muhlenbergia richardsonis*). The very deep Poujade soils (Double-O) are on low-lying lake terraces that have a thin mantle of recent alluvium over lacustrine volcanic sediment. They are moderately well drained with vegetation of basin big sagebrush (*Artemisia tridentata*), black greasewood, and basin wildrye. The Lawen (Malheur Lake) soils are slightly higher lake terraces, and are formed in loamy alluvium. They are very deep, well-drained soils formed in wind- and water-deposited sediments. Vegetation is

generally basin big sagebrush, western needlegrass (*Achnatherum occidentale* ssp.), Indian ricegrass (*Achnatherum hymenoides*), and basin wildrye.

Near the margins of the basin, perennial streams deposit alluvium over the lacustrine sediment. The sediment eroding from the hills and plateaus is low in alkalinity. The Fury and Widowspring series of soils are very deep and formed in this alluvium. These soils have very dark surface layers, evident by the high content of organic matter and high productivity. The moderately well-drained Widowspring (upper Blitzen Valley) series soils are in areas farther from streams. Vegetation found on Widowspring soils are basin big sagebrush and basin wildrye. The poorly drained Fury soils (dominant throughout the entire Blitzen River Valley) are adjacent to streams. Fury soils are typified by a wide variety of plants including sedges, tufted hairgrass (*Deschampsia caespitosa*), rushes, quackgrass (*Agropyron repens*), alkali bluegrass (*Poa juncifolia*), Sandberg's bluegrass (*Poa secunda*), saltgrass, yarrow (*Achillea millefolium*), lupine (*Lupinus* spp.), three-tip sagebrush (*Artemisia tripartita*), silver sagebrush, willow, shrubby cinquefoil (*Dasiphora fruticosa*), wildrye, and wild rose (*Rosa woodsii*).

Soils on the lake plains that are subject to a fluctuating water table have a high level of salinity and alkalinity. Evaporative recharge is a process that is common to the formation of these soils. During evaportative recharge, water moves upward to the soil surface and carries dissolved salts that concentrate as surface water evaporates and that appear as a white crust. A limited number of plant species are adapted to these saline and sodic conditions. Soils that fit this category are Alvodest, Thenarrows, and Skidoosprings series. The Alvodest series soils (Harney Lake) are very deep, poorly to moderately drained soils formed in lacustrine sediments on basin floors. Vegetation found on these soils is represented by black greasewood, basin wildrye, and saltgrass. The Narrows series (dominant in Mud Lake and Malheur Lake areas) is found on lake terraces. These are very deep, poorly drained soils formed on lacustrine sediments. Alkali bluegrass, saltgrass, and alkali sacaton (*Sporobolus airoides*) symbolize this soil series. Skidoosprings soils (Double-O and the upper Blitzen Valley) consist of a deep, moderately well drained duripan that are formed in lacustine deposits derived from volcanic rock. These soils are generally found on high lake terraces as remnant mounds in stream dissected areas. Plants associated with these soils are basin wildrye, black greasewood, and inland saltgrass.

The next soils by landscape feature are the series found on plateaus and hills surrounding the basin where a duripan has developed and are represented by the Raz soil series (Double-O and lower Blitzen Valley). These soils are found on lava plateaus and consist of well-drained duripan formed in the alluvium, colluviums, and residuum derived from basalt and tuff. Plants found in association with these soils are Wyoming big sagebrush, bluebunch wheatgrass (*Pseudoroegneria spicata*), Thurber's needlegrass (*Achnatherum thurberianum*), bottlebrush squirreltail (*Elymus elymoides*), and Indian ricegrass.

Soils within refuge boundaries on the steep slopes of the valley basin are Felcher (south and west aspects) and Westbutte (north and east aspects) series. The Felcher series soils (lower Blitzen Valley) dry out in early summer and have lower plant productivity. These are deep, well-drained soils formed in colluvium from volcanic rock. Plants associated with this soil are bluebunch wheatgrass, Wyoming big sagebrush, and Thurber's needlegrass. The Westbutte series stays moist longer in the summer; it has higher organic content and higher plant productivity. This series is a moderately deep, well-drained soil formed in colluvium composed of weathered basalt, tuff, and andesite. Plants found in this series are Sandberg's bluegrass, antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*A. tridentata* ssp. *vaseyana*), and scattered western juniper (*Juniperus occidentalis*).

3.7 Fire

Fire has been used as a tool on the Refuge to remove decadent vegetation and improve wildlife habitat for decades and perhaps for as long as a century. There is some documented use of fire prior to 1985; however, most information about the use of fire before this date is based on anecdotal accounts from former refuge biological staff. Fire was used primarily in the winter months to burn cattail stands and overgrown fields to improve wildlife habitat, open up choked marshes, or open a large area to see the condition of water control structures. The majority of prescribed burns from 1985 to the present were implemented during the winter into early spring.

Between 1985 and 1991, the Refuge did not have an established prescribed fire program, and the fire program consisted of a crew leader and three firefighters dedicated to wildland firefighting during the summer. During this period and likely prior to this, biological staff determined where fire was to be used and implementation was performed by refuge staff. From 1985 to 1991, refuge reports show that the primary use of fire was for habitat maintenance and debris removal and that use of fire resulted in the treatment of 17,865 acres, with an average of 2,552 acres per year.

A permanent and professional fire program was established at the Refuge in 1992 with the appointment of a full-time fire management officer and increased staffing. At this time the Refuge began to increasingly use fire as a tool and incorporated the use of mechanical equipment into the program's treatment strategy. From 1992 to 2002, the fire program used prescribed fire and mechanical treatments for habitat maintenance, debris removal, exotic species control, fuel breaks, and hazardous fuels reduction, with the majority of the use for habitat maintenance. Over this period, 32,190 acres were treated with an average of 3,261 acres per year. The refuge fire program was also responsible for fuels management for the southeast Idaho refuges and the northwest Oregon refuges.

Beginning in 2002, the fuels management program reduced the number of annual treatments and acres treated because of staffing shortages, the reoccurrence of perennial pepperweed in areas treated with fire, and a lack of funding for follow-up chemical treatment. The majority of the treatments were for hazardous fuels reduction, but two treatments during this time were for exotic species control. Total acres treated from 2002 to 2006 were 5,098, averaging 1,274 per year, and no treatments were completed in 2006.

In 2007, the Refuge's fuels program was increased with the addition of a new fire management officer, and the Refuge also became a signatory partner in the Burns Interagency Fire Zone, which meant that prescribed fire resources were readily available to implement fuels treatment projects at the Refuge. Between 2007 and 2010, the majority of prescribed fires were conducted for habitat maintenance by burning fields that were out of the haying/grazing rotation and were scheduled to be sprayed in the summer post-treatment, or fire was used to remove decadent vegetation in marsh areas where invasive weeds would not be an issue. There was also an increase in the use of mechanized treatments during this period. During this time a single fall burn was performed with moderate success. From 2007 to 2010, 29,037 acres were treated for an average of 5,807 acres per year.

3.7.1 Objectives of Prescribed Fire in Emergent Marsh

Prescribed fire is used in wetlands at the Refuge to maintain ecological processes, specifically: thinning and opening up emergent vegetation, removing decadent material, stimulating herbaceous production, maintaining herbaceous species diversity, and improving wildlife habitat and foraging. It

is also used to reduce the accumulations of hazardous fuels. Prescribed fires are usually conducted in the winter when marsh vegetation is dormant, migratory nesting birds are not present, and reptiles and amphibians are hibernating. At the Refuge it would be ideal to apply prescribed fire to 25 percent of the marshlands annually. However, budget constraints drive the actual amount that can be accomplished. Appendix Q contains a detailed discussion of the use of prescribed fire on the Refuge.

USFWS Prescribed Fire Objectives in Emergent Marsh

1. Remove 50 percent or more of the decadent vegetation
2. Maintain 20 to 40 percent open water among emergent vegetation
3. Release tied-up nutrients
4. Reduce or maintain invasive plant density and cover
5. Maintain habitat for focal plants and animals
6. Provide underwater waterfowl food (both plants and invertebrates)
7. Provide safe nesting and brood-rearing habitat
8. Reduce hazardous fuels
9. Reduce the likelihood of catastrophic wildfire

Complications associated with Prescribed Fire in Wetlands

Noxious weeds: Introduced noxious weeds are a major concern with fire and wetlands. Fire can stimulate the growth of noxious weeds in wet meadows and nearby uplands. Fire equipment can facilitate spreading of seeds. Disturbances such as fire lines often facilitate establishment of noxious weeds.

Access: Access for fire equipment in wetlands is often limited. Operations usually must take place when the ground is frozen. Specialized amphibious equipment like a Marshmaster is usually required on fire lines. Aerial ignition is often required for the main portion of the burn unit to reach areas beyond the range of wheeled or tracked vehicles; however, it is costly.

Adjacent uplands: The uplands surrounding marshes are usually excluded from prescribed burns. Fire in uplands removes woody shrubs and leaves the area vulnerable for colonization of invasive species like cheatgrass and noxious weeds. Intensive follow-up seeding is usually required. The amount of fire line, labor, and equipment needed to keep fire out of uplands can often be insurmountable.

Management Implications for Prescribed Fire in Emergent Marsh and Wet Meadow

- Prescribed fire treatment areas should be rotated to maintain wetlands in various stages of density and recovery. Suitable no-action areas should be allowed for escape cover and alternate habitat. This will provide a wide range of habitat, nesting, and foraging opportunities for wildlife.
- Prescribed burns should be conducted in the late fall and winter when vegetation is dormant and amphibians, reptiles, and invertebrates are hibernating.
- Head fires should be used to minimize fire-residence time. Backing fires and peat fires should only be allowed when addressing specific goals like reducing organic layers or eradicating seed banks.
- Prescribed burn plans should include both pre-burn work and follow-up actions to address invasive species and noxious weeds.

With careful planning and a science- and biological-based understanding, prescribed fire can be a valuable tool in maintaining the productivity and species diversity in wetlands.

3.8 Environmental Contaminants (Point Source)

On-refuge Contaminant Sites: There are no known point sources of environmental contaminants within the approved refuge boundaries.

Off-refuge Contaminant Sites: Three sites have been identified in the Harney Basin as known sources of contaminants. The Burns Air Force Radar Station, located 35 miles northwest of the Refuge, is designated by the Environmental Protection Agency as a Superfund project for the removal of friable asbestos and soils contaminated with polychlorinated biphenyls (PCBs) . There is no known pathway for movement of contaminants from the site to refuge lands. The other two locations, in Frenchglen, have been designated by ODEQ as leaking underground storage tank sites. It is unknown whether or not there is a potential conduit to move contaminants from these sites to refuge lands. Additional information on these sites can be obtained at the EPA and ODEQ websites found in the reference section of this chapter (EPA 2011; ODEQ 2011). Municipal wastewater is not an issue in this area, as the only treatment facilities are located in the Burns/Hines communities. These facilities have no outlet to any watercourse that feeds into Malheur, Mud, or Harney lakes. With a rural landscape dominated by ranching and agriculture interests, there is some potential for contamination from fertilizers and other agrochemicals topically applied to flood-irrigated meadows in the Diamond Valley and adjacent to Malheur Lake.

3.9 Air Quality

The action area is not located in a Class I airshed, nonattainment area, or maintenance area (EPA 2009). Air pollution sources include local agricultural activities, wildfires, vehicle traffic on Oregon State Highway 205, and local and refuge traffic.

3.10 Water Quality

States are required to identify waters that do not meet their water quality standards under Section 303(d) of the Clean Water Act (CWA). Such waters are classified as impaired and termed water quality limited. The Blitzen River and its tributaries (Mud, Bridge, and McCoy Creeks) as well as the Silvies River and Silver Creek are 303(d) listed streams for water temperature (http://www.deq.state.or.us/wq/assessment/rpt2010/search.asp). In addition, Silvies River is listed for dissolved oxygen and Bridge Creek is listed for iron, beryllium, and manganese. Under the CWA, when a state lists a water body on the 303(d) list as impaired, it must develop a total maximum daily load (TMDL) for the impaired water body to address the sources of the limitation to bring the water body into compliance. Currently, the TMDL for the Blitzen River has not been developed by the ODEQ or approved by the EPA.

A reconnaissance investigation addressing water quality, wetland hydrology, and surface water drainage through the irrigation systems both on and off the Refuge was carried out in 1988-1989 (Rinella and Schuler 1992) following the mid-1980s floods. The study found elevated concentrations of arsenic, boron, mercury, and selenium in some Harney and Malheur lake water and/or biological tissue samples exceeding recommended criteria or guidelines for the protection of the health of

humans, fish, or wildlife, or adversely affecting other identified beneficial uses. In addition, small but detectable concentrations of dichlorodiphenyltrichloroethane (DDT) and its metabolites, and endrin, were reported in lake bottom sediment, while most biota (aquatic plants, invertebrates, fish, bird eggs, and bird tissue) contained small or undetectable levels of organochlorine pesticides and polychlorinated biphenyls (PCBs) were contained in most biota. Although elevated concentrations of some constituents were found in some of the samples, bio-accumulation did not appear to be an issue. None of the elevated concentrations were thought to be associated with agricultural drainage or irrigation systems, but were attributed to water evaporation increasing and accumulating concentrates of harmful ions during periods of drought, and dissolution of these deposits during periods of high water raising the overall loading of these elements. It was concluded that irrigation drainage and agricultural runoff was not causing significant harmful effects to human or resource health.

A later study carried out in 2002-2003 (Mayer et al. 2007) on this same system investigated a variety of standard water-quality measures but did not look at pesticide residues. Mayer et al. (2007) reported the main water-quality parameters of concern in the Blitzen River were conductivity, dissolved oxygen, turbidity, and suspended sediment, total phosphorus, and total nitrogen. With distance downstream, dissolved oxygen decreased, and conductivity, turbidity, suspended sediment, total Phosphorus, and total Nitrogen increased. Low dissolved oxygen concentrations, in particular, were a concern downstream during the summer base flow period. Concentrations were below State standards at downstream sites. Irrigation and wetland return flows contribute to low dissolved oxygen and higher biological oxygen demand in the Blitzen River and may be responsible for some of the low concentrations farther downstream. However, warmer temperatures downstream also contribute to low dissolved oxygen rates.

Late-season increases in river turbidity and total suspended sediments are suspected to be related to dam operations. These two parameters increased at about the time that the dams were opened up in late July and early August.

The timing of conductivity increase downstream on the river seems to implicate return flows as sources of higher conductivity. The return flows were generally much higher than the river conductivities. The increases downstream in the river were observed to occur through the irrigation season and reach maximums in late July, coinciding with the end of the irrigation season on the Refuge.

Return flows were also implicated as a potential source of nutrients to the river. Concentrations of both macronutrients were higher in return flows, and they increased downstream in the river. The wetlands, particularly the wet meadows, appeared to be a source of phosphorus and possibly nitrogen, based on the nutrient budget for the west side of P Ranch area. Despite the fact that nutrient concentrations increase downstream, there did not seem to be a problem with eutrophication and planktonic algae in the river. Concentrations of chlorophyll were very low throughout the river. This may be because of limited phosphorus availability, based on phosphorus concentrations and nitrogen-to-phosphorus ratios in the river.

3.11 Visual Quality

The Refuge and the surrounding area are natural in appearance and undeveloped in nature. Where human signs exist, the feeling is rural, with high integration into the natural world. As a result, the Refuge and the surrounding area are considered to have very high visual quality. Due to the low level

of development, very little light is radiated into the night sky, resulting in excellent star-viewing opportunities.

3.12 Surrounding Land Use

Much of the land surrounding the Refuge or within Harney Basin is in public ownership, and is administered by the BLM, the U.S. Forest Service (USFS), or Oregon Department of State Lands. These public-trust lands are open to public access under the authority of those agencies. Most lands in private ownership are found along the north and east boundary of Malheur Lake, and land use is dominated by rangeland, with some agricultural production (alfalfa).

Harney County has an overall population of 7,700, with small communities in a rural setting. Industrial and commercial development is light, with enterprise based on livestock and agricultural production or recreational and service oriented. The community of Frenchglen is the only consolidated residential area adjacent to the Refuge, and most development near the Refuge consists of individual residences.

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Western meadowlark
©Dan Dzurisin

Chapter 4 Biological Environment

This chapter addresses the biological resources and habitats found on the Refuge. However, it is not an exhaustive overview of all species and habitats. The chapter begins with a discussion of biological integrity (historic conditions and ecosystem function), as required under the Improvement Act. The bulk of the chapter is then focused on the presentation of pertinent background information for habitats used by each of the priority resources of concern (ROCs) and other benefitting species designated under the CCP. That background information includes descriptions, conditions, and trends of habitats and threats (stresses and sources of stress) to the habitats and/or associated ROCs. This information was used to develop goals and objectives for the CCP.

4.1 Biological Integrity, Diversity, and Environmental Health

The National Wildlife Refuge System Administration Act (as amended) requires the maintenance of the biological integrity, diversity, and environmental health (BIDEH) of the System. The BIDEH policy (601 FW 3) defines *biological integrity* as "the biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities." *Biological diversity* is defined as "the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur." Simply stated, BIDEH is represented by native fish, wildlife, plants, and their habitats as well as those environmental conditions and processes that support them. The Administration Act states that each refuge will be managed to fulfill refuge purpose(s) as well as to help fulfill the System mission. We strive to accomplish these purposes and our mission by ensuring that the biological integrity, diversity, and environmental health of Malheur Refuge is maintained and enhanced.

The Refuge System policy on BIDEH (601 FW 3) also provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on the refuges and in associated ecosystems, that represents BIDEH on each refuge.

4.1.1 Overview

Throughout this document, the concept of a healthy system (either aquatic or terrestrial) is the proposed goal or direction the Refuge wishes to take in habitat management. The Refuge defines a healthy system as a landscape, land unit, or habitat in which natural ecological processes function in concert to permit an area to be productive and have a fundamentally dynamic nature. These interacting processes result in a mosaic of communities that are resilient to disturbances but that change over time along the ecological continuum defined by the Ecology Work Group (Appendix L). This result ensures balance, appropriate niches, or natural variation necessary for the wide array of potential wildlife species that could use the area. The refuge goal of restoring or maintaining the resiliency of this system and understanding the importance of all the components or needs of wildlife (migration, production, and maintenance habitat) ensures the richness necessary to maintain a healthy system, provide for the wide diversity of wildlife that use the area, and allow the area to buffer or absorb impacts from major disturbances.

This chapter addresses the biological resources and habitats found on the Refuge; however, it is not an exhaustive overview of all species and habitats. The chapter begins with an introduction to the biological environment of the Refuge, followed by a discussion of biological integrity as required under the National Wildlife Refuge Improvement Act. Then, the priority resources of concern are defined along with a discussion of how these were selected, and pertinent background information

for habitats used by the priority ROCs and other benefiting species designated under the CCP is provided. Background information consists of a description, location, condition and trends, associated wildlife and habitats, refuge management activities, and finally stresses and sources of stress to the habitats and associated resources of concern.

Malheur National Wildlife Refuge is composed of three very distinct environments, each including a diversity of native habitats and landscapes. The core of the Refuge is dominated by a shallow lake basin and encompasses Harney, Mud, and Malheur lakes. This 103,799-acre area covers 56 percent of refuge lands. The Blitzen Valley, a broad corridor (64,215 acres) to the south of the lake basin, is divided along its entire length by the Blitzen River and associated riparian habitat. The valley covers 34 percent of the Refuge and provides most of the water feeding the central lake basin. The Double-O is a broad valley basin which covers 10 percent (19,198 acres) of refuge lands. Intermittent water from the Silver Creek watershed flows through this management area and drains into Harney Lake (see Chapter 3). Together, these three environments result in a diversity of habitats, which support more than 415 species of birds, mammals, fish, reptiles, and amphibians.

4.1.2 Wildlife and Habitat Conditions and Changes Since 1800

The Harney Basin ecosystem, of which the Refuge is a part, has undergone dramatic alteration over the past 200 years. Three of the most discernible changes are

- changes in Harney Basin lake and river hydrology due to diversion dam and irrigation operations;
- changes to species composition (decline and loss of native species and influx of non-native and invasive species) into the system; and
- conversion of basin habitats to agricultural and ranching lands (including diking and irrigation).

Many of the habitat changes and the spread of non-native and invasive species were underway long before the Refuge was established. This section discusses the connection between these landscape-level changes and the current vegetation and wildlife on the land and waters managed by the Refuge. This summary is not a complete analysis of all factors related to changes in native vegetation, fish, and wildlife. Much of the information presented here is based on staff knowledge of the area.

Historic Description of Habitat and Wildlife

Historically the Blitzen and Double-O valleys, along with the lake basin located within the refuge boundary, had a much different appearance than they do today. Wigand's work (Wigand 1987) on the vegetation and water table history of Diamond Pond, located in the Diamond Craters, illustrates the constant flux and change in water levels which prevailed in the area prehistorically. Between 1400 and 900 B.P., increased grass pollen signified greater effective moisture resulting in deeper water with abundant pondweed (*Potamogeton* sp.). Increased greasewood and saltbush pollen around 500 B.P. provide evidence of drought conditions. Widgeongrass (*Ruppia* sp.) seeds and pollen and the presence of bivalve mollusk (*Musculium* sp.) shells indicate shallow brackish water. Abundant juniper and grass pollen samples indicate moister conditions from 300 to 150 B.P. Numerous hornwort fruits (*Ceratophyllum* sp.) indicate deeper, freshened water during this period. The last cycle, sampled from the mid-1880s, showed another climate change with sagebrush re-expansion and increased sedge (*Scirpus* sp.) macrofossils indicating shallower water.

Fur trapper Peter Skene Ogden's journal of 1826 describes the lakes portion of the Harney Basin as swampy country with flat terrain and rivers flowing into two lakes with no outlet (see Section 5.1.2). Eli Cooley's diary of 1845 (Cooley and Cooley 2004) describes the vegetation along the lower Silvies River as plenty of grass and willow. As their wagon train moved west along the north side of Malheur Lake, cutting across the end of Wright's Point and camping by Harney Lake, the habitat was described as plenty of grass, no wood, and some sage. As they moved upstream along Silver Creek before crossing it and turning west, the area was again defined as having plenty of grass and willow.

The 1853 journal of wagon train emigrant Benjamin Owen labeled the lower Blitzen River as a deep miry stream. They had trouble finding a suitable ford and had to travel over 5 miles (in the vicinity of Rattlesnake Butte) upstream to secure a safe crossing for their wagons and livestock (Beckham 1995).

The Wallen party of 1859 moved through the basin on the north side of Malheur Lake and described the area as follows: "the country is a beautiful level valley, covered with luxuriant growth of bunch grass, wild pea vines, and red clover, interspersed with fields of camas on a rich soil abundantly watered by numerous mountain streams …. This wide savannah or grassy meadow section is abundant; pronghorm, deer, elk, and several species of grouse, prairie chickens, ducks and geese, etc." (Beckham 1995).

Langston provides a historical perspective of habitat conditions before substantial alterations by settlers in her book entitled *Where Land & Water Meet: a Western Landscape Transformed* (Langston 2003). She states that when Peter French first arrived in the Blitzen Valley in the early 1870s, he found "a water world: a maze of streams, channels, wetlands, bogs, alkaline lakes, and lush riparian meadows—all fed by waters from the Blitzen River." She also documents that in a 1935 radio talk show, William L. Finley stated, "Peter French … wandered into what is now known as the Blitzen Valley, a wide flat plain watered by a fine stream, green with wide meadows of luxuriant grasses, interspersed with thickets of willow, and with great areas of swampy ground and shallow ponds." Moreover, tule marshes characterized extremely wet areas surrounding the P Ranch at the southern end of the Blitzen Valley. In fact, French noted that his livestock took cover in tules during extreme winter weather (Langston 2003).

Documentation of vegetation prior to Euro-American settlement is sketchy, existing only in the form of broad-sweeping descriptions caught in diaries and correspondence. Nevertheless, combining these references with soils information and comparisons with similar systems within the Northern Great Basin suggests that the area hosted a complex, heterogeneous mixture of plant species ranging from cattails and bulrushes in permanent marshes to dryland grasses, forbs, and shrubs in highland areas with rushes, sedges, and wetland grasses appearing along moisture gradients.

Changes to Harney Basin Hydrology, Wildlife, and Habitats Since 1850

Although people were present in Harney Basin prior to the 1850s, human influences were probably limited to minimal impacts by Northern Paiutes, fur-trapping expeditions, and settlers moving by wagon train through the area. Beckham's (1995) document on the historical appearance and uses of the Donner und Blitzen River from its headwaters to the confluence with Malheur Lake shows the trend of changes that have occurred throughout the basin over time.

In the 1870s stockmen poured into the rangelands of the Harney Basin claiming all the primary water sources and thus dominating the surrounding lands. Meanwhile, the State of Oregon was accepting

applications to purchase tracts of swamplands and in the 1880's began issuing deeds. Peter French and other cattlemen acquired control of these deeds throughout the basin. This initiated an ambitious period of irrigations projects, first in the Blitzen River Valley but soon expanding to other waterways in the basin. Water was diverted into canals and ditches, flooding out sagebrush and inducing the growth of meadow grasses. This heavy irrigation had dramatic effect on basin landscapes, affecting not only uplands, but wetlands and the lakes. Giles French wrote of Peter French's irrigation projects: "His irrigation projects of themselves held water of Malheur Lake at a lower level, causing more dry land between the water and the meander line" (French 1964).

The Blitzen River has undergone significant alterations since the late 1800s. The construction of an intensive irrigation system, including seven diversion dams and a vast network of ditches, dikes, and ponds, was initiated under the management of Peter French and reached its peak during the CCC era following the Great Depression. The channelization of approximately 17.5 miles of the Blitzen River between Bridge Creek and Busse Dam also took place prior to Federal acquisition in 1935. Human activity in its various forms has disrupted the natural hydrology of historic river meanders and smaller braided tributaries; however, the ability to move irrigation water around the Blitzen Valley via canals and ditches has expanded wetland habitats that would not otherwise exist.

Changes to Species Composition: Irrigation and livestock grazing have had a profound impact on basin habitats and wildlife. Native grasses and forbs are not adapted to heavy grazing pressure or extended irrigation and have become susceptible to the spread of exotic plant species in many areas. Non-native pasture and forage grasses were also introduced. These grasses had a competitive advantage over native species under heavy grazing or irrigation pressure and thus altered many plant communities. Increased and improved irrigation around riparian areas permitted reed canarygrass to invade and largely replace the native understory plant community. Today, areas within irrigated meadows are dominated by creeping wildrye, orchardgrass, timothy, smooth brome, Nebraska sedge, meadow foxtail, and reed canarygrass. Creeping wildrye and Nebraska sedge are native species, but the remainder have been introduced to the area and did not occur before European settlement. These two factors were the beginning of the decline of wildlife species tied to upland or riparian habitats such as the yellow-breasted chat, willow flycatcher, meadowlark, and bobolink. On the other hand, grazing may have benefited other wildlife species such as greater sandhill cranes, horned larks, and snow geese. The positioning of wetlands, pasture, and croplands may have actually helped sustain populations of waterfowl and other birds that prefer short, nutritious grass.

Interruption of ecological function on the Blitzen River, Silvies River, and Silver Creek also had a profound impact on fish species. Channelization destroyed habitat complexity on large reaches of these waterways and is believed to have reduced the abundance of fish species. Barriers prevented or delayed migratory fish patterns and isolated portions of some populations. Altered water parameters such as water quality have pushed some species such as mountain whitefish to the least disturbed stretches of these streams. The increase in human disturbance has also naturally led to the introduction of exotic species such as sunfish, bluegills, large-mouth bass, and bullheads.

Conversion of Basin Habitats to Agricultural and Ranching Lands: At the close of the 1800s and the beginning of the new century, homesteaders moved onto lands below the Malheur Lake meander line, leading to conflict between ranchers and these new immigrants. During this time, heavy use was made of the lake bottom by large and small ranching operations for grazing, haying, and crops. During the same time frame, women's millinery fashions created a major market for plume hunters, who decimated populations of herons and egrets on Malheur Lake.

It was in this altered environment that Malheur National Wildlife Refuge was established in 1908. As a result of the outrage over the decimation of colonial nesting birds on Malheur Lake, President Theodore Roosevelt set aside unclaimed government lands encompassed by Malheur, Mud, and Harney lakes.

4.1.3 History of Refuge Management

As discussed in Chapter 1, the purposes of the Refuge primarily pertain to the perpetuation of breeding birds, migratory birds, and other wildlife.

Malheur Refuge lies in the shrub-steppe association of the Basin and Range Province of Oregon (Bailey et al. 1994) and hosts a significant portion of riparian and floodplain habitats (wet meadows and marshes) that are under-represented and degraded throughout this ecoregion. It is one of the oldest and most important migratory bird refuges in the Refuge System. It has long been recognized for its contribution to the Pacific Flyway as a major and essential feeding and resting location for Pacific Flyway birds migrating between the northern breeding grounds and wintering areas to the south. It is also an important breeding ground for wetland-dependent migratory birds.

The maintenance and enhancement of wetland systems occurring within the Refuge contributes not only to management for refuge purposes but also to biological integrity at multiple landscape levels. On the larger landscape scale, it is important to migratory birds on the Pacific Flyway. At the local scale, the area is significant because of native wetland and riparian plant communities and their value to resident wildlife. At the same time, the Service recognizes that wetland management should be balanced with the habitat requirements of native fishes (redband trout) and the need to improve water quality.

After the Refuge was established the Refuge remained unstaffed until 1911, when State game wardens were assigned to enforce State hunting and trapping laws. It was not until 1915 that data were finally compiled about lake levels and bird populations. Considerable time was spent banding waterfowl after 1920, and these records were used to determine bird population trends on the lakes.

In the 1930s, drought had a profound effect on the basin; with decreased flows from rivers and streams, lake levels shrank. Without a fence around the Refuge, the sole refuge employee spent considerable time keeping adjacent landowners from using refuge lands for agricultural purposes. Resolution to this issue came in 1935 when the Blitzen Valley was added to the Refuge. Acquisition of water rights for the Blitzen River allowed the release of water to the lakes that had previously been kept behind ranch dams.

William Finley described the Blitzen Valley and lake condition at that time as

> a wide flat plain watered by a fine stream, green with wide meadows of luxuriant grasses, interspersed with thickets of willow, and with great areas of swampy ground and shallow ponds. … Within the boundaries of this refuge such favorite waterfowl as Canada geese, Mallards, Pintails, Gadwall, Redheads, Ruddy Ducks and Cinnamon Teal nest and rear their young by the thousands, while during the fall and spring migrations myriads of northern-bred ducks and geese find a haven of refuge on Malheur Lake and in the swamps of the Blitzen Valley where natural food is abundant. Not only are ducks and geese found here but the great American egret, the White-faced Glossy Ibis, and the Black-necked Stilt…. Herons, bitterns,

> coots, grebes, and great colonies of California and Ring-billed gulls, Forester Terns, Black Terns and other marsh-loving birds held interest of the visitor. … Of upland game and song birds there is an unusual population. Sage hens stalk about the sagebrush covered slopes, and the California or Valley Quail scurry under the tickets. The introduced Hungarian Partridge and the Ring-necked Pheasant find the climatic conditions here to their liking. … Although birds, both in number of species and the number of individuals, form the greatest of the wildlife population, the visitor can find a large number of beaver along the Blitzen River.

Nationwide waterfowl numbers had declined so rapidly because of widespread drought that Federal funds were allotted to restore breeding and feeding areas. Malheur Lake was given high priority, and thus began the era of the Civilian Conservation Corps and major refuge restoration projects. Projects included the construction of Refuge Headquarters, boundary fences, dikes (to better conserve water for both the lakes and valley), canals (to carry water to favored feeding grounds), and roads (to better patrol the area). The water delivery system within the Blitzen River Valley was developed or enhanced to provide water for new wetlands (Boca, Benson, Knox, Wright, and Buena Vista ponds).

Although most of the projects were considered very beneficial to restoring water to the lakes and wetlands, some of the projects continued the disruption of the natural hydrological processes in the basin, such as replacement of five wooden diversion dams with concrete diversion dams, which included fish ladders. In addition, when some projects were combined with other human impacts, such as grazing and irrigations practices, whole plant communities were altered. The Refuge developed a cropland management program to provide carbohydrate-rich crops for fall migrants, particularly waterfowl and cranes.

The 1940s and 1950s saw the next major change to Harney Basin ecology and impacts to the Refuge, with the introduction of common carp to the Silvies River. Carp spread throughout the system in a very short period of time and altered wetland systems by uprooting submergent and emergent vegetation, increasing turbidity, and exposing wetlands to wind and wave erosion. This had a tremendous impact on the number of birds using Malheur Lake, particularly waterfowl and other wetland nesting and feeding species. Intermittent attempts to eradicate carp were carried out in 1955, 1961, 1968, and periodically since then. Control efforts showed positive results for one to two years after treatment until population dynamics re-established carp in treated areas.

Other management activities during this period saw the third major addition to the Refuge with the purchase of the Double-O Unit to provide habitat for shorebirds, waterbirds, and waterfowl. Grazing was used as a management tool to maintain short-grass habitat for waterfowl, cranes, and other grasslands nesting species. Rainbow trout were introduced into Krumbo Reservoir (constructed in the mid-1950s), and trumpeter swans were reintroduced to the Refuge.

In the 1970s, the Refuge shifted its management direction to bring activities in line with new Service directives by developing a refuge land use plan for habitat management. This called for a shift in management actions by reducing the amount of cattle grazing on the Refuge and providing other tools to maintain short grass or meadow habitat. Management actions to control exotic and invasive species were initiated. Formal survey procedure and protocols were developed to monitor habitat and wildlife. All these changes were part of a move to support greater conservation of resources under new national policies.

Higher-than-normal precipitation levels in the 1980s resulted in extensive flooding throughout the basin and the subsequent destruction of infrastructure and habitat. With the high water and the deleterious effects of carp on Malheur Lake, conditions were in place to accelerate destruction of Malheur Lake ecology. Wind, waves, and ice scoured the lake substrate, creating a shallow uniform lake bottom in which sediments never settled and emergent and submergent vegetation became mostly absent from the central portion of Malheur Lake. With the loss of emergent vegetation, the muskrat population on the lake was drastically reduced and to date has not recovered. Refuge staff was also charged with developing a master plan for the Refuge.

As quickly as the water rose in the 1980s, the lake rapidly diminished in the early 1990s, with watering covering just a few thousand acres in the center of the lake. This shift sharply curtailed wildlife use of the lake. From the 1990s onward, the Refuge continued to repair the damage to habitats and infrastructure and provide for wildlife needs in the Blitzen Valley while waiting for increased precipitation events to restore water to Malheur Lake.

Fish passage, screening, and fish traps became an important issue trying to ensure passage of Great Basin redband trout over the dams on the river while preventing movement of carp through the system. The concrete fish ladders in operation since the dams were constructed were retrofitted with new denil-style fish passage structures. Screens were placed on a number of diversion canals and ditches to prevent entrainment of native fishes and decrease spawning areas for invasive carp in fields, ponds, and ditches. Fish traps were manufactured and fitted at the top of the fish ladders to sort carp from the native fish moving upstream on migration. Fish screens were installed on the diversion of the East Canal. A fish screen and passage structure was installed on the Blitzen River at the West Canal diversion to prevent entrainment of fish into the irrigation ditch and permit passage of fish up and down the mainstem of the Blitzen River. Research conducted by Matt Anderson concluded that fish passage and screening on the Blitzen River was not optimal for the native redband trout (Anderson 2009). Therefore, ODFW recommended that new fish ladders be installed. In 2009, construction of three new fish ladders and screens was started to improve fish passage and screening and was complete in 2012.

The Refuge put a greater emphasis on controlling exotic and invasive species as infestations increased in size. Fire became a more active management tool for enhancing wetland, meadows, and grassland habitats through the removal of decadent growth, reduction in fuel loads, and setting back undesired vegetation. With degradation of the lake ecosystem, an emphasis was placed on maintaining water on wetlands units and meadows for as long as possible to maximize production for all species of waterfowl, cranes, and other birds that use these habitats. This had the desired outcome, and production has been sustained at very high levels. However, maintaining water on these habitats has also provided ideal conditions for water-tolerant plant species and a competitive advantage to the exclusion of other species, resulting in dense monotypic stands of emergent vegetation and encroachments into meadow habitats.

Restoration efforts focused on riparian and riverine habitats. Canals and ditches were fenced to reduce erosion from cattle and to provide an opportunity for re-establishment of riparian plants. The upper Blitzen River was the site of a restoration project in which inverted rock weirs were staggered over a 5- mile length of river between the P Ranch and the confluence of the river with Bridge Creek. The restoration project was intended to create in-stream and riparian habitat, reconnect the river to the floodplain, and raise the level of the deeply incised river. Assessments of the effect and success of this project are still being conducted.

4.1.4 Changes in Species Composition of Wildlife Populations after Refuge Establishment

Hydrologic Changes that Led to Altered Habitats

It can be hypothesized that the greatest difference between plant community conditions prior to Euro-American settlement and current conditions can be directly correlated with the extent and availability of water. Prior to hydrological modifications (ditches, dams, and the channelization of 17.5 miles of the Blitzen River, as well as the rerouting and damming of Silver Creek in the Double-O Unit), concentrations of plants would have been dependent on the level of flooding that occurred in conjunction with topographic features. Beckham (1995) believes that the Blitzen Valley once hosted a much higher percentage of upland and meadow plant communities, such as basin big sagebrush, bluebunch wheatgrass, and basin wildrye, than exist today.

After settlement, some uplands and meadows were leveled to maximize efficiency of flood irrigation, which was provided by a complex system of diversion dams and ditches, and to facilitate the production of grain and grasses. Under current refuge management an emphasis on extended irrigation in these areas provides ideal conditions for water-tolerant plant species, and some sites have become dominated by such species as cattails, phragmites, and reed canarygrass. However, extended irrigation has also encouraged the re-establishment of woody riparian species, such as willow, to some of its historic range.

Although historic numbers for waterfowl in the Blitzen Valley and Double-O are not available, it is likely that construction of the water-delivery systems and the managed impoundments and wet meadows in these irrigated units led to increased numbers of breeding waterfowl, cranes, and shorebirds. However, this benefit to waterfowl could not compensate for the loss of quality waterfowl habitat in Malheur and Mud lakes because of invasive carp.

When refuge grain fields were abundant, use of the valley by migrant geese and ducks was very high with peaks in the hundred-thousands. However, as the grain fields were converted back to irrigated meadows, high use by migrants diminished.

Gabrielson and Jewett (1940) stated that the greater sandhill crane was rapidly disappearing from Oregon in the late 1930s and estimated that the remaining flock numbered only about 100 pairs in the Blitzen Valley and east of Steens Mountain. The Blitzen Valley was a stronghold for crane survival during the era of unregulated market hunting. By the late 1990s, the refuge crane population had increased to 245 pairs (Ivey and Herziger 2000). Migrant crane use of refuge grain fields increased over time as populations recovered from unregulated hunting and peaked in the early 1980s at approximately 3,500. However, during the flood years of the mid-1980s and the subsequent droughts in 1988 and 1992, refuge grain crops were poor, and fall crane use declined to less than 10 percent of the peak and has remained low.

While nesting colonial waterbirds were historically abundant in Malheur Lake, there is no evidence that colonial waterbirds were nesting in the Blitzen Valley or Double-O units before refuge acquisition and subsequent development of large impoundments. Today, managed impoundments support substantial numbers (numbering in the thousands in good years) of nesting white-faced ibis, Franklin's gulls, and eared grebes.

It is likely that changes to the Blitzen River hydrology have caused significant declines in the carrying capacity of the river for native fishes, mollusks, and other aquatic species. Development of the irrigation system contributed to lower water quality (primarily water temperature) and eliminated connectivity between many braided channels in the valley, significantly reducing aquatic and riverine habitat diversity and availability for aquatic fauna. This loss of extensive riverine habitat may also have had a major impact on local beaver populations.

Influx of Exotic and Invasive Species

Exotic plants and animal invasions are a serious threat to the biological integrity of the Refuge. Invasive plant species displace native vegetation, alter the composition and structure of vegetation communities, affect food webs, and modify ecosystem processes (Olson 1999). Ultimately, invasive plant and animal species can result in considerable impacts to native wildlife. Common carp are believed to have had the largest impact to habitat and wildlife, causing reduced migratory bird use of the Refuge.

Exotic Plants in Riparian and Wetland Systems: Exotic invasive plants that have proliferated in riparian and wetland areas include perennial pepperweed, reed canarygrass, Canada thistle, and Russian olive. Common reed is also present on a much smaller scale in some wetland units. All of these species displace native plant communities and reduce the habitat values for many wildlife species. For example, reed canarygrass forms tall, dense, almost impenetrable stands, which have almost no value for nesting birds and other wildlife.

Exotic Species in Aquatic Systems: The Harney Basin supports fish mirroring the native fishes of the Columbia River with a few species absent or undetected, before they disappeared. (As noted in Chapter 3, the basin was connected thousands of years ago to the Columbia River drainage.) Since Euro-American settlement, a variety of warm-water fish species have been introduced to the basin to increase the diversity and quality of recreational angling. Many of these introduced fish prey on native species and/or compete with them for food resources. Common carp were introduced into the Silvies River in the 1920s and invaded Malheur Lake in the late 1940s, becoming a noticeable problem in the early 1950s. Their presence has resulted in devastation of aquatic plant and invertebrate communities, reduced water quality, and increased turbidity, and they have caused a large reduction in waterfowl use and production on the lake (Ivey et al. 1998). Carp have also spread or have the potential to spread to most of the aquatic systems of the Blitzen Valley and the Silver Creek drainages. A small established population of bullfrogs located at the south end of the Blitzen Valley could threaten the Refuge's population of Columbia spotted frog by predation, loss of habitat, and food resources.

A number of non-native fish have been recorded in various surveys on the Refuge. These fish include common carp, rainbow trout (*Oncorhynchus mykiss*), mosquito fish (*Gambusia affinis*), yellow bullhead (*Ictalurus natalis*), brown bullhead (*Ictalurus nebulosus*), black bullhead (*Ameiurus melas*), largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), white crappie (*Pomoxis annularis*), and yellow perch (*Perca flavescens*).

Exotic Plants in Upland Systems: Major invasive weeds that have invaded refuge upland habitats include perennial pepperweed, Russian knapweed, and whitetop. These species occupy a large percentage of lowland shrub communities and have replaced native grasslands and forbs, which are

important to native animals, such as small mammals. More recently, medusahead has invaded shrub lands on the southernmost portion of the Refuge (approximately 30 acres).

Control Efforts: An IPM approach is used, which includes a variety of tools such as mechanical/physical control methods, cultural control methods, biological control, pesticides, habitat restoration, and protocols preventing new introductions (see Appendix G, Integrated Pest Management Plan). Control efforts are planned annually, and Pesticide Use Proposals (PUPs) are submitted to regional and/or national IPM coordinators for approval.

Mechanical, physical, biological, and chemical methods have been used to combat invasive plants in a variety of habitats. Biological methods have included prescribed use of cattle and sheep grazing and prescribed burning. Insects introduced for biological control include thistle stem gall flies, thistle beetles, and thistle weevils for Canada thistle. Considerable progress has been made with infestations of Russian olive around Malheur Lake, using burning, grazing, and chemical control.

Much effort has focused on controlling carp. Annual wetland management plans prescribe drawdowns of impoundments to kill carp; traps have been placed in major dams to prevent their migration upstream; various types of netting techniques have been used for removal and population assessments and electroshocking has been used to remove them from some areas. Rotenone, a piscicide, has been used to supplement other measures of carp control. Several large-scale rotenone projects were conducted on the Refuge during years when lake levels were low and such treatments were deemed cost-effective. These treatments resulted in temporary increases in waterfowl use before the carp population rebounded.

4.2 Priority Resources of Concern

A key step in biological planning involves selection of priority ROCs (sometimes called conservation targets in other planning methodologies). These priority ROCs framed the development of the CCP's goals and objectives for wildlife and habitat.

4.2.1 Selection Process

Resources of concern, as recommended under the Service's Habitat Management Planning policy (620 FW 1), include:

> all plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect "migrating waterfowl and shorebirds." Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts (620 FW 1.4G).

Negative features of the landscape, such as invasive plants, may demand a large part of the refuge management effort but are not designated as resources of concern.

To identify these resources, the team reviewed numerous plans and assessments that have been completed (see Section 1.7). A large list of species, species groups, and habitats were identified (see

Appendix E, Biological Resources of Concern list). The list was then narrowed to a shorter list of priority ROCs.

The main criteria for selection of the priority ROCs included the following requirements drawn from the document *Identifying Refuge Resources of Concern and Management Priorities: A Handbook* (USFWS 2008a):

- Reflective of the Refuge's establishing purposes and the Refuge System mission
- Species that may be used as an indicator of the health of one the main natural habitat types found at the Refuge
- Recommended as a conservation priority in the Wildlife and Habitat Management Review (USFWS 2008a)
- Federally or State listed, candidate for listing, or species of concern

Other criteria that were used in section of the resources of concern included the following:

- Species groups and/or refuge features of special management concern
- Species contributing to the biological diversity, integrity and environmental health of the ecosystem
- Species where it is feasible to estimate population size (needed for future monitoring and adaptive management)

Early in the planning process, the planning team invited extended team members to assist in identifying priority species for the Refuge (see Appendix I for names of team members). A number of different species were recommended by the participants in this collaborative workshop. The list was refined to 21 priority species for the Refuge and consists of canvasback, sago pondweed, northern shoveler, tui chub, white pelican, eared grebe, redhead, ruddy duck, yellow-headed blackbird, greater sandhill crane, bobolink, cinnamon teal, willow flycatcher, yellow warbler, redband trout, snowy plover, gadwall, mallard, sage thrasher, loggerhead shrike, and sage sparrow. Each species in discussed in more detail by habitat below.

4.2.2 Relationship of Priority Resources of Concern to Habitat Goals and Objectives

Wildlife habitat goals and objectives were designed directly around the habitat requirements of the priority ROCs. Goals were written for priority ROC habitats. Objectives were developed from the habitat requirements of priority ROC species.

To develop objectives, the team followed the process outlined in the document *Identifying Resources of Concern and Management Priorities for a Refuge: A Handbook* (USFWS 2008a). For each priority ROC, the team identified the ecological attributes of habitats that are necessary to meet the ROC's life history requirements, and are therefore, critical to sustain the long-term viability of the ROC and other benefitting species. Ecological attributes of habitats include parameters such as vegetation structure, species composition, age class or seral stage, patch size and/or contiguity with other habitats, hydrologic regime, absence of human disturbance, and natural disturbance events (e.g., flooding, fire). These attributes, when described in measurable terms, provide specific habitat targets that strongly correlate with the ability of a habitat to support priority species, and by extension, other benefitting species. For most attributes, the team developed "desired" conditions that

were based partly on scientific literature review and partly on the team's professional judgment. These desired conditions for specific attributes were used to help design measurable habitat-based objectives, as presented in Chapter 2.

Limiting factors were also considered in developing objectives. A limiting factor is a threat to, or an impairment or degradation of, the natural processes responsible for creating and maintaining plant and animal communities. In developing objectives and strategies, the team gave priority to mitigating or abating limiting factors that presented high risk to ROCs. In many cases, limiting factors occur on a regional or landscape scale and are beyond the control of the individual refuge. Therefore, objectives and strategies may seek to mimic, rather that restore, natural processes. For example, mowing and/or grazing may be used to maintain a desirable vegetation structure, when restoring native grassland communities may be impractical.

4.3 Major Habitat Types on Malheur Refuge

4.3.1 Lacustrine (lakes)

Overview

Malheur Lake: One of the largest inland marshes in the United States, Malheur Lake may vary dramatically in size (from 500 to 110,000 acres) but generally fluctuates about 2 feet during the calendar year and upon average covers approximately 37,500 acres, or 20 percent of the total refuge acreage. On the basis of water depth, water chemistry, and vegetation, it is classified as an Inland Deep Fresh Marsh (Shaw and Fredine 1956). The lake is described in great detail in Duebbert (1969). It receives water from the Blitzen and Silvies rivers, fills from the center, then flows east and finally to the west, and then connects with Mud Lake. Water supply is predominantly influenced by snowpack on Steens Mountain to the south and the Blue Mountains to the north.

The western section of Malheur Lake is a series of natural ponds separated by a network of low dune islands and peninsulas. The center section, the deepest area of the lake, is predominantly open water with some hardstem bulrush stands near the mouth of tributaries. The eastern section tends to be more alkaline and lacks tall emergent vegetation.

Common emergent species in Malheur Lake include hardstem bulrush, cattail, burreed, Baltic rush, and various sedges. The largest stands of hardstem bulrush are at the mouths of both rivers and typically support mixed colonies of ibises, egrets, Franklin's gulls, and western grebes. The lake contains extensive areas of open, aquatic bed habitat supporting submergent plants such as sago pondweed, water milfoil, horned pondweed, coontail, small and leafy pondweed, white water buttercup, bladderwort, and widgeon grass.

Harney and Mud Lakes: Harney Lake has a bottom elevation about 8 feet lower than Malheur Lake and is deeper than Malheur Lake when it is full. However, Harney Lake dries up completely during dry periods, shifting from a hypersaline lake to a dry salt flat (Dugas 1996). Water often enters Harney Lake through Silver Creek. Harney Lake is too saline to support emergent vegetation.

Regional Distribution, Condition, and Trends of this Habitat Type

These types of aquatic systems are thinly scattered throughout the Great Basin.

The large invasive carp population in Malheur and Mud lakes and in the Blitzen and Silvies rivers has severely compromised submerged aquatic vegetation (e.g., sago pondweed); therefore, the lakes do not adequately support refuge purposes. Historically, Malheur Lake was a key staging area for canvasbacks and tundra swans in the Pacific Flyway. As a consequence of declining habitat quality, these and other waterfowl no longer stage in significant numbers on the lake except during years following major carp control efforts. Waterfowl production is less than 10 percent of its potential on the lake because of carp. There were high numbers of canvasbacks using Malheur Lake during the falls of 1993 and 1994, after drought conditions and a carp control project in 1992; duck production was estimated to be over 100,000 produced per year on Malheur Lake before the carp invasion (Cornely 1982). During the 1980s, high water levels eliminated most emergent vegetation in Malheur Lake, causing a significant number of colonial birds to abandon nesting on Malheur Lake and shift to flooded private lands to the north. The large stands of hardstem bulrush that were present before the 1980s flood have not recovered. Historically, Mud Lake had an extensive bulrush community used by nesting canvasbacks; however, with low water levels there are minimal bulrush stands present on the lake.

Malheur Lake also supports a diverse community of other exotic fish species, and they likely have an adverse effect on the native species in the system. Other invasive aquatic species, such as quagga and zebra mussels, are not present but could arrive in the lake system in the future, with huge potential for negative effects on the natural biological integrity of the lakes and adjacent wetlands.

When Harney Lake is full and less saline, it supports extensive stands of wigeongrass and high numbers of waterfowl. At higher salinities, it supports an abundance of brine shrimp and brine flies, important food sources for many birds.

Key Species Supported

The primary wildlife value of the refuge lakes includes their importance as foraging sites for migrating waterfowl, waterbirds, and shorebirds and as nesting habitat for colonial nesting waterbirds and diving ducks. Canvasbacks and tundra swans are particularly abundant when sago pondweed is abundant in the lakes, and many other dabbling and diving ducks are also supported in large numbers. Very high numbers of nesting colonial birds use the lake when habitat conditions are favorable, including white-faced ibis; American white pelican; great and snowy egrets; herons; Franklin's, California, and ring-billed gulls; Caspian and Forster's terns; and western, Clark's, and eared grebes. Total colonial waterbird nests have at times exceeded 10,000 when the lakes reach optimal conditions. Migrant shorebirds use the lakes extensively, when natural fluctuating water cycles expose mudflats. The lakes are also very important to molting geese and ducks as the expansive open water provides them security from predators. Malheur Lake supports over 10,000 molting ducks in good years, and some of the mallards molting there have been documented as birds that nested in California. Occasionally, when Harney Lake is full, it supports well over 300,000 migrating ducks foraging on extensive beds of wigeongrass.

The emergent vegetation in the lakes also once supported most of the Refuge's population of muskrats and also supported many beaver and mink.

The lakes are very important in preserving the life-history diversity of redband trout in the Harney Basin. A portion of the population migrates to the lower Blitzen River and also Malheur Lake during high water years. Migrations expand resources available to redband trout and allow expression of diverse life histories (Anderson 2009). Native tui chubs are also abundant in the lakes when water

conditions are favorable, and they too are likely limited by other exotic fishes in the system. Historically, large numbers of native suckers were reported spawning in Sodhouse Spring (Bendire 1875-1876) and they were likely once abundant in the lakes. Priority ROCs for this habitat type are presented in Table 4-1 and include canvasback, northern shoveler, tui chub, and American white pelicans.

Table 4-1. Selected Priority Resources of Concern Lacustrine Habitats

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Canvasback	Concentrate in large numbers in lakes and open marshes heavily vegetated with beds of sago pondweed (Mowbray 2002). Nesting requirements similar to redheads.	Migration and breeding	Tundra swan, geese, ducks, coots, grebes, fish, muskrat
Northern shoveler	Prefer margins of open shallow wetlands usually with submergent vegetation and associated nearby grasslands, sagebrush, or rangelands for nesting. Prefer grass cover for nesting from 0 to 2 feet (0.6 m) in height, 295 feet (>90 m) from water (Dubowy 1996).	Breeding and foraging	Teal, shorebirds, herons, egrets, other wading birds, blackbirds
Tui chub	Inhabit small streams to lakes, prefers areas of shallow water with heavy vegetation for spawning, 3 feet (1 m). Diet of invertebrates, plant material, algae, plankton (Bird 1975; Knopf and Kennedy 1981).	Spawning and foraging	Redband trout, cormorant, marsh and wading birds, mergansers, other native fish species
White pelican	Inhabit marshes and open water areas such as lakes and nesting on isolated, flat, low-lying islands with sparse interspersed vegetation adjacent to bare soil (Evans and Knopf 1993). Foraging in shallow water ≤37 feet (11.4 m) and prey dominated by small to medium sizes 1-27 inches (2.5-68.6 cm) (Finholt and Anderson 1995; McMahon and Evans 1991).	Breeding and foraging	Geese, ducks, herons, egrets, rails, white-faced ibis, coot, shorebirds, yellow-headed and other blackbirds, marsh wren, common yellowthroat, black tern, muskrat, mink

Refuge Management Activities

There is little direct management of the lakes. The primary management activity on Malheur Lake has been periodic carp control using rotenone when lake levels were low. A riprap barrier with

screened culverts has been installed at the Narrows Bridge on Highway 205 to slow carp movements between Malheur and Mud lakes. In the 1950s dikes were constructed between dunes in the Cole Island Dike area to span the lake north to south, while other smaller dikes were constructed to keep water out of private lands north of the lake, but these dikes were destroyed during the flood of the 1980s and are no longer functional.

4.3.2 Riverine

Overview

The major areas of riverine habitat on the Refuge are the Blitzen River and its tributaries. Ideal riverine conditions exist when hydrologic floodplains are intact and when waterways support riparian communities that provide shade to maintain cooler water temperatures and are appropriate to stream channel type. A fully functional river or stream exhibits balanced pool-riffle-glide ratios depending on slope and substrate due to the lack of fine sediments covering large section of river reaches. In such a waterway, water turbidity is typically low with an appropriate level of sediment storage, which buffers against the sediment loading of critical rearing pools and spawning gravels for native fishes. Boulders, undercut banks, logs, and vegetation provide ample hiding cover for native fishes and other aquatic species. Eddies and other slow-current areas contain abundant populations of various aquatic invertebrates. Low turbidity also allows a variety of native aquatic vegetation to establish and propagate in suitable microniches.

On the Refuge, the highest quality riverine habitat occurs at the south end of the Refuge in the unchannelized reaches of the Blitzen River and in the major tributary streams (Mud, Bridge, and Krumbo creeks). Although artificial, the East Canal from Page Dam to Bridge Creek provides attributes of riverine habitat and is in better condition than much of the Blitzen system. Below the confluence of Bridge Creek, the river channel is deeply incised and does not support floodplain hydrology or riparian vegetation and is poor quality habitat for native fish. The river suffers from poor water quality with high sediment and nutrient loading and, in summer, warm temperatures (see Chapter 3).

Silver Creek in the Double-O Unit is disconnected above the Refuge by Moon Reservoir dam and no longer has a natural channel until it reaches the boundary between the East Freeman and Martha Lake fields where the channel is re-established. Riverine habitat conditions are very poor, as flows are intermittent and the lower channel is artificially maintained by the diversion of spring water.

Regional Distribution, Condition, and Trends

A portion of lower Bridge Creek and 17.5 miles of the Blitzen River were channelized early in the 20th century prior to refuge acquisition, resulting in degraded riverine conditions through much of this portion of the Blitzen Valley. In some reaches, channel incision has lowered water tables enough to allow sagebrush to grow along the river. Development of the irrigation system, including six active irrigation dams, further modified riverine hydrology and caused significant reduction of riverine habitats as floodplain connectivity was disrupted and natural riverine function was reduced.

Much of the degradation of refuge water quality may be the result of historic overgrazing by livestock and the condition of upstream rangelands. It appears these factors still contribute to silt loading and high stream temperatures due to the slow recovery of riparian habitat in affected areas.

Since restrictions on livestock grazing were implemented in the 1970s, riparian habitat associated with the riverine system has recovered in the south Blitzen Valley, but remains poor elsewhere.

Channelization and overgrazing have increased incision of the Blitzen River, compromised in-stream habitat diversity, and diminished the system's ability to disperse energy during high flow events. Channelization has also led to the loss of the functionality of most floodplains on the Refuge, and the associated channel incisions have reduced adjacent water tables and limited recovery of riparian vegetation. The presence of invasive carp likely has a significant impact in reducing the carrying capacity of the riverine system for native species. Altered hydrology and passage impediments have also influenced water and habitat conditions and access by redband trout.

Key Species Supported

Riverine habitats are prime habitat for redband trout, other native fishes, and native mollusks. This habitat is also important to Oregon spotted frogs, mergansers, belted kingfishers, river otters, and mink. Redband trout is the sole priority ROC species under this habitat type, and more information about this species is listed below in Table 4-2.

Table 4-2. Riverine Habitat Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Redband trout	Native fish habitat for redband trout: stream shading (>80%), bank cover (no bare soil), bank stability (<5% eroding), channel stability (<1% channel movement), fine sediment <2 mm (<10%), cover (>50% of channel (Zoellick and Cade 2006); percent late summer pools (25%-75%), mean annual base flow (>45% of annual flow) (Raleigh et al. 1984).	Year-round	Native suckers, sculpins, dace, whitefish, mollusks, river otter, beaver

Refuge Management Activities

Within the past two decades, the refuge staff has focused on improving fish passage through refuge dams and screening irrigation diversions to minimize loss of fish via irrigation diversion. Considerable effort has been applied to enhance stream-side riparian habitat in Bridge and Mud creeks and along the southern reach of the Blitzen River through plantings. Inverted weirs were installed in this reach of the river to raise the water table and increase habitat diversity in the natural channel. These projects are still being monitored to assess their effectiveness.

4.3.3 Woody Riparian

Overview

The Refuge hosts a variety of riparian habitat along the Blitzen River and its tributaries, along ditches and canals, along remnant traces of previously active sloughs in the Blitzen Valley, and in a few patches in the Double-O Unit. Riparian habitat encompasses 800 to 1,000 acres. Although many plant associations are found within this habitat type, the principal woody species include willows, cottonwoods, alder, redosier dogwood, Wood's rose, golden currant, common snowberry, Lewis' mock orange, water birch, and alder. Herbaceous groundcover is characterized by Nebraska sedge, yellow monkey-flower, Northwest cinquefoil, American speedwell, wooly sedge, slender-beaked sedge, meadow barley, tufted hairgrass, western yarrow, and Baltic rush. The south Blitzen Valley also supports extensive stands of willow associated with irrigated meadows, and these stands are very important for riparian landbirds. Smaller stands of willow are associated with wet meadows and seasonal wetlands in the north Blitzen Valley and the Double-O.

Regional Distribution, Condition, and Trends

Since major reductions in livestock grazing occurred during the 1970s, riparian habitats have increased and expanded, especially in the south Blitzen Valley. The condition of riparian habitat is generally good. There is much diversity in the plant communities along the Blitzen River, its tributaries, and the East Canal. In other portions of the Refuge, diverting water for irrigation or incision of stream banks has lowered the water table, and this has prevented riparian species from re-establishing.

Threats to riparian habitat on the Refuge include invasion by non-native plants, such as reed canarygrass, water hemlock, Russian olive, and perennial pepperweed; river channelization; lowered groundwater table; and water quality impairments. Grazing by trespassing livestock occasionally occurs and can be damaging to the structure of riparian habitat.

Key Species Supported

There are 97 native landbird species considered by the Partners in Flight plan to be associated with riparian habitat in the Columbia Plateau (Altman & Holmes 2000). This plan lists several species as "dependent," including western wood peewee, Bullock's oriole, willow flycatcher, yellow-breasted chat, yellow-billed cuckoo, and yellow warbler. The same species, including lazuli bunting and excluding western wood peewee, are considered focal species under the plan.

Common refuge breeding bird species using this habitat include song sparrow, willow flycatcher yellow warbler, American robin, eastern kingbird, and black-billed magpie. Also present, but less common, are long-eared owl, black-headed grosbeak, yellow-breasted chat, cedar waxwing, and lazuli bunting. Many other warblers, vireos, and sparrows use this habitat type during migration. Riparian areas are very important to beaver, porcupine, and mule deer (especially in winter) and are used as cover by raccoons, striped skunks, and weasels. Montane voles and jumping mice are also closely associated with this habitat. The priority ROC species under this habitat type include willow flycatcher and yellow warbler and more information about these species is listed below in Table 4-3.

Table 4-3. Woody Riparian Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Willow flycatcher	Inhabit thickets of willow, cottonwood, dogwood, and other shrubs along river corridors or waterways through the broad valley. Shrub layer cover >40%-80% of native shrubs more than 3 feet (1 m) tall; canopy tree cover <30% (Altman and Holmes 2000; Sedgwick 2000).	Breeding and foraging	Yellow-billed cuckoo, black-headed grosbeak, long-eared owl, yellow-breasted chat, song sparrow, eastern kingbird, skunk, weasel
Yellow warbler	Found in riparian and wet deciduous thickets dominated by willow, alder, dogwood, and other early successional species. Mean territory 0.14-0.29 ha, nest height of 1.6-6.5 feet (0.5-2.0 m) located in dense stands (Knopf and Sedgwick 1992; Lowther et al. 1999).	Breeding and foraging	Yellow-billed cuckoo, black-headed grosbeak, long-eared owl, yellow-breasted chat, song sparrow, eastern kingbird, skunk, weasel

Refuge Management Activities

Historically, willows, other shrubs, and trees were mechanically and chemically removed to maximize wet meadow forage for livestock. This practice ended in 1972, and grazing and haying activities were also excluded from stream banks to protect riparian habitat. A 400-foot ungrazed corridor along the Blitzen River and a 200-foot corridor for other streams were established as a standard in the Blitzen Valley Management Plan (USFWS 1990). Selective burning, grazing, haying, or mechanical disturbance may be used to reinvigorate decadent riparian stands. Many riparian areas have been excluded from livestock grazing by implementing hay-only management practices or through the use of protective fencing.

Refuge riparian habitat has been managed for structure, patch size, and patch distribution or spacing of woody clumps within a specified area to meet life-history needs of migratory landbirds, including willow flycatchers and yellow warblers (USFWS 1990).

4.3.4 Palustrine Emergent (temporarily flooded wet meadows)

Overview

Meadows are influenced by water depths and the timing of irrigation. On the Refuge, they are temporarily flooded and managed artificially by irrigation. The largest areas of meadow habitats are located in the southern Blitzen Valley, where much of the valley is flat and water supplies are more dependable. Meadows in the northern half of the Blitzen Valley and in the Double-O Unit tend to be drier and less extensive; however, they are widely dispersed throughout these managed units of the Refuge. The Blitzen Valley and Double-O currently supports approximately 20,000 to 25,000 acres of meadow habitats. Water conditions in meadows range from subirrigated up to 1 foot in depth. Drier sites are typically dominated by creeping wildrye or saltgrass, while wetter areas tend to be dominated by sedges such as woolly sedge, Nebraska sedge, and slender-beaked sedge. Other native species include Baltic rush, arrow-grass, Nevada bluegrass, western yarrow, slender cinquefoil, large-leafed avens, and fringed willow-herb.

Regional Distribution, Condition, and Trends

Beginning in the 1870s, uplands, marshes, and irrigated meadows in the Blitzen Valley and Double-O were converted to wet meadows to provide forage for livestock. Further development of the irrigation system in the Blitzen Valley by the CCC led to further habitat conversions in the 1940s. Acreage numbers for meadow habitats have remained relatively stable since these earlier conversions.

The largest threats to the biological integrity of meadows are invasive plant species. Reed canarygrass poses the greatest threat and has already degraded extensive areas of meadow habitat in the Blitzen Valley. Reed canarygrass stands are very poor wildlife habitat. Limited water supplies are another threat to maintenance of meadows. If water supplies are reduced by global warming in the future, the Refuge will need to be strategic about how it uses and delivers water to important meadow habitat.

Key Species Supported

The primary importance of meadows is to provide nesting cover for ground-nesting birds. Cover provided by drier meadow sites serves nesting cinnamon teal, northern shovelers and northern pintail. Short vegetation in meadows provides habitat for nesting bobolinks and shorebirds, such as Wilson's snipe, Wilson's phalarope, American avocets, and black-necked stilts. Other nesting species are numerous (e.g., mallard, gadwall, short-eared owl, western meadowlark, long-billed curlew). Meadows also serve as foraging sites for territorial greater sandhill cranes, Canada geese, waterfowl, white-faced ibises, and other waterbirds. Meadows support large numbers of montane voles and other small mammals, which are important prey for raptors and mammalian predators (e.g., weasels and coyotes). Deer, pronghorn, and occasionally elk graze in refuge meadow habitats. Priority ROC species for this habitat type are listed below in Table 4-4.

Table 4-4. Palustrine Emergent (temporarily flooded wet meadow) Priority Resources of Concern Species

Focal Species	Habitat Type	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Cinnamon teal	Palustrine emergent (temporarily flooded wet meadow)	Use seasonal and semipermanent freshwater marsh nesting near water in low dense perennial vegetation composed of rushes, grasses, and various forbs interspersed with willows, rabbitbrush, and greasewood. Emergent layer cover with a height of 11-35 inches (28-90 cm); grass layer cover with a height of <4 inches (10 cm); water depth 5.5-58.5 cm) (Thorne and Zwauk 1993).	Breeding and foraging	Mallard, northern harrier, northern shoveler, northern pintail, short-eared owl
Greater sandhill crane	Palustrine emergent, (seasonally flooded marsh associated with wet meadow)	Found in isolated, open, wet marshy meadows dominated by grasses, sedges, and rushes surrounded by shrubs. Shrub/emergent cover <30%; grass cover layer 40%-50%; forb cover layer 10%-20% (Mullins and Bizeau 1978; Stone 2009).	Breeding and foraging	Shrike, teals, gadwall, meadowlark, common yellowthroat, Savannah sparrow, blackbirds, voles, mice, nesting shorebirds
Bobolink	Palustrine emergent, (seasonally flooded marsh associated with wet meadow)	Breed in subirrigated meadow composed of grasses and large forbs. Dependent on annual growth of grass cover layer 50%-70%, up to 3 feet (1 m) tall; 10%-20% forbs; bare ground <20% (Dechant et al. 1999; Moskwik and O'Connell 2006; Wittenberger 1978).	Breeding and foraging	Shrike, teals, gadwall, meadowlark, common yellowthroat, Savannah sparrow, blackbirds, voles, mice, nesting shorebirds

Refuge Management Activities

During spring irrigation, wet meadows are sheet flooded (subirrigated to 5 inches of standing water). To provide habitat for breeding greater sandhill cranes, Canada geese, and early nesting mallards, irrigation will commence by March 15 for a majority of wet meadow habitat. Fall irrigation of some meadow areas may be desirable to achieve other habitat goals. Irrigation water is maintained in meadows through early August for crane broods, except when drawdowns are necessary to repair facilities or accomplish other habitat management projects (e.g., mowing).

Meadows are managed to provide two habitat structure objectives: to provide dense nesting cover for ground-nesting birds, and to provide short stubble for early green-up as forage for early nesting birds such as waterfowl and cranes and as short-cover nesting sites for shorebirds. To achieve the second objective, meadows are treated by mowing the vegetation in late summer and removing it as hay or through rake-bunch grazing.

4.3.5 Palustrine Emergent (seasonally flooded marsh associated with wet meadows)

Overview

This habitat type, measuring approximately 17,000 to 18,000 acres, exists within a mosaic of wet meadow and open water areas. Emergent marshes are found throughout the southern Blitzen Valley, become less extensive north of Buena Vista, and occur in the southern half of the Double-O Unit. Common emergent plant species include burreed, bulrushes, cattails, sedges, rushes, and spike rushes. Refuge emergent marshes are dominated by hardstem bulrush, cattails, or broad-fruited burreed. These emergents typically tolerate fluctuations in water availability ranging from 3 feet (1 m) above to 4-5 inches (10-12 cm) below the soil surface. Submergent plants such as pondweeds, bladderworts, waterweeds, and duckweeds occur in adjacent deeper open water (aquatic beds) areas. Willow species can occur along elevated ecotones along marsh perimeters.

Regional Distribution, Condition, and Trends

The greatest challenge associated with this habitat is maintaining an adequate prescribed fire cycle to remove excess litter, create open water areas, and generally make it more conducive to use by wildlife (e.g., nesting cranes and mallards). The two prevalent invasive species within emergent marshes are common reed and hybrid cattail. Some emergent stands in the Blitzen Valley (i.e., common cattail) have expanded and encroached into adjacent wet meadow and open water areas in the past decade, reducing habitat values for some nesting birds.

Common reed and hybrid cattails have the potential to displace significant areas of marsh plant community types that are more valuable for nesting birds.

Key Species Supported

Wildlife species associated with these marsh habitats include sandhill cranes, trumpeter swans, overwater nesting ducks (diving ducks and mallards), rails, bitterns, black and Forster's terns, coots, marsh wrens, common yellowthroats, and yellow-headed and red-winged blackbirds. Marshes provide foraging, resting, pairing, and nesting habitat for these species. Emergent vegetation in marshes provides escape cover for broods of numerous species, particularly late-season nesters such as gadwall, redhead, and grebes. The priority ROC species under this habitat type are listed below in Table 4-5 and include yellow-headed blackbirds and greater sandhill cranes.

Table 4-5. Palustrine Emergent (seasonally flooded marsh associated with wet meadow) Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Yellow-headed blackbird	Found in a variety of wetland areas but in this region prefers seasonal wetland with dense emergent vegetation over standing water. Favor vegetation around 23 inches (60 cm) in height, a mean stem density of 80-104/yd², over 11-22 inches (28-57 cm) of water (Twedt and Crawford 1995).	Breeding and foraging	Bitterns, mallards, other waterfowl, sora, other rails and marsh birds, other blackbirds, willets, snipe, other shorebirds, swallows
Greater sandhill crane	Prefer coarse, emergent vegetation predominately hardstem bulrush, cattail, and burreed with an average water depth of 7 inches (18.0 cm) (Littlefield 1995; Tacha et al. 1992) for nesting.	Nesting	Bitterns, mallards, other waterfowl, sora, other rails and marsh birds, other blackbirds, willets, snipe, other shorebirds, swallows

Refuge Management Activities

The maintenance of existing emergent communities is artificial, requiring extensive infrastructure and active water diversion. Tools such as burning, mowing, disking, and using herbicides have been used to enhance this habitat type. Herbicides are occasionally used to control invasive species within this community.

4.3.6 Palustrine Open Water/Emergent (semipermanently flooded wetland impoundments)

Overview

This habitat type, measuring between 2,200 and 2,800 acres, is primarily provided in wetland impoundments in the Blitzen Valley and Double-O units. Palustrine open water habitats are semi permanently flooded at depths that preclude the development of extensive stands of emergent vegetation. Extensive areas of emergents occur in larger impoundments. The aquatic beds of these impoundments support submerged and floating plants including common and greater duckweed; Canadian waterweed; coontail; water milfoil; common bladderwort; white water crowfoot; and sago, longleaf, and small pondweeds. Emergent plants occupy shallow areas within and alongside of open water communities and include bulrushes, cattails, sedges, rushes, and spike rushes.

Regional Distribution, Condition, and Trends

Most refuge impoundments are in good condition and meet the goal of providing hemi-marsh conditions (approximately half marsh and half open water); however, a few are overgrown with

emergent vegetation and lack diversity and extent of open water. These are typically sites that have poor water control or that have undergone changes in hydrology.

Palustrine systems are threatened by a number of factors. Invasive species such as carp and reed canarygrass reduce their wildlife values. Aging infrastructure and management of vegetation within the water delivery system poses challenges in ensuring reliable and consistent water supplies.

Key Species Supported

These impoundments are the primary habitat for breeding and foraging of the Refuge's population of trumpeter swans. The impoundments provide brood water for late-nesting ducks, such as redheads and gadwalls, and provide overwater nesting substrate for a large variety of wetland birds, including Canada geese, diving ducks, mallards, American coots, rails, grebes, and colonial species such as white-faced ibises and Franklin's gulls. They also provide foraging habitat for migrating waterfowl and serve as night roosts for staging sandhill cranes and Canada geese. They serve migrant shorebirds when they are being flooded or drawn down and provide very shallow or moist mudflats.

Muskrats use the emergent marsh component of this habitat for their lodges. Their lodges are also used by mink, which hunt muskrats and wetland birds in the marshes. Raccoons also forage in these areas.

The priority ROC species for this habitat type are listed in Table 4-6 and consist of eared grebes, redhead ducks, and ruddy ducks.

Table 4-6. Palustrine Open Water/Emergent (semipermanently flooded wetland impoundments) Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Eared grebe	Inhabit large fresh open water marshes and prefer to nest in waters with abundant and diverse submergent aquatic beds and periphery emergent vegetation and 10 feet (3 m) deep. 60:40 to 70:30 ratio of open water to emergent vegetation with a stem density 8-144 stems/yd², open water areas with submergent vegetation covering 40%-70% of area dominated by sago pondweed (Cullen et al. 1999; Dechant et al. 2002).	Breeding and foraging	Swans, geese, ducks, herons, egrets, rails, ibis, coot, yellow-headed and other blackbirds, swamp sparrow, marsh wren, common yellowthroat, black tern, muskrat, mink
Redhead	Inhabit permanently or semipermanent palustrine wetlands, water depth 8-39 inches (20-100 cm) (interspersed open water pockets 1.7-2.5/yd²; emergent stem density bulrush	Brooding	White pelican, egrets, herons, mergansers, grebes, cormorants, rails, ducks, coot, marsh wren, black tern, red-winged and yellow-headed

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
	350-450 stems/yd² or cattails 32-52 stems/yd² (Custer 1993; Low 1945; Woodin and Michot 2002).		blackbirds, muskrat
Ruddy duck	Inhabit large open water areas with submergent vegetation during foraging but use dense emergent vegetation >35 inches (91 cm) in height for breeding. Prefer stems density 88-200/yd² with a water depth of 16-24 inches (42-61 cm) (Bura 2002).	Breeding and foraging	Swans, geese, ducks, herons, egrets, rails, ibis, coot, yellow-headed and other blackbirds, swamp sparrow, marsh wren, common yellowthroat, black tern, muskrat, mink

Refuge Management Activities

With the exception of small natural depressions next to springs (e.g., Double-O Spring), the palustrine community has been maintained through active and intensive management. Emergents within impoundments are managed to maintain a hemi-marsh condition. Tools such as burning, mowing, disking, and using herbicides have been used to reduce extensive stands of emergents. Occasional drawdowns oxidize nutrients and consolidate substrates to facilitate the germination of submergent vegetation, such as sago pondweed. When pond bottoms are exposed production of smartweed and other desirable native colonizers is higher after reflooding, especially in mudflats in shallow benches. Periodic drawdowns are occasionally used to remove carp from impoundments. When impoundments cannot be totally dried up, rotenone, netting, and electroshocking have been used to remove invasive carp.

4.3.7 Dry Meadow

Overview

Dry meadows are influenced by water depths and the timing of irrigation through the availability of subirrigation. Standing water is typically not found within these plant communities. The largest areas of dry meadow habitats are located in the northern Double-O and scattered throughout the Blitzen Valley where gradual shifts in elevation facilitate the presence of this habitat type, which lies between wet meadows and sagebrush lowland/salt desert scrub. The Blitzen Valley and Double-O currently supports approximately 4,500 to 5,500 acres of dry meadow habitats. Dry meadow habitats are typically subirrigated but may be temporarily inundated during flood events. Shallow depth to water table makes these areas largely uninhabitable by woody upland vegetation such as basin big sagebrush and greasewood. Sites are typically dominated by creeping wildrye, Nevada bluegrass, bluejoint, or saltgrass. Other native species include western yarrow, slender cinquefoil, and lanceleaf goldenweed.

Regional Distribution, Condition, and Trends

Depth to water table is a driving factor influencing the presence of dry meadow communities. Water management within wet meadows and emergent marshes impact outlying water tables, and these

impacts cause this habitat type to either expand or contract. In areas near prevailing ecotones between dry meadows and sagebrush lowland/salt desert scrub habitats, upland shrub invasion has occurred. This habitat is highly susceptible to invasion by perennial pepperweed.

The largest threat to the biological integrity of dry meadows is invasive plants (either upland shrubs or noxious weeds). Fire suppression over the last century has favored the expansion of shrub communities into this habitat, and the prolific availability of weed seed throughout the Refuge proves difficult to manage.

Key Species Supported

The primary importance of dry meadows is to provide nesting cover for ground nesting birds such as cinnamon teal, bobolink, gadwall, and mallard. These communities are also significant for the western meadowlark, a species that uses this habitat type for breeding and foraging. The latter species is the priority ROC species for this habitat type and more information about it is listed in Table 4-7.

Table 4-7. Dry Meadow Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Western meadowlark	Prefer open country with meadows and fields with good grass and litter cover and little or no woody layer. Grass layer 20%-80%, forb layer 1%-17%, mean thatch layer of 16%, bare ground ≤10% (Dechant et al. 2002; Greer 2009; Lanyon 1994)	Breeding and foraging	Savannah sparrow, vesper sparrow, horned lark, blackbirds, sandhill crane, northern harrier, curlew

Refuge Management Activities

Active management within dry meadows consists mainly of weed control and the stimulation of nesting cover via occasional disturbance (prescribed fire, haying, rake-bunch grazing). Water management of adjacent habitats does influence these plant communities by raising or lowering the prevailing water table.

4.3.8 Salt Desert Scrub

Overview

Salt desert scrub occurs in barren alkali flats or alkaline valley bottomlands, and occupies 40,000 acres of the Refuge. This community is most abundant in alkaline areas around the Double-O Unit, Harney Lake, and Mud Lake but also occurs in portions of the Blitzen Valley and along the east end of Malheur Lake where soil alkalinity is high. Infrequent inundation of outer playa areas or wind erosion from these playas distributes salts to nearby low-lying areas, causing elevations in alkalinity and pH, which favor this community association. The plant community for this habitat type consists of widely spaced shrubs with dense patches of rhizomatous grasses, as well as low densities of other annual and perennial grasses and succulent forbs. Dominant species are black greasewood and inland

saltgrass, but shortspine horsebrush, fourwing saltbush, bud sage, green and gray rabbitbrush, alkali sacaton, alkali cordgrass, and alkali bluegrass are often present. Mat muhly and Sandberg's bluegrass may be present in mosaics which exhibit more moderate conditions (lower pH.).

Regional Distribution, Condition, and Trends

These upland sites also experience moderate to heavy grazing by livestock during the winter, and this probably reduced the resiliency of this community to resist invasive plants. Perennial pepperweed has significantly encroached in these areas at lower elevations and has replaced vast areas of native vegetation. Rabbitbrush tends to be invasive in some sites after burning.

Livestock grazing may compromise plant species diversity within this community type. There is no wildlife benefit to grazing in these uplands. Perennial pepperweed has invaded vast areas of this habitat in the Blitzen Valley and to a lesser degree in the Double-O Unit.

Key Species Supported

This community is preferred for nesting by loggerhead shrikes, which use the thorny shrubs to impale their prey. Similar to the sagebrush lowland community this habitat is important as nesting cover for ground-nesting birds, such as mallards, gadwalls, and short-eared owls when in proximity to water. Nesting birds primarily rely on tall grass and forb components. A variety of landbirds also breed here, including sage thrashers, Brewer's sparrows, black-throated sparrows, sage sparrows, Brewer's blackbirds, and western meadowlarks. Many mammalian species use these communities including American badgers, weasels, black-tailed jackrabbits, cottontails, Townsend's and northern pocket gophers, and deer mouse. They are typical denning sites for coyotes and are also frequented by bobcats. They also get used regularly by mule deer and pronghorn. The priority ROC species under this habitat type is loggerhead shrike, and more information about this species is listed below in Table 4-8.

Table 4-8. Salt Desert Shrub Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Loggerhead shrike	Found in open gentle terrain with low density of shrubs (particularly sagebrush) mixed with low and sparse grasses such as saltgrass. Shrub layer cover 5%-15%, grass layer cover 50%-70% <10 inches (25 cm) tall (Pampush and Anthony 1993; Paton and Dalton 1994).	Breeding and foraging	Sage sparrow, sage thrasher, vesper sparrow, snakes, shrews, lizards

Refuge Management Activities

Although this habitat type was historically intensively grazed, in more recent years cattle have been excluded from grazing in this habitat type on the Refuge. Prescribed burning is periodically used in these sites to set back succession and composition over the short term, but these communities often do not contain enough continuous fuels to accomplish a complete burn, so the result is a mosaic burning pattern.

4.3.9 Sagebrush Lowland

Overview

These upland habitats occur in elevated basin bottomlands with deep silty or sandy soils along stream channels in valley bottoms and flats. Lowland sagebrush habitat is found on 4,300 to 4,500 acres of the Refuge. Structurally, these habitats are composed of widely spaced medium-tall to tall shrubs (1.5-6 feet) with an understory of perennial bunchgrasses. Basin big sagebrush, Wyoming big sagebrush, rabbitbrush, and basin wildrye are dominant features in this habitat type. These habitats occur in upland areas on the valley floors of the Blitzen Valley and Double-O units. The fire frequency in these habitats ranges from 10 to 25 years (ODFW 2006).

Regional Distribution, Condition, and Trends

Historically, this habitat was probably more abundant in the Blitzen Valley. As the development of the irrigation system changed the water regime, it likely also changed the composition of plant communities on lower-elevation upland sites. However, most of the loss of upland habitat due to development of irrigation more likely occurred in the meadow areas dominated by creeping wildrye/Nevada bluegrass communities throughout the Blitzen River Valley. These communities have developed along the incised river and stream channels and along the edges of some refuge canals and dikes.

Before the reduction of grazing in the 1970s, these upland sites were moderately to heavily grazed by cattle during the winter, with cattle use extending into early spring, for over 30 years. This use degraded these sites and likely changed a number of plant community characteristics.

Invasive plants, such as cheatgrass, have degraded this community and have altered the natural fire regime by allowing more frequent fire-return intervals. Perennial pepperweed has significantly encroached in these areas at lower elevations and has replaced vast areas of native vegetation. Rabbitbrush tends to proliferate in some sites after burning.

Weed invasions are the biggest threats to this habitat type. There is no wildlife benefit to grazing in these uplands. Grazing by trespassing livestock can be an issue.

Key Species Supported

A primary value of this upland community is as dense nesting cover for ground-nesting birds, such as mallards, gadwalls, and short-eared owls. These birds primarily rely on tall grass and forb components. A variety of landbirds also breed here, including California quail (*Callipepla californica*), sage thrashers, Brewer's sparrows, Brewer's blackbirds, and western meadowlarks. Many mammalian species also use these communities, including American badgers, weasels, black-tailed jackrabbits, cottontails, potentially pygmy rabbits, Townsend's and northern pocket gophers, least chipmunk, bushy-tailed and desert woodrats, northern grasshopper mouse, deer mouse, and sagebrush vole. These habitats are typical denning sites for coyotes and are also frequented by bobcats. They also get used by mule deer, pronghorn, and elk and provide good hiding cover for these species. The priority ROC species under this habitat type consist of gadwall and mallard. More information about these species is listed below in Table 4-9.

Table 4-9. Sagebrush Lowland Priority Resources of Concern Species

Focal Species	Habitat Type	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Gadwall	Sagebrush lowland	Prefer islands of brushy habitat with Great Basin wildrye, or tall grass or forb component in proximity to open water. Shrub layer cover <10%; herbaceous veg. cover 10%-20%, 9-13 inches (25-35 cm) tall, within 147 feet (45 m) of open water (Leschack et al. 1997; Sousa 1985).	Nesting	Short-eared owl, mallard, western meadowlark, sage thrasher
Mallard	Sagebrush lowland	Nesting in dense cover scattered shrub lands surrounded by water for brooding (Drilling et al. 2002). Nests are generally equal to or less than 164 yards (150 m) from water (Dzus and Clark 1997).	Early season nesting and brood water	Short-eared owl, gadwall, song sparrows

Refuge Management Activities

The primary management activities in these upland communities are weed control and prescribed burning to reinvigorate basin wildrye for dense nesting cover for ducks.

4.3.10 Sagebrush Steppe

Overview

This community includes 14,000 to 15,000 acres on the Refuge and is dominated by shrubs with an understory of various bunchgrass and forb species found within interspaces. It can be found above greasewood/lowland sagebrush communities on various aspects, slopes, and soil types. It occurs around the fringe of the Blitzen Valley at higher elevations, at several locations in the Double-O Unit, and along the south side of Harney Lake. Plant species include Wyoming and low sagebrush, bluebunch wheatgrass, Sandberg's bluegrass, bottlebrush squirreltail, Idaho fescue, needle-and-thread, Thurber's needlegrass, western yarrow, arrowleaf balsamroot, and various locoweed and phlox species. A gradient in soil depth determines whether Wyoming big sagebrush or low sagebrush dominates a site. Low sagebrush sites typically host higher densities of forbs due to higher concentrations of available soil moisture due to shallow, rocky conditions. These communities depend on natural fire cycles or equivalent disturbance to maintain a balance between shrub, grass, and forb components. A lack of disturbance lends itself to high shrub densities with sparse vegetation in the interspaces.

Regional Distribution, Condition, and Trends

Originally, upland habitats were composed of native shrubs, bunchgrasses, and forbs. Most of the former native vegetation has been severely altered by historical land use, including intensive livestock grazing, reduced burning frequency, and cultivation. Large areas of shrub-steppe have been seeded to crested wheatgrass or as part of former "fire restoration" activities.

Invasive plants, such as medusahead and cheatgrass, are major threats to the remaining shrub-steppe areas of the Refuge. Medusahead is capable of outcompeting native grasses and forbs in the understory. An altered fire regime resulting in more frequent fire return intervals due to the volatility of cheatgrass can limit recovery of sagebrush species in these communities, and wildfire can exacerbate these invasions.

Key Species Supported

Examples of obligate shrub-steppe species include sage-grouse, Brewer's sparrow, sage sparrow, and sage thrasher. Likely because of the elevation, condition and fragmentation of refuge shrub-steppe, only very limited use by sage-grouse has been observed. Historically the area also supported sharp-tailed grouse (*Tympanuchus phasianellus*), which were last documented in southeastern Oregon in 1940. Many other birds occur in shrub-steppe but are not as dependent on sagebrush. Examples of these include burrowing owl (*Athene cunicularia*), lark sparrow (*Chondestes grammacus*), vesper sparrow, horned lark, loggerhead shrike, long-billed curlew, and western meadowlark.

Mule deer, pronghorn, and occasionally elk use these areas, which are within their winter range. Coyotes, bobcats, and badgers are common in these areas, and mountain lions are rarer, but present. The black-tailed jackrabbit, Nuttall's cottontail, least chipmunk, Townsend's and golden-mantled ground squirrels, and northern and Townsend's pocket gophers are locally abundant in shrub step.

A variety of reptiles use shrub-steppe habitat, including sagebrush, fence and side-blotched lizards; western rattlesnakes; racers; gopher snakes; and common garter snakes. Amphibians are represented by spade-foot toads.

The priority ROC species for this habitat type is the sage thrasher, and more information about this species is listed below in Table 4-10.

Table 4-10. Sagebrush Steppe Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Sage thrasher	Found in open terrain with a high density of sagebrush and large contiguous tracts. Shrub layer cover 5%-25%, 31 inches (>80 cm) in height; other shrub cover <10%; herbaceous cover 5%-20%; tract size >39 acres (16 ha) (Altman and Holmes 2000; Reynolds et al. 1999).	Breeding and foraging	Sage sparrow, sage-grouse, long-billed curlew, ground squirrel, mule deer, pronghorn

Refuge Management Activities

To provide green winter browse for wintering Canada geese, crested wheatgrass seedings have been treated with livestock grazing to provide short stubble. Otherwise, cattle have been excluded from most of these sites on the Refuge. Research on restoring crested wheatgrass areas to more native shrub-steppe communities is being conducted in conjunction with the Eastern Oregon Agricultural Research Center (USDA Agricultural Research Service).

4.3.11 Dune

Overview

Dune habitat on the Refuge is located adjacent to playa basins and is characterized by open sand ridges with widely spaced shrubs, grasses, and forbs. Created by wind erosion off nearby dry playa bottoms (i.e., Stinking and Harney lakes), dune shrub communities are made up of shortspine horsebrush, fourwing saltbush, bud sage, green and gray rabbitbrush, and black greasewood. Grasses include Indian ricegrass, needle-and-thread, bottlebrush squirreltail, and alkali sacaton. Forbs include tufted evening primrose, Paiute suncup, Geyer's milkvetch, sharpleaf penstemon, and various lupines. Dunes cover about 6,300 acres on the Refuge and are primarily located on the east side of Harney Lake and as islands on Malheur Lake.

Regional Distribution, Condition, and Trends

Possibly because of harsh conditions, constantly shifting sand and specific adaptations of the plants that inhabit these sites, this habitat has fewer invasive weed issues than other upland types on the Refuge. Some invasive weeds, such as Russian thistle, are present, but their extent is very limited. The dunes are unstable and slowly shift over time. We have no trend data for the dunes but consider them basically pristine and unique habitat on the Refuge.

Dunes are susceptible to invasion by exotic weeds such as *Halogeton*, povertyweed, and Russian thistle. These plants could change the dynamics of sand movement in the dunes and lead to increased stability, which would change the natural vegetation patterns on the dunes and compromise their integrity. Grazing by trespassing livestock occasionally occurs as well as use by trespassing all-terrain vehicle riders. Both of these are a significant threat to the stability of the dunes.

Key Species Supported

Vertebrate wildlife associated with dunes are dependent on the associated vegetation and include many small mammals, including black-tailed jackrabbits, western cottontails, kangaroo rats, dusky-footed woodrats, and deer mice. Occasionally mule deer use the dunes to forage and seek cover. Shrub-steppe nesting birds such as sage thrashers, sage sparrows, and black-throated sparrows nest in the associated brush. Reptiles such as western fence lizards, side-blotched lizards, short horned lizards, and Pacific rattlesnakes frequent the dunes and some likely lay their eggs there. During high water periods, the sandy shorelines are used by foraging shorebirds. The priority ROC species under this habitat type is the sage sparrow, and more information about this species is listed below in Table 4-11.

Table 4-11. Dune Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Sage sparrow	Prefer large patches of contiguous sagebrush; semi-open, evenly spaced shrub habitat with big sagebrush and rabbitbrush as part of the community component. Shrub layer cover 10%-25% with a height of >19 inches (50 cm); herbaceous layer cover >10%; open ground >10% (Altman and Holmes 2000; Martin and Carlson 1998).	Breeding and foraging	Sage thrasher, sage-grouse, loggerhead shrike, badger

Refuge Management Activities

Dune habitats have received no direct management as these area lie within the RNA and proposed wilderness boundary for Harney Lake. Natural ecological factors continue to shape the dune terrain, without any significant human influences. The primary management objective is protection from trespassing livestock and people.

4.3.12 Playa

Overview

Refuge playa habitats are located primarily in Harney Lake (a 40,000-acre playa when dry) and the Double-O. Stinking Lake is the second-largest refuge playa and is spring-fed and isolated from other surface hydrology. Total average refuge acres of playa habitats are approximately 29,000. During low-water periods, there are large playa areas in Mud Lake and a few along the east side of Malheur Lake. The flat playa surfaces that appear during drier periods are periodically flooded but generally too alkaline to support vegetation. They are bare or scattered with dead vegetation killed by floodwaters of the 1980s (Dugas 1996), and these unique habitats are often intermixed with saltgrass or desert salt-scrub communities. Evaporation of closed basin water during dry periods results in high levels of alkalinity and associated pH. During high-water events, the alkaline water is diluted, stimulating the temporary production of aquatic species. Playa soils are typically very deep and poorly drained. Virtually no vascular plants reside within Harney and Stinking lakes, with the exception of spring areas where steady freshwater inflows modify water chemistry.

Regional Distribution, Condition, and Trends

Generally, refuge playa habitats are in pristine condition with these communities least impacted by human actions or changed by environmental conditions. A few playas in the Double-O have been bisected by roads. Harney Lake is a designated Research Natural Area and wilderness study area, and has been protected for those values. Stinking Lake is designated as a Research Natural Area.

When dry, playas are popular for off-road all-terrain vehicle use, which can cause soil compaction and erosion, reducing their resiliency and allowing soils to blow away. With access on the Refuge restricted, this is mostly a limited trespassing issue. Disruption of natural water supplies from local

runoff by road construction or drainage systems could reduce the flood frequency and the wildlife value of playa habitats.

Key Species Supported

Playas systems are rich in invertebrates, such as brine flies and brine shrimp. They support breeding snowy plovers and occasionally American avocets and black-necked stilts. Harney Lake is the most important breeding site for snowy plovers in the Harney Basin and has supported over 400 breeders. When these habitats develop standing water, large numbers of waterfowl have been observed using the sites. Because they are rich in invertebrates, playas attract high numbers of migrant shorebirds when they are wet. When brine shrimp are abundant, the Refuge's playas receive high use by Wilson's and northern phalaropes, northern shovelers, ruddy ducks, gulls, and eared grebes. Peaks of over 15,000 phalaropes have been counted at Stinking Lake. The priority ROC species under this habitat type is the snowy plover, and more information about this species is listed below in Table 4-12.

Table 4-12. Playa Priority Resources of Concern Species

Focal Species	Habitat Structure and Attributes	Life History Requirements	Other Benefiting Species
Snowy Plover	Found in barren or sparsely vegetated alkaline or saline lakes, playas, and flats. Bare ground with little vegetation of any kind; nests are usually <0.8 mile from water; water levels for foraging are from 0-1 inch (0-2 cm) deep (Page et al. 1985; Page et al. 1995).	Breeding and foraging	Phalaropes, eared grebe, northern shoveler, ruddy duck, shorebirds

Refuge Management Activities

These systems generally do not require any management other than protecting them from trespassing and off-road vehicle use.

4.3.13 Cropland

Overview

Croplands are maintained on the Refuge to provide forage for fall-staging sandhill cranes and waterfowl. Grain fields are present at scattered locations in the Blitzen Valley. In the past two decades, refuge maintenance staff have planted and irrigated these fields. Winter wheat and spring barley are the primary crops planted, which are rotated among about 300 acres of grain fields. These fields are left unharvested for wildlife use.

Grain crops are occasionally planted in bottoms of refuge impoundments as part of the drawdown cycle to reinvigorate wetland nutrients.

Regional Distribution, Condition, and Trends

Historically, a much higher percentage of the Blitzen Valley was managed as grain fields. Grain crops were extensive in the late 1930s through the 1950s to support fall migrants. Many fields that are now managed as wet meadows were leveled and ditched to allow farming. Approximately 1,300 acres of grain fields were managed in the 1990s (USFWS 1990). Today about 80 acres of grain fields are managed on the Refuge.

Invasive weeds can be a threat to these lands if farming operations are terminated, with soils freshly tilled, and if the field is left idle and not restored.

Key Species Supported

Grain field farming has primarily been conducted to support fall-staging sandhill cranes. They are heavily used by cranes, Canada geese, mallards, northern pintails, and occasionally American wigeon. They are also used by mule deer, pronghorn, and upland game birds, including pheasants and California quail. Red-winged, yellow-headed, and Brewer's blackbirds, as well as a variety of sparrows, also use them.

Refuge Management Activities

Crops are maintained on an annual basis. These areas are periodically treated for invasive weeds.

4.3.14 Cold and Hot Springs

Overview

Springs occur throughout the Refuge, ranging from the southern end of the Blitzen Valley to the Double-O Unit. They provide stable, permanent sources of water for flood irrigation, pond filling, and/or maintenance, and wildlife.

Regional Distribution, Condition, and Trends

The ability of many springs to provide high quality aquatic habitat for fish and wildlife has been compromised due to the prevalence of common carp throughout the Refuge's water system. Those areas that have remained carp-free provide abundant submergent vegetation and associated invertebrates.

Key Species Supported

Springs provide habitat for a diverse assemblage of macroinvertebrates, native plants, fish, other aquatic species, and wildlife. These areas provide essential habitat for spotted frog (breeding, feeding, and winter refugia) and trumpeter swan (warm-water springs are often the only open water available during the winter).

Refuge Management Activities

Areas adjacent to cold and hot springs are treated as needed for invasive weeds.

4.3.15 Cliffs, Rimrock, and Outcroppings

Overview

Areas of steep basalt cliffs and outcroppings can be found along the sides of the Blitzen Valley and the south end of Mud and Harney lakes and in the Double-O Unit. This habitat type occurs within the refuge perimeters of the Blitzen and Double-O valleys.

Regional Distribution, Condition, and Trends

Frequent wildfires have reduced the quality of vegetation occurring on and near cliff areas. The trend for the condition of these habitats is generally stable. Some sites have been modified in the past for use as sources of gravel and rock.

Invasive weeds are a threat to the integrity of habitat surrounding cliffs and talus areas as they reduce the value of the sites for foraging wildlife. Disturbance of nesting raptors is an issue and human trespass needs to be minimized during the nesting period.

Key Species Supported

These areas provide nesting habitat for cliff dwelling birds, as well as various reptiles and are particularly important for nesting raptors, including golden eagles; prairie falcons; red-tailed hawks; and great-horned, screech, barn, and long-eared owls. Historically, they supported nesting peregrine falcons and they will likely soon reoccupy such refuge sites based on upward population trends and available habitat. These areas are used by mule deer, bighorn sheep, black-tailed jackrabbit, Nuttall's cottontail, yellow-bellied marmots, golden-mantled ground squirrels, and bushy-tailed and desert woodrats. Many lizard and snake species are associated with this habitat type and some of the sites support rattlesnake hibernacula, especially in the Double-O Unit.

Refuge Management Activities

These systems generally do not require any management other than protecting them from trespassing.

4.4 Major Species Groups

4.4.1 Migratory and Resident Birds

Waterfowl

The Refuge supports several priority waterfowl species that are highlighted in the North American Waterfowl Management Plan (North American Waterfowl Management Plan Committee 1998). Species present that are identified as "high" priority in the plan and which use the Refuge are tule greater white-fronted goose, northern pintail, mallard, and lesser scaup. Most of the refuge use for these high-priority species is provided during migration periods. However, substantial numbers of mallards nest on the Refuge with some nesting by pintail and lesser scaup. Additionally, "other" priority waterfowl species identified in the plan use the Refuge or the area surrounding the Refuge, including Pacific greater white-fronted goose, Wrangel Island snow goose, wood duck, redhead, canvasback, ring-necked duck, and American wigeon. Most refuge use is migratory, but breeding

pairs of wigeon, canvasback, ring-necked, and redhead ducks are observed each year. The Refuge also supports a breeding Rocky Mountain population of trumpeter swans, which are a priority for the Pacific Flyway.

Use of the Refuge is substantial for many of these waterfowl species and varies with habitat conditions. A comparison of peak refuge counts, conducted in the 1980s and 1990s during spring and fall migration, with annual the Pacific Flyway midwinter population indices shows that the Refuge supported up to the following percentages for each species:

- 66 percent of the white goose (snow and Ross's) population (spring 1996)
- 63 percent of the American wigeon population (fall 1993)
- 48 percent of the tundra swan population (in fall 1980 after carp control on Malheur Lake)
- 40 percent of the American green-winged teal population (fall 1993)
- 24 percent of the ruddy duck population (spring 1995)
- 22 percent of the northern shoveler population (fall 1993)
- 10 percent of the northern pintail population (spring 1996)
- 5 percent of the mallard population (fall 1996)

Additionally, refuge counts for both redheads and canvasbacks exceeded the Pacific Flyway midwinter indices (328 percent for redheads in fall 1992 and 148 percent for canvasbacks in fall 1995). However, it should be noted that the midwinter counts do not include Mexico, where substantial numbers of redheads and canvasbacks winter.

Tule and Pacific greater white-fronted geese, snow geese, and Ross's geese use the Refuge, primarily during migration. Tule geese primarily use the marshy areas on the north side of Malheur Lake in the fall, while white geese and Pacific white-front geese use the area more extensively in the spring. They use the lakes for night roosting and forage in irrigated meadows on the Refuge in the north Blitzen Valley and Double-O. However, it should be noted that the majority of these birds forage off-refuge on the Silvies River floodplain. Large numbers of western Canada geese winter here.

Breeding waterfowl most commonly found on the Refuge include western Canada geese, cinnamon teal, mallard, gadwall, redhead, northern shoveler, northern pintail, American wigeon, canvasback, and ruddy duck. Several other species breed here but in much lower densities. A small flock of resident trumpeter swans use the Refuge year-round and nest in the Blitzen Valley.

Waterfowl annual production has declined from production numbers of over 100,000 birds to between 50,000 and 60,000 annually by the 1980s (Cornely, 1982). A precipitous decline occurred in the early 1950s which was strongly suspected to be correlated with expanding carp populations and degradation of Malheur Lake aquatic habitats. Waterfowl production has rebounded from the lows of the 1960s but still remains less than half of historic production levels (Cornely, 1982). Information on production in the last decade is incomplete.

Waterbirds

Thirty different species of waterbirds occur on the Refuge. The Refuge supports several colonial waterbird species identified as priority species in the Intermountain West Waterbird Conservation Plan (Ivey and Herziger 2006), including greater sandhill cranes, western and Clark's grebes, American white pelicans, California gulls, and Forster's terns.

Greater sandhill cranes are also listed as a sensitive species in Oregon. Malheur supports the highest number of breeding greater sandhill cranes of any refuge in the western United States. A statewide pair survey in 2000 found 245 pairs on the Refuge, 21 percent of the Oregon population (Ivey and Herziger 2000).

Comparing peak refuge counts of nesting waterbirds with population estimates for the Great Basin bird conservation region, most colonial waterbird numbers peak counts exceeded 10 percent of regional populations. The Refuge supported

- 20,500 breeding white-faced ibises (35 percent of regional population in 1998);
- 7,782 breeding western and Clark's grebes (50 percent of the regional population in 1983);
- 4,090 breeding American white pelicans (15 percent of the regional population in 1988); and
- 1,730 breeding great egrets (77 percent of the regional population in 1983).

The Refuge also supports high numbers of breeding Franklin's gulls in good water years. The Refuge also supports very high numbers of sora, Virginia rails, American coots, and American bitterns.

Nesting populations fluctuate annually and quite dramatically depending on water levels and habitat conditions. Populations have disappeared during drought conditions and then rebounded with rising water levels. Populations such as white pelican (nesting on Malheur and Harney Lakes and in the Blitzen Valley) have moved as habitat conditions changed.

Shorebirds

The Refuge provides vital habitat for a wide variety of shorebirds. Twenty-seven shorebird species are found on the Refuge during different seasons of the year. The most common migrant species are the western sandpiper, long-billed dowitcher, Wilson phalarope, American avocet, and common snipe. From 1990 to 1995, the Refuge participated in the Pacific Flyway Project (Ivey et al. 1995), a study coordinated by Point Reyes Bird Observatory. Shorebird numbers were counted each spring and fall when the migrating shorebirds were using the Refuge as a stopover site (Figure 4-1). Total peak numbers exceeded 20,000 individuals during migration. Using peak numbers of shorebirds counted along the Pacific coast as estimates of Pacific Flyway populations (Page et al. 1999), refuge uses were as follows: the western sandpiper peak was <0.5 percent of the Pacific Flyway population, the long-billed dowitcher peak was 4.4 percent, and the American avocet peak was 10.8 percent.

Malheur, Mud, Harney, and Stinking lakes provide most of the shorebird habitat on the Refuge and within the Harney Basin. Other important shorebird habitat on the Refuge can be found in the Double-O and Blitzen Valley units. Stinking Lake is an especially important shorebird use area. For example, Littlefield and Paullin (1976) documented 8,300 Wilson's phalaropes and 10,000 American avocets there on August 21, 1975. These birds were likely attracted to crustaceans and brine flies, which are abundant when saline playa lakes are at low levels and salts are concentrated. Breeding snowy plovers use Harney Lake and other refuge playas, and the Refuge supports over 400 breeding adults in good years.

Raptors

Twenty-three species of raptors have been recorded on the Refuge. The recorded species consist of osprey, bald eagle, northern harrier, sharp-shinned hawk, cooper's hawk, northern goshawk, red-shouldered hawk, Swainson's hawk, red-tailed hawk, rough-legged hawk, golden eagle, American

kestrel, merlin, peregrine falcon, prairie falcon, barn owl, flammulated owl, western screech-owl, great horned owl, burrowing owl, long-eared owl, short-eared owl, and northern saw-whet owl.

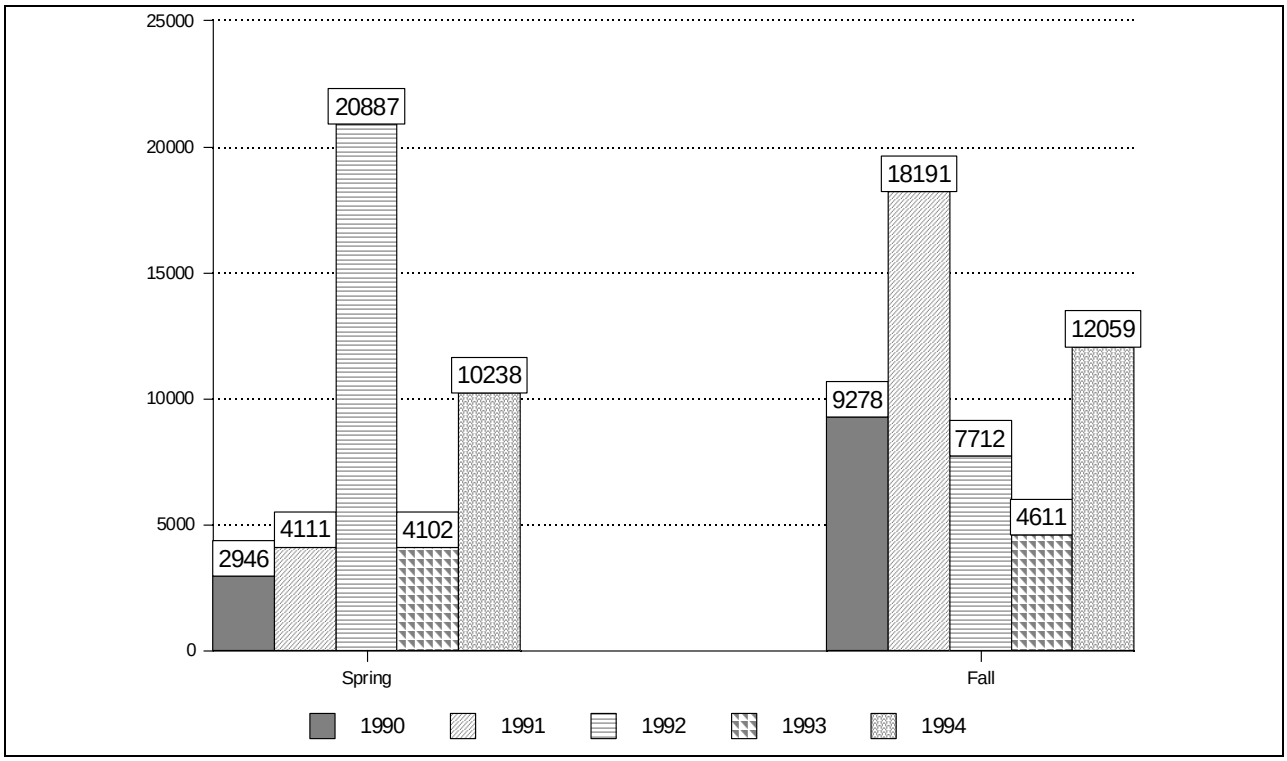

Figure 4-1. Total shorebird numbers from counts conducted at Malheur National Wildlife Refuge during the Pacific Flyway Project, 1990-1994.

Passerines

The Refuge supports at least 130 species of passerines, many of them identified as priority species by the Oregon and Washington Partners in Flight (Altman and Homes 2000). Riparian-dependent priority species include willow flycatchers, yellow warblers, Bullock's orioles, and yellow-breasted chats. The Refuge also supports the largest local population of bobolinks in the western U.S. Passerine species found in the uplands include loggerhead shrike, sage sparrow, sage thrasher, black-throated sparrow, lark sparrow, and Brewer's sparrow.

Other Birds

Thirty-four species of non-passerine birds are found on the Refuge, including five species of gulls, three species of hummingbird, and seven species of woodpecker.

4.4.2 Fisheries

Native Fishes

The Harney Basin, because of historic connections with the Columbia River drainage, supports a fish fauna mirroring the native fishes of the Columbia, with a few species absent or undetected, before they disappeared. A diverse assemblage of native fishes inhabit the Refuge, including the Great

Basin redband trout, bridge lip sucker, coarse scale sucker, chisel mouth, northern pikeminnow, red-sided shiner, mountain whitefish, longnose and speckled dace, and Malheur mottled sculpin. Of these species, redband trout and Malheur mottled sculpin are listed as Oregon State-sensitive species.

Non-native Fish Species

A number of non-native fish are present in the Refuge's permanent wetlands, rivers, impoundments, and lakes. Introduced fish include common carp, green sunfish, largemouth bass, rainbow trout, bluegill, yellow bullhead, brown bullhead, black bullhead, mosquito fish, yellow perch, pumpkinseed, and white crappie. Many of the introduced species were stocked by the State of Oregon for recreational fisheries. Other species invaded the Refuge during flood events.

4.4.3 Other Wildlife and Plants

Land Mammals: Fifty-eight species of mammals have been observed on the Refuge. The muskrat is the most conspicuous mammal in Malheur Lake and has an important influence on the marsh ecology. Like waterbird populations, numbers of muskrats fluctuate primarily in response to habitat conditions and, to a lesser extent, disease. The benefit of muskrats to a marsh results from their feeding and lodge-building activities. By cutting emergent vegetation for food, muskrats create an interspersed habitat more desirable for waterfowl than pure stands. Muskrat lodges provide attractive and productive nest sites for Canada geese and trumpeter swans.

Deer mice, montane voles, Great Basin pocket mice, and least chipmunks made up 91 percent of the small mammals captured between 1973 and 1975 (Feldhamer 1979). Other mammals include pronghorn, mule deer, beaver, raccoon, coyote, bobcat, mink, long-tailed weasel, bats, and black-tailed jackrabbit.

Reptiles and Amphibians: The following amphibians occur on the Refuge: long-toed salamander; great basin spadefoot, pacific tree frog, western toad, Columbia spotted frog, and bullfrog.

The following reptiles occur on the Refuge: western fence lizard, sagebrush lizard, side blotched lizard, short-horned lizard, western skink, rubber boa, racer, striped whipsnake, gopher snake, common garter snake, western terrestrial garter snake, night snake, and western rattlesnake.

The following species occur near the Refuge, but no known specimens have been collected on the Refuge: collared lizard, leopard lizard, desert horned lizard, western whiptail, and western ground snake.

Invertebrates: At least 54 species of butterflies and dragonflies occur on the Refuge. There is a great diversity of aquatic macroinvertebrates due to the diversity of aquatic habitats. No comprehensive list of these organisms exists for the Refuge.

4.5 Threatened, Endangered, and Sensitive Species

4.5.1 State or Federally Listed Species Known to Occur on the Refuge

One goal of the Refuge System is "To conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered." In the

policy clarifying the mission of the Refuge System, it is stated, "We protect and manage candidate and proposed species to enhance their status and help preclude the need for listing" (16 U.S.C. 1531-1543; 87 Stat. 884).

In accordance with the above, the planning team considered all species with Federal or State status in the planning process. Table 4-13 lists species that are federally endangered, threatened, or candidate species and are known to occur on or near Malheur Refuge. A discussion of the federally listed candidate species follows the table in Section 4.5.2.

A total of 19 Federal species of concern (declining or in need of conservation) are known to occur or are likely to occur on the Refuge: least bittern, white-faced ibis, black tern, ferruginous hawk, burrowing owl, yellow-breasted chat, willow flycatcher, sage-grouse, mountain quail, Lewis' woodpecker, redband trout, fringed myotis, long-legged myotis, silver-haired bat, small-footed myotis, spotted bat, Townsend's big-eared bat, Yuma myotis, and Preble's shrew. Among this group the willow flycatcher and redband trout were selected as focal species whose requirements indicating the habitat parameters that would also support a large group of other species using these areas.

Table 4-13. Federally Listed Species Known to Occur on or Adjacent to Malheur Refuge

Common Name	Scientific Name	Federal Status*	Current Occurrence on Refuge
Malheur wire-lettuce	*Stephanomeria malheurensis*	Endangered	Adjacent to Refuge
Great Basin Columbia spotted frog	*Rana luteiventris*	Candidate species	Page Springs, Mud Creek, Double-O Springs
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate species	Occasional migrant according to historic records
Greater sage-grouse	*Centrocercus urophasianus*	Candidate species	Incidental and adjacent to Refuge

4.5.2 Habitat Needs, Conditions, and Trends of Federally Listed, Proposed, or Candidate Species

Malheur Wire-lettuce: This annual plant is not present on the Refuge but is located on public lands adjacent to the Refuge. It is found on top of a dry, broad hill on volcanic soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush, gray rabbitbrush, green rabbitbrush, and cheatgrass. Malheur wire-lettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site (USFWS 1991).

This plant is in great danger due to its small population size. Natural fluctuations in population numbers occur in response to variations in annual rainfall and spring frosts and are particularly problematic for small populations. Immediate threats include competition from cheatgrass and predation by native herbivores, such as black-tailed jackrabbits. Currently, there are no plans to introduce this species in appropriate refuge habitats. The Refuge is working closely with USFWS Ecological Services and other State and Federal agencies on the status of this plant.

Great Basin Columbia Spotted Frog: The Columbian spotted frog consists of two distinct populations: the Northern and Great Basin populations. The Refuge is believed to have a population of the Great Basin distinct population segment (DPS) of the Columbia spotted frog. The Great Basin Columbia spotted frog is designated as a Federal candidate species for listing under the Endangered Species Act. However, the geographic distribution of the Northern and Great Basin DPS Columbia spotted frogs overlap in eastern Oregon, quite possibly on the Refuge, given the available data. The Northern Columbia spotted frog is not designated as a Federal candidate species. Sporadic monitoring of spotted frogs has occurred for over two decades on the Refuge; however, refuge-wide species distribution and genetic analyses have yet to be completed. Known populations within the northwest portion of the Refuge appear to be geographically isolated from populations approximately 25 miles south within the Blitzen River watershed.

There are numerous threats to Columbia spotted frogs (e.g., habitat destruction, fragmentation and/or degradation of wetlands, non-native predatory species, fire and fire suppression, contaminants). The habitat present on the Refuge needs to be assessed to determine water for breeding, summer habitat, and winter refugia to aid in the conservation of the species. In addition, results from the assessment will assist Refuge management and biologists to understand the distribution of Columbia spotted frogs on the Refuge, help facilitate the development of an annual egg mass monitoring protocol, and identify the role the Refuge plays in Columbia spotted frog conservation.

Yellow-billed Cuckoo: The yellow-billed cuckoo has been documented on the Refuge; however, no breeding has been recorded and cuckoo observations are considered accidental. Refuge sightings account for most of the recent sightings of the yellow-billed cuckoo in Oregon (USFWS 2008b).

The primary reason for the decline of the yellow-billed cuckoo west of the Rocky Mountains is loss of tall streamside habitat. They tend to prefer trees with extensive canopies, such as cottonwood, which are not abundant on Malheur Refuge.

Greater Sage-grouse: This species is a rare user of the Refuge, but it uses public lands adjacent to the Refuge. Occasional sighting have been documented of sage-grouse watering on the East Canal during drought years. They have also occasionally been observed foraging in meadows at the northern end of the Double-O in late summer. Other uses have not been documented.

4.6 Invasive and Nuisance Species

4.6.1 Exotic and Invasive Plant Species

Invasive plant species infect and degrade many of the aquatic and terrestrial habitats on the Refuge. Some highly invasive species (e.g., pepperweed and reed canarygrass) can produce monotypic stands that completely displace native and desirable plant communities. These native communities are essential habitat that supports high-priority species and species groups on the Refuge (e.g., migratory birds). The Refuge's overall strategy to manage invasive plants is to use an IPM approach. For IPM, mechanical, physical, biological, and chemical methods are used to control invasive plants as a basis for achieving desirable habitat conditions. Many factors affect efficacy of control efforts for invasive plants. Aerial spraying is limited because treated ditches typically cannot be charged soon after applications based upon pesticide label restrictions. For species with extensive infestations throughout the Refuge (e.g., pepperweed), the Refuge's strategy involves containment to prevent spread to uninfested areas.

There are nine species of plants found adjacent to or on the Refuge (Table 4-14) which are classified by the Oregon Department of Agriculture as noxious weeds.

Table 4-14. Oregon Department of Agriculture Noxious Weeds Found on or Adjacent to Malheur Refuge

Common Name	Scientific Name
Canada thistle	*Cirsium arvense*
Diffuse knapweed	*Centaurea diffusa*
Medusahead rye	*Taeniatherum caput-medusa*
Perennial pepperweed	*Lepidium latifolium*
Puncture vine	*Tribulus terestris*
Russian knapweed	*Acroptilon repens*
Salt cedar	*Tamarix ramosissima*
Scotch thistle	*Onopordum acanthium*
Whitetop	*Cardaria draba*

The plants listed below are of the highest priority for the Refuge and are part of invasive species management.

Perennial Pepperweed: Flooding during the mid-1980s initially spread pepperweed throughout the Refuge and adjacent private lands; subsequent drought (1988-1992) exacerbated this invasive plant problem. There are approximately 30,000 acres of perennial pepperweed infestation on the Refuge, likely because the water delivery system has spread seeds throughout the system. Pepperweed represents a significant threat to the Refuge's capability to meet refuge purposes and habitat management objectives, especially those related to migratory birds. Pepperweed infests and forms monotypic stands and displaces grass/shrub uplands, wet meadows, and riparian habitat that are used by breeding waterfowl, cranes, and landbirds. Because it infests meadows, it can jeopardize the Refuge's haying program, which provides short-grass habitat used by breeding aquatic migratory birds. Pepperweed also infests and compromises fire breaks. Moreover, areas disturbed during riparian restoration may become infested with pepperweed.

Phragmites, Reed Canarygrass, and Other Undesirable Plant Species: Plants such as these are also displacing native/desirable species in marsh/meadow complexes. Based on habitat surveys, approximately 80 percent of the 60,000 wetland and meadow acres on the Refuge are infested to some degree with invasive plants. As a result, habitat quality for breeding migratory birds is declining relative to the degree of infestations.

Russian Olive: This species spread across refuge lands around Malheur and Mud lakes during the floods of the 1980s.

4.6.2 Exotic Wildlife Species

Common carp are the most invasive and detrimental wildlife species that inhabits the Refuge. Carp first invaded the Refuge in the late 1930s or early 1940s. The Silvies River provided access to Malheur Lake, and carp migrated up the Blitzen River and invaded the wetlands of the Blitzen Valley. Carp invaded the Double-O Unit during the early 1950s when the natural sand dune barrier separating Malheur and Mud lakes was breached and allowed water and carp from Malheur and Mud lakes to enter Harney Lake. By the early 1960s carp had successfully invaded virtually all aquatic systems within the Refuge and surrounding private lands. Before carp invaded the Refuge, duck production averaged over 111,000 ducks annually in the 1940s and peaked at 147,000 ducks in 1948. After the carp population became established, duck production has averaged less than 30,000 annually (Ivey et al. 1998). Carp compete directly with waterfowl and waterbirds for aquatic invertebrates and vegetation, and their benthic foraging causes a detrimental decrease in water quality.

A small population of bullfrogs has established at the south end of the Blitzen Valley. This invasive species could be a threat to the Oregon spotted frog population because of predation or habitat competition.

4.7 Wildlife and Habitat Research, Inventory, and Monitoring

The Refuge has a long history of strong biological monitoring and research. Many projects are collaborative efforts between the Refuge and other Service programs, agencies, nongovernmental organizations, and universities.

4.7.1 Monitoring

Table 4-15 summarizes surveys conducted by refuge biological staff in the late 1990s. Due to changes in staff and budget cuts, many of these surveys were discontinued in the last decade.

Table 4-15. Biological Surveys Conducted at Malheur Refuge during the Peak of Biological Monitoring in the Late 1990s

Survey Type	Survey Type
Mid-winter waterfowl survey (flight)	Migration waterfowl surveys (5 flights)
Muskrat house surveys	Raptor survey routes (4)
Read goose neck collars	Bald eagle roost counts
Use telemetry to scan for radio-marked waterfowl	Golden eagle nest survey
Crane pair survey	Water temperature monitoring (Hobotemps)
Goose pair survey	Monitor goose, duck and crane nest success
Predator survey	Neotropical migrant monitoring station (mist net; spring, fall)
Common raven roost surveys	Colonial waterbird surveys
North American migration count	Duck and waterbird pair survey

Survey Type	Survey Type
Dove coo count (2 routes)	Spotted frog surveys
Trumpeter swan production survey	Duck brood survey
Bobolink survey	Snowy plover survey
Upland habitat monitoring	Breeding bird survey routes (7)
Botulism monitoring	Aquatic plant surveys
Tule goose surveys	Fall crane use surveys
Fall crane survey for Pacific Flyway	2 Christmas bird counts (Sodhouse, P Ranch)

4.7.2 Refuge Research

Many research studies have been conducted at Malheur National Wildlife Refuge since the Refuge was established. Projects are listed below in chronological order and a complete copy is on file at Malheur Refuge library, summarized in the narratives or available as literature cited:

- Breeding Habits of the Canvasback, *Nyroca valisineria* (Wilson), on the Malheur National Wildlife Refuge (Erickson 1942).
- Relationship between Land-use Patterns and Waterfowl Production at Malheur National Wildlife Refuge, 1964 (Jarvis 1965).
- Breeding Biology of Greater Sandhill Cranes on Malheur National Wildlife Refuge, Oregon (Littlefield 1968; Littlefield and Ryder 1968).
- Color Marking of Greater Sandhill Cranes on Malheur Refuge, Oregon. The study is ongoing and was initiated by Carroll Littlefield in the late 1960s. The objective of this study is to color mark greater sandhill cranes and monitor their movements and life history. Marking these birds helps document effects of land use practices on cranes breeding at Malheur Refuge and assess their migration and wintering movements, annual productivity, and behavior.
- Land-use Patterns and Duck Production at Malheur National Wildlife Refuge (Jarvis and Harris 1971).
- Distribution and Survival of Mallards Banded at Malheur National Wildlife Refuge (Jarvis and Furniss 1978).
- Productivity of Greater Sandhill Cranes on Malheur National Wildlife Refuge, Oregon (Littlefield 1976).
- An Ecological Study of the Common Raven (*Corvus corax*) at Malheur NWR and its Effects on the Nesting Success of Selected Waterfowl (Stiehl 1976, 1985; Stiehl and Trautwein 1991).
- Factors Affecting the Ecology of Small Mammals on Malheur National Wildlife Refuge (Feldhamer 1977).
- Effects of Experimental Management Schemes on Production and Nesting Ecology of Ducks at Malheur National Wildlife Refuge (Clark 1977). This is a duck nesting ecology study.
- The Breeding Biology of an Isolated Bobolink Population in Oregon (Wittenberger 1978).
- Effects of Haying and Grazing on Duck Production in the Blitzen Valley (Unit 12) of Malheur National Wildlife Refuge, Oregon (Ivey 1979).

- Historical Review and Status of Colonial Nesting Birds on Malheur National Wildlife Refuge, Oregon (Thompson et al. 1979).
- Burning, Haying, Grazing, and Non-use of Flood Meadow Vegetation (Britton and Cornely 1980; Britton and Sneva 1979). This study evaluated management effects on wet meadows.
- Future Management of Malheur Lake Marsh: Recommendations of the Technical Advisory Committee (Summerfelt et al. 1980).
- Waterfowl Production at Malheur National Wildlife Refuge, 1942-1980 (Cornely 1982).
- History and Status of the Franklin's Gull on Malheur National Wildlife Refuge, Oregon (Littlefield and Thompson 1981).
- Malheur-Harney Lakes Basin Study, Oregon (Horton et al. 1983; Littlefield 1982; Paullin et al. 1977).
- Manipulation of Flood Meadow Vegetation and Observations on Small Mammal Populations (Cornely et al. 1983).
- Nesting History of Golden Eagles in Malheur-Harney Lakes Basin, Southeastern Oregon (Thompson et al. 1984).
- Habitat Definition of Nesting Birds in the Double-O Unit, Malheur National Wildlife Refuge (Foster 1985).
- Fire Ecology and Management in Plant Communities of Malheur National Wildlife Refuge Southeastern Oregon (Young 1986).
- Effects of Cattle Grazing on Passerine Birds Nesting in Riparian Habitat (Taylor 1986).
- A Summary of Trumpeter Swan Production on Malheur National Wildlife Refuge, Oregon (Cornely et al. 1985).
- Autumn Sandhill Crane Habitat Use in Southeast Oregon (Littlefield 1986).
- The Re-establishment of American White Pelican Nesting in the Malheur-Harney Lakes Basin, Oregon (Paullin et al. 1988).
- Effects of Land Management on Nesting Success of Sandhill Cranes in Oregon (Littlefield and Paullin 1990).
- Rough-legged Hawk Habitat Selection in Relation to Livestock Grazing on Malheur National Wildlife Refuge, Oregon (Littlefield et al. 1992).
- Nests and Eggs of Colonial Birds Nesting in Malheur Lake, Oregon, with Notes on DDE (Cornely et al. 1993).
- Population Trends of Small Mammals on Malheur Refuge, Oregon. This study was initiated in 1986 by Dr. David Kerley of Eastern Oregon State College at La Grande. The purpose is to monitor long-term trends in small mammal populations in Great Basin sagebrush and greasewood shrub communities. Field work only. No report.
- Environmental Contaminants and Reproductive Success of Waterfowl, Stilts, and Coots at Malheur Refuge. This study was initiated by Dr. Charles Henny, of Patuxent Wildlife Research Center, Pacific Northwest Field Station, to investigate levels of contaminants in eggs of selected wetland species and to determine if contaminants were impacting production in these species. Field work only. No report.
- Willow Flycatcher Reproductive Success, Population Dynamics, and Habitat Relationships. Jim Sedgwick of the National Ecology Research Center initiated this study in 1988. The study is designed to examine the extent and causes of variation in reproductive success and the survival, productivity, and habitat relationships of willow flycatchers at Malheur Refuge. Site tenacity, as related to reproductive success and habitat quality, predation, parasitism by brown-headed cowbirds, and environmental (habitat) correlates of reproductive success receive special attention. Field work only. No report.

- Recovery of Vegetation at Malheur Lake Following Extensive Flooding (Spencer 1994).
- Overview of Shorebird Abundance and Distribution in Wetlands of the Pacific Coast of the Contiguous United States. From 1990 to 1995, refuge staff participated in the Pacific Flyway project, a study coordinated by Point Reyes Bird Observatory (see Page et al. 1999). One count of Malheur, Mud, and Harney lakes was conducted each spring and fall using airboats.
- Archaeological and Geomorphic Investigations of Prehistoric Sites on Malheur Lake. This study, conducted by Intermountain Research of Silver City, Nevada, examines the relationship of archaeological sites and the geomorphic processes that have shaped the landforms on Malheur, Mud, and Harney lakes. (Raven and Elston 1992)
- A Radio-telemetry Study to Identify Sandhill Crane Colt Mortality Factors. In 1991, a radio-telemetry study was initiated by Gary Ivey to determine causes of crane colt mortality. This study continued through 1998 to provide data for better management of sandhill cranes on the Refuge. Field work only. No report.
- Breeding Biology of Eared Grebes at Malheur National Wildlife Refuge. This study was conducted by Dr. Wendy Hill of Lafayette College in Pennsylvania. She studied two eared grebe colonies, one at Boca Lake and the other near the mouth of the Blitzen River in Malheur Lake. (Hill et al. 1997).
- Use of Integrated Pest Management to Restore Meadows Infested with Perennial Pepperweed at Malheur National Wildlife Refuge (Kilbride et al. 1997).
- Roaring Springs Ranch Riparian Bird Monitoring. A study to determine occurrence and abundance of riparian-dependent songbirds was initiated by refuge biologists on Roaring Springs Ranch. The Ranch signed a cooperative agreement with the Refuge and BLM regarding grazing practices along streams on their property and adjacent Federal land. This study was designed to monitor bird species during the breeding season to note changes in bird populations as the riparian zone along these creeks recovers.
- Eastern Kingbird Study. From 2001 to 2010, Malheur Refuge has been the site of eastern kingbird studies that have shown a decline in the Malheur Refuge's kingbird population along with an increase in the population of American crows. Field work only. No report.
- Establishing Native Plants in Crested Wheatgrass Stands Using Successional Management (Fansler and Mangold 2007). Field work only. No report.
- Factors Influencing Nest Success of Greater Sandhill Cranes at Malheur National Wildlife Refuge, Oregon (Ivey and Dugger 2008)
- Geomorphic History and Current Channel Condition of the Donner und Blitzen River, Malheur National Wildlife Refuge, Oregon (Salant et al. 2010).
- Migratory Behavior and Passage of Redband Trout (*Oncorhynchus mykiss*) in the Donner und Blitzen River, Oregon (Anderson 2009).

4.8 Paleontological Resources

Paleontological resources, also known as fossils, are the remains or traces of prehistoric plant and animal life that are found in the geologic formations in which they were originally buried. At Malheur Refuge fossils are found within volcanic ash deposits on the Refuge dating from the Pleistocene epoch (2.6 million to 11,700 years ago). Fossilized remains (vertebrae) of a camel-like species have been recovered from the site. The site may also contain additional fauna and flora, but other than a cursory examination by a paleontologist from the John Fossil Beds National Monument, there has not been any scientific investigation of the site. The site has regional importance as it encompasses a period of geologic time that has not been found elsewhere in eastern Oregon.

Paleontological resources are considered to be nonrenewable, sensitive, scientific, and educational resources and are protected by the Paleontological Resource Preservation Act (P.L. 111-011 2009).

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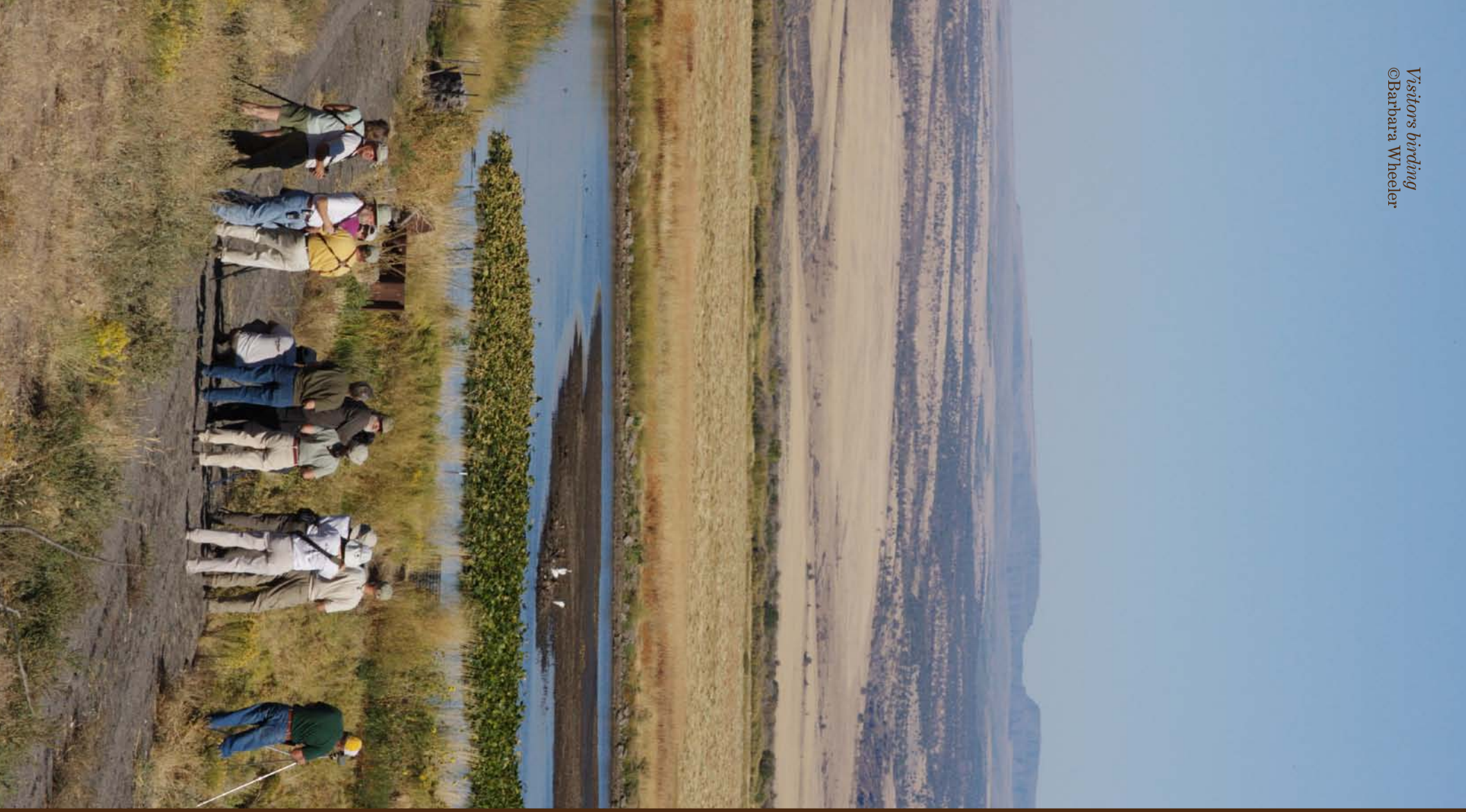

Visitors birding
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Chapter 5 Human Environment

This chapter covers topics and the current status (as of 2011) of programs associated with the human environment. This includes cultural resources and history; infrastructure and administrative facilities; and programs associated with wildlife-dependent recreational uses (the "Big Six"): wildlife observation, wildlife/nature photography, interpretation, environmental education, hunting, and fishing. Other related activities, such as non-priority uses, illegal uses, and area outdoor recreational opportunities and trends are also included. Some of the facilities and wildlife-dependent recreational uses are shown on Map 3a. Finally, the chapter also includes socioeconomic data for local, regional, and State areas.

Note that some program offerings, areas open, and facilities available will change under the alternatives proposed in Chapter 2. This chapter is a complete description of the current management situation (Alternative 1) as it stands in 2011.

5.1 Cultural Resources

Archaeological and other cultural resources are important components of our nation's heritage. The Service is committed to protecting valuable evidence of plant, animal, and human interactions with each other and the landscape over time. This may include previously recorded or undocumented historic, cultural, archaeological, and paleontological resources as well as traditional cultural properties and the historic built environment. Protection of cultural resources is legally mandated under numerous Federal laws and regulations. Foremost among these are the National Historic Preservation Act (NHPA) as amended, the Antiquities Act, the Historic Sites Act, the Archaeological Resources Protection Act (ARPA) as amended, and the Native American Graves Protection and Repatriation Act (NAGPRA). The Service's Native American Policy (1994) articulates the general principles guiding the Service's relationships with tribal governments in the conservation of fish and wildlife resources. Additionally, refuges seek to maintain a working relationship and consult on a regular basis with the tribes that are or were traditionally tied to lands and waters within refuges.

This cultural history provides an overview of the known archaeological, ethnographic, and historical uses of Malheur National Wildlife Refuge.

5.1.1 Native American Overview

General Prehistory of the Harney Basin

The profusion of wildlife and plants found in the Harney Basin provided Native Americans with an abundance of food and resources for over 11,000 years. Use of the area was greatly influenced by climatic changes, some lasting one or two centuries. In turn, these changes altered the range of plants across the basin, influencing both wildlife and human use. In particular, the archaeological record documents how cyclical fluctuations of water levels have dictated the types of resources available in the wetlands and have affected human settlement and resource-gathering patterns.

Archaeological research shows that people were using the area now managed by the Refuge by 9,800 years ago. At that time, the Harney Basin contained a huge lake that covered 255,000 acres. These early inhabitants used plants and animals found along the edge of this vast lake and in the surrounding uplands. Hunters used spears to hunt large game animals. Ground stone tools used to process plants, such as grass seeds and roots, have been found from this period, but are not abundant and suggest that plant foods were not as highly processed as in later periods. Abundant plant

resources also meant that materials used to fashion baskets were readily available. It is around this time that twined bags, mats, burden baskets, and trays begin to appear in the archaeological record of the Northern Great Basin (Adovasio 1986).

The climate then became progressively drier, lowering lake levels (Wigand 1987). The shallower lake meant that the marsh covering Malheur Lake actually increased in size and supported more plants and wildlife. Eventually the dry climate caused the marsh to shrink and then disappear, limiting the resources available to both people and wildlife. Evidence of Native American use of the immediate area decreases as the climate became drier, and the inhabitants of the area focused their activities around higher elevation springs (Fagan 1973). Stone tools show that animals continue to be hunted in the area, and there is a gradual change from the use of spears to the atlatl and dart. The atlatl consists of a piece of wood shaped with a handle on one end and a hook on the other end. It is used to hurl a light spear (dart) through the air with more accuracy than that of a hand-thrown spear.

Use of the Refuge increases around 6,000 years ago, when climatic conditions became wetter and marsh resources increased. The first documented use of the spring at Refuge Headquarters begins at this time and continues into the historic period (Aikens and Greenspan 1988; Raven and Elston 1992). Inhabitants of the Headquarters site were fishing for tui chub, suckers, and squawfish, and were hunting ducks, antelope, mountain sheep, coyote, muskrat, and bison. It is during this time period that the historical pattern of seasonal movements to resource areas becomes more apparent in the prehistoric record.

Small villages appear along the edge of the lakes, the Blitzen Valley marshes, and the Donner und Blitzen River around 3,500 years ago. These sites include either stone ring structures or house pits. Three sites excavated in the Blitzen Valley show increased use of marsh and river resources, and a stable way of life. At one of these early villages, rabbit, fish, and large game animals were being eaten; grass and juniper seeds were being harvested; and conifer and sagebrush were being used to fuel fires (Musil 1990, 1991). Unfortunately, the inhabitants of this village were forced to abandon their homes when volcanic cinders from an eruption at Diamond Craters blanketed the landscape.

Projectile point styles indicate that the bow and arrow was being used by 2,500 years ago. This new technology greatly increased a hunter's accuracy. Modifications to arrows included blunting the end so waterfowl could be hunted with the bow and arrow. Before the introduction of the bow and arrow, waterfowl hunting was limited to capturing ducks and coots in long twined nets strung across narrow areas of the marsh. Large numbers of birds could be herded into the nets in the late summer when they molted their flight feathers.

Around 1,400 years ago, the lakes and marshes shrank again as a drought hit the area (Wigand 1987). Smaller wetlands meant fewer resources for people, so they used the area less. The subsequent return of moist conditions brought an abundance of lake, marsh, and upland resources—and people. As resources increased, so did the number of sites around the lakes, in the Double-O area and in the Blitzen Valley. This may be the period of most intensive use of resources in the basin.

Geomorphic data from the Headquarters site suggests that the lake rose significantly 1,050 years ago and again flowed into the Malheur River for a short time before it shrank to its current size (Dugas 1996). This rise in lake levels forced the inhabitants of the area to move to higher ground around the lakes including shorelines created during older high lake stands. As the lake grew deeper the size of the marsh decreased when the water became too deep to support marsh plants. Conversely, as water

levels decreased, a greater abundance of marsh resources again became available for humans and wildlife.

But the cycle of wet and dry was to continue. A drought around 700 years ago and then another around 500 years ago again briefly limited the resources available to inhabitants of the basin. As conditions improved**,** people increased their use of the area, living in stone ring villages in the valley or house pits on the lakes. At the Headquarters site, a cache pit filled with seeds from wapato (Indian potato), bulrush, and goosefoot attests to the harvest of important plant foods around 400 years ago (Raven and Elston 1992). The presence of the cached seeds suggests that the site was occupied continuously for several years. Fish bones were found in two fire hearths from this time period, as well as charred sagebrush and willow.

Mat-covered shelters, known as wickiups, have been documented during this late period. In historic times these structures were used from late spring through early fall as the Northern Paiute Indians moved to different resource areas to harvest plants and animals. Of particular interest during this late occupation of the basin is the harvest of tui chub at Harney Lake, where roasting pits and garbage piles filled with thousands of fish bones have been excavated. All of similar size, the tui chub were caught in gill nets and then roasted, which preserved them for long-term storage (Raymond 1994).

Burns Paiute elders recall the continuation of a seasonal round into historic times. They talk about gathering plants, hunting, and fishing as foods became abundant in the rivers, lakes, marshlands, and uplands of the Harney Basin. Spring was a time for gathering roots and fish, which they dried and stored away. Tui chub were harvested in Harney and Malheur lakes, and salmon were procured from the Malheur River (Burns Paiute Tribe; Couture 1978; Soucie n.d.).

In the summer they traveled around their territory, gathering seeds and berries and hunting game. In the autumn, they harvested the tiny black seeds of wada (*Sueda depressa*), a plant that grows along the shores of Harney Basin lakes. (The term Wada'Tika [the Paiute name for the Burns Paiute Tribe] refers to the Paiutes living in the Harney Basin and literally means "wada eaters.") Fall was also a time for hunting waterfowl, jackrabbit, bighorn sheep, and antelope. Families came together in the fall for communal antelope and rabbit drives. Fall was also an important time for collection of plant materials to be used for manufacture of sandals, baskets, and clothing during the winter (Burns Paiute Tribe; Couture 1978; Soucie n.d.).

During the winter they retrieved their supplies of dried food and erected houses of tule (bulrush) mats near springs in the wetlands around Malheur, Mud, and Harney lakes. While the rest of their territory lay frozen, the wetlands offered fresh plants, waterfowl, and mammals to supplement their stored food (Burns Paiute Tribe; Couture 1978; Soucie n.d.).

Many of these important resources are still harvested today by the Burns Paiute Tribe at a variety of locations in the basin. Members of the Tribe continue to harvest important plants on the Refuge as they seek to sustain and share their cultural traditions of basket weaving, and tule mat and duck decoy construction with tribal youth.

5.1.2 Euro-American Overview

Fur Trapping Expedition

In 1826 French-Canadian fur trapper Peter Skene Ogden led a large expedition of trappers from the Hudson's Bay Company into the Harney Basin. The fur trappers were looking for beaver, river otter, and other fur-bearing animals. On November 1, 1826, as Ogden reached the north side of Malheur Lake, he described the lake portion of the Refuge, including the separation of Harney and Mud lakes by the large lunette dune and the salty nature of the water in both lakes. He also described in very brief detail the shrub component surrounding the lakes and mentioned the presence of bison skulls on the surface (Elliott 1909).

Ogden and his company of trappers remained on the north side of the lakes. However, had they gone to the south side of Malheur Lake, they would have found fresh water at the spring near today's Refuge Headquarters and the abundant plant and animal resources of the Blitzen Valley.

During their late fall arrival, they encountered Northern Paiute Indians camped along the shore of the lakes. The Hudson's Bay Company frequently expected local tribes to supply food for their large expedition groups. Unfortunately, the Paiutes were entering the winter season after a very unproductive summer and were unable to help the explorers with food.

On November 3, Ogden documents his company's hardships and provides a description of the Paiutes and their small villages (Elliott 1909). He also describes the hardships the Indians were enduring because of a lack of food:

> From 4 a.m. snow has fallen. This will make it difficult for my 2 express men from Ft. Vancouver to find our tracks though every precaution was taken making marks at different camps; if only the Indians do not destroy these marks. It is incredible the number of Indians in this quarter. We cannot go 10 yds. without finding them. Huts generally of grass of a size to hold 6 or 8 persons. No Indian nation so numerous as these in all North America. I include both Upper and Lower Snakes … They lead a most wandering life. An old woman camped with us the other night; and her information I have found most correct. From the severe weather last year, her people were reduced for want of food … Unfortunate creatures what privations you are doomed to endure; what an example for us at present reduced to one meal a day, how loudly and grievously we complain; when I consider the Snake sufferings compared to our own! Many a day they pass without food and without a murmur. Had they arms and ammunition they might resort to buffalo; but without this region the war tribes would soon destroy them. This country is bare of beaver to enable them to procure arms. Indian traders cannot afford to supply them free. Before this happens a wonderful change must happen. One of Mr. McKay's party was sent back to request us to raise camp and follow his tracks. A chain of lakes [most likely the springs in the Double-O area] was all they had seen, no game. Truly, gloomy are our prospects (Laut 1905).

The lack of available food and a scarcity of fur-bearing animals around the lakes led Ogden to write the name "Malheur," the French word for misfortune, on his maps of the area. From that time on, the area would be identified as Malheur Lake. Ogden mistakenly believed the lake was connected with

the Malheur River, thus providing the river with its name. It would be nearly 20 years before the next significant presence of Euro-Americans in the Basin.

Wagon Trains

The 1845 Meeks Wagon Train represented the next major entry of non-natives into the area. Convinced by Stephen Meek, who claimed that he knew a shorter route to the Willamette Valley, nearly 800 pioneers followed Meek across Oregon's high desert. As the wagon train entered the Harney Basin, their primary concerns were finding water and feed for their livestock. Water and grass had not been particularly abundant since the wagon train turned off the established Oregon Trail, and livestock were beginning to suffer. Under the direction of Meek, they arrived in the northern portion of the Harney Basin and then, in search of water, detoured south to the lakes. They camped along Malheur and Harney lakes but found that the water, because of its alkaline nature, was not fit for humans or animals. The ill-fated wagon train eventually made their way to The Dalles, but not before suffering from the deprivations of the high desert. In his diary, Eli Casey Cooley (Cooley and Cooley 2004) talks about the wagon train's entrance into the Harney Basin and their travels along the north side of the lakes to Silver Creek, where they encountered the first potable water after leaving the Silvies River.

In September 1853, the "Lost Wagon Train" led by Elijah Elliot, seeking a shorter route to the Willamette Valley, followed the route of the Meeks Wagon Train into the Harney Basin. Upon entering the Basin, Elliot decided to detour around the south side of Malheur Lake, where the group encountered marshy areas that were difficult to traverse. The wagon train forded the Blitzen River and, in doing so, left behind one of the most reliable sources of fresh water in the area. The wagon train continued around Mud and Harney lakes until they reached the springs in the Double-O area. Many members of the wagon train believed they were hopelessly lost, but riders from Central Oregon eventually located the wagon train many miles west of the Double-O area and led them to safety (Bassett et al. 1998; Gibson n.d.).

Military Expeditions

Various military expeditions ventured into the area in the late 1850s, and several military camps were established in the Harney Basin in the 1860s, including a camp near the tip of Wrights Point and another at Fort Harney. Many local landmarks received their names during these expeditions. Harney Lake received its name in 1859 in honor of General William S. Harney after he ordered an expedition through the basin in search of a reliable route to the Snake River. Steens Mountain is named after Major Enoch Steen, who led an expedition to survey a military road through the area in 1860.

Many early bird observations were recorded in military journals from these expeditions. The first published descriptions of waterfowl and wildlife in the area occurred in 1874, when Captain Charles Bendire wrote about the birds found in the vicinity of Malheur Lake (Bendire 1875-1976). Bendire made additional observations about pelican nests on islands in Malheur Lake, as well as a large cormorant colony and Western gull and Forster's tern colonies. This information would later attract feather hunters to the area and eventually bring about the establishment of the Refuge.

Ranching in the Blitzen Valley

It took 10 years after passage of the 1862 Homestead Act for settlers to arrive in the Blitzen Valley. Dr. Hugh Glenn of California took advantage of the Act to begin building a vast cattle empire in

southeastern Oregon. In 1872 he sent Peter French with 1,200 head of cattle, six vaqueros, and a cook to Oregon. French used the Act to claim 160 acres at the south end of the Blitzen Valley for his boss. Using this as headquarters for the ranch he managed for Glenn, French continued to acquire land over the next 25 years using not only the Homestead Act, but also the Swamp Land and Desert Acts. French eventually managed a ranch that encompassed more than 140,000 acres including the Blitzen, Diamond, and Catlow valleys.

Under each of the Acts, applicants were required to make "improvements" to the land for agricultural purposes; this could include improvements for livestock grazing. As a result of these stipulations, the Blitzen Valley and surrounding areas underwent a transformation from the more natural conditions attributed to pre-European contact to the highly altered landscape of today. Roads were constructed; water was directed into ditches to drain or irrigate areas; streams were impounded to control the direction and velocity of flow; meadows were hayed; and uplands were grazed.

After French's death in 1897, the ranch was managed as the French-Glenn Livestock Company until debts forced the sale of land in 1907 to Henry L. Corbett and C.E.S. Wood of Portland. They formed the Blitzen Valley Land Company under the management of area rancher William Hanley. The goal of the company was to restore the property to a successful working ranch. To accomplish this, the company needed to improve water distribution in the valley. Between 1907 and 1913, the company channelized 17½ miles of the Donner und Blitzen River to improve drainage of adjacent wetlands. They also authorized the construction of 8 miles of the Busse Ditch and 4 miles of the Stubblefield Ditch to improve distribution of water in the north end of the valley.

In 1916, the company was reorganized as the Eastern Oregon Livestock Company (EOLC). Louis Swift of the Swift Packing Company of Chicago purchased 46 percent of the company under this reorganization. The construction of a Union Pacific rail line from Ontario to Crane in 1916 made shipping livestock to market easier. Swift was interested in the thousands of feral pigs in the Blitzen Valley, as well as the cattle raised on the ranch. Under his direction the pigs were rounded up and herded to Crane, where they were loaded on stock cars and transported to his Chicago meatpacking plant.

In 1920, the company established the Blitzen River Reclamation District. Tracts of 160 acres were laid out and leased in a sharecropping arrangement. Several dairies were established on these tracts, and the EOLC used the railroad at Crane as a venue for shipping dairy products out of the county. The EOLC also established a hotel and store at Frenchglen in the mid-1920s. In 1918, an irrigation ditch was constructed from Page Springs along the west side of the valley to what is now known as Krumbo Lane. In 1928, Swift bought out Corbett's controlling shares in the company and owned the ranch until 1935 when he sold it to the U.S. Government.

Settling the South Side of Malheur Lake

Sometime after Bendire's 1874 spring ornithology visit to the south side of Malheur Lake, Peter Stenger began using the area for summer livestock grazing. He constructed a small sod structure for shelter at the location of today's Refuge Headquarters. This "sod house" provided intermittent shelter over the years and was used to describe the area from that time onward.

Eventually Peter French expanded the French-Glenn Livestock Company holdings to the south side of Malheur Lake. He established a sub-headquarters at Sod House Ranch to maintain control of land at the north end of the ranch. Continued expansion of the ranch eventually created conflicts between

homesteaders on Malheur Lake and the ranch. As the ranch expanded northward in the 1880s, more and more water was diverted from the Donner und Blitzen River via in-stream impoundments to irrigate hay meadows, and water was also being diverted along the Silvies River. This resulted in diminishing quantities of water reaching Malheur Lake and a corresponding change in the high meander line of the lake. The ranch claimed ownership of all land up to the high meander line, but with diminished lake levels the area between the former high meander line and the actual lake was undefined. Settlers claimed it was new public domain land available for settlement, but the ranch claimed it was just an extension of their original riparian claim. The State of Oregon claimed that the land belonged to them under the provisions of the Swamp Land Act.

By the late 1880s settlers were building shacks on any available high spot on this newly exposed land. They farmed and grazed the adjacent ground until water levels became too high, but eventually water levels would decrease and they were in business again. Eventually French was pressured into filing lawsuits against "squatters" on the south side of the lake by Glenn's heirs. While the lawsuits worked their way through the court system, the settlers became increasingly hostile toward French and the ranch holdings. Fences were cut and stores of winter hay were burned by angry settlers. Eventually these hostilities culminated in the death of Peter French. On December 26, 1897, French was shot by Ed Oliver, one of the homesteaders, while he was moving cattle near Sod House Ranch. Oliver was eventually acquitted of murder.

French's demise did not end the conflict. Settler Sarah Marshall won her case against the French-Glenn Livestock Company, when appeals in the case reached the U.S. Supreme Court. The Court ruled in 1901 that the lands were not part of the Company's original claim based on their riparian rights, and awarded the property to Marshall as a claim on the public domain. This decision by the Court also gave the President a legal basis for declaring unclaimed land around the lakes federal property, thus providing an opportunity for establishment of the Refuge 7 years later.

A Ranch on the West Side of Harney Lake

In 1875, the partnership of Amos W. Riley, Colonel James A. Hardin, and John Taylor established a ranch on the west side of Harney Lake. Already owners of extensive holdings in Nevada, they claimed the springs at today's Double-O Ranch, as well as the area around the outlet of Silver Creek at Harney Lake and land bordering Silver Creek, as part of their Oregon ranch. Centered on the productive springs of the Warm Springs Valley, cattle from the ranch had access to plentiful native grasses and reliable water.

The Double-O Ranch was seriously impacted in 1878 during a raid led by Bannock Indians. The ranch had been abandoned as the crew fled to Fort Harney for protection. All of the buildings at the ranch were destroyed and most of the ranch's cattle and horses were herded west to the Wagontire area where they were slaughtered. Reconstruction began immediately, and the ranch recovered to become the third largest ranch in Harney County.

In 1890, Taylor dropped out as a partner and Hardin sold his half interest in 1892 to Riley. Beginning with a mere 1,200 acres, the ranch grew to over 8,600 acres before being sold to William Hanley in 1903. Hanley combined the Double-O property with his larger Bell-A Ranch holdings, creating the second largest cattle operation in Harney County.

In 1909, irrigation ditches were constructed from the springs to various areas of the ranch. With the addition of irrigation water, the ranch grew ample amounts of winter feed for ranch livestock and for

sale to neighboring ranches. Many of these irrigation ditches are still used today to move spring water and Silver Creek water around the Double-O Unit.

When Hanley died in 1933, his wife, Clara, continued operation of the ranch. The deepening nationwide depression and the ongoing drought forced reductions in the number of cattle the land could support. Mrs. Hanley sold 14,751 acres of the Double-O area to the U.S. Government in 1941 for $116,143, and the land was added to the Refuge.

Plume Hunters

In the late 1880s, plume hunters were decimating North American bird populations in the name of fashion. The hunters were collecting breeding feathers for the hat industry, where the latest fad included wearing part or all of a bird on ladies hats. Shorebirds and colonial nesting birds suffered the most as hunters targeted large flocks, injuring birds indiscriminately and orphaning chicks. In an era when an ounce of breeding feathers was worth more than an ounce of gold, it's not surprising that plume hunters sought to make a fortune by hunting birds on Malheur Lake.

On a trip to Harney County in 1908 to photograph nesting white herons (later renamed great egrets) on Malheur Lake, wildlife photographers William L. Finley and Herman T. Bohlman learned that most of the white herons had been killed in 1898 by plume hunters (Finley 1910). After 10 years the white heron population had still not recovered.

Outraged by their observations, they presented the situation to fellow members of the Oregon Audubon Society. Facing similar circumstances at Klamath Marsh, the Society pushed for designation of both areas as wildlife refuges. As President of the Society, Finley approached President Theodore Roosevelt with the proposal. Already familiar with Finley and Bohlman because of their involvement in the establishment of Three Arch Rocks Refuge in 1907 on the Oregon Coast, Roosevelt was amenable to Finley's proposal.

The Lake Malheur Reservation was established on August 18, 1908, by executive order of President Theodore Roosevelt. Roosevelt set aside unclaimed government lands encompassed by Malheur, Mud, and Harney lakes "as a preserve and breeding ground for native birds." The newly established "Lake Malheur Reservation" was the nineteenth of 51 wildlife refuges created by Roosevelt during his tenure as president. At the time, Malheur was the third refuge in Oregon and one of only six refuges west of the Mississippi.

Managing the New Bird Reservation

Management of the new Lake Malheur Reservation was given to the Department of Agriculture's Bureau of Biological Survey. Oversight was provided by the Washington D.C. Office, but the Reservation remained unstaffed until 1911. In 1910, the Oregon Fish and Game Commission was created to oversee hunting and trapping in the state. In 1911 William L. Finley, one of the main proponents for establishing the Refuge, was appointed State Game Warden. Concerned about the continuing illegal activities on the new bird reservations, Finley appointed state game wardens to enforce the no-hunting ban and to monitor trapping activities at the Malheur and Klamath Marsh Reservations. The new game wardens were paid by the Bureau of Biological Survey, but were selected by the State Game Commission and enforced state game laws.

The drought years of the 1930s would also have a profound effect on the bird reservation. Lake levels shrank with the decrease in flows from the rivers and creeks that fed the lakes. Without a permanent fence around the bird reservation, the Refuge game warden, George Benson, was tasked with keeping adjacent land owners from using lands within the reservation for agricultural purposes. His log books and letters to his supervisors document his frustrations with the new task facing him. Resolution did not come until the Blitzen Valley was added to the bird reservation.

William L. Finley again played an integral part in the purchase of the Blitzen Valley as an addition to the reservation. Finley worked closely with J.N. "Ding" Darling, Chief of the Bureau of Biological Survey at the time, and later with Ira Gabrielson, first Director of the U.S. Fish and Wildlife Service (USFWS), to purchase the Valley. The purchase would include acquiring the water rights held by the ranch for waters flowing from Steens Mountain. Control of the river would allow the reservation to restore water to the lakes by releasing water held behind ranch dams.

The 64,717-acre Blitzen Valley portion of the Refuge was acquired from the Eastern Oregon Land and Livestock Company for $675,000 in 1935 using funds designated for national unemployment relief (e.g., the Civilian Conservation Corps [CCC]) and added to the Lake Malheur Reservation under an executive order signed by President Franklin D. Roosevelt. The order specified that the land was for use "as a refuge and breeding ground for migratory birds and other wildlife." At the same time, the name of the reserve was changed to Malheur Migratory Bird Refuge. With the addition of the Blitzen Valley, the Refuge grew to encompass 146,503 acres of habitat for native birds and other wildlife.

The Bureau of Biological Survey continued managing the Refuge, and George Benson remained the Refuge Protector. However, Refuge Superintendent Stanley Jewett was appointed to oversee all aspects of Refuge development. Jewett's first priority was to establish CCC camps on the Refuge to begin working on Refuge projects, including construction of a boundary fence around the Refuge.

In 1940, the Migratory Bird Refuge was renamed Malheur National Wildlife Refuge after the Bureau of Biological Survey was combined with the Bureau of Fisheries in 1939 to become the U.S. Fish and Wildlife Service.

Civilian Conservation Corps

The Great Depression severely impacted the country, with economic turmoil and rampant unemployment throughout the nation. In an effort to revive America, President Franklin Delano Roosevelt in 1933 created the CCC. This action would ultimately have a profound effect on Malheur Refuge.

Roosevelt's plan was to recruit thousands of unemployed young men, enroll them in a peacetime army, and send them to do battle (or to wage war) against destruction and erosion of our natural resources. This young, inexperienced, $30-a-month labor force met and exceeded all expectations. Enrollee families received $25.00 of the enrollee's monthly wage. The economic boost provided by this money was felt in cities and towns all across the nation. Between 1933 and 1942 three million young men worked on CCC projects across the United States; more than 1,000 young men would complete projects during this time at Malheur Refuge.

With the purchase of the Blitzen Valley portion of the Eastern Oregon Land and Livestock Company holdings, the Refuge became an ideal location for CCC projects (CCC 1935-1942), hosting three

CCC camps. A seasonal camp was built near today's Refuge Headquarters during the spring and summer of 1935. The first permanent camp was established at Buena Vista Station in October 1935. Large camps were located at Refuge Headquarters, Buena Vista Station, and Five Mile Lane, north of Frenchglen. A small side camp was set up at Ewing Springs on Malheur National Forest to cut timber for work projects on the Refuge. The last camp was closed in 1942 with the start of World War II. Little evidence remains of the camps, as the wood buildings associated with the camps were dismantled by the army and moved to Alaska to serve as barracks during construction of the Alaskan Highway.

In communities close to the camps, local purchases averaging about $5,000 monthly staved off the failure of many small businesses. Each of the three camps sent trucks to Burns for food and other provisions at least weekly, if not daily. This, in addition to local hires, contributed about $15,000 per month to the Harney County economy. Skilled local men were hired by the CCC and the Refuge to teach enrollees a variety of tasks including carpentry, heavy equipment operation, surveying, and concrete construction techniques. In addition to classes offered at the camps, the enrollees learned many life skills from these men in the course of their interactions and many used them to develop careers later in life. The Biological Survey, which later became the U.S. Fish and Wildlife Service, selected work projects, while the Army ran the day-to-day operations of the camps.

Construction materials could not always be purchased from local businesses, so these items were often manufactured by CCC enrollees on-site or at other locations. The stone blocks used to construct the buildings at Headquarters were quarried near Buena Vista Station, while the basalt used for the house at Buena Vista Station was transported from the Diamond Craters area. Willow stays, used for fence construction, were cut from the banks of creeks in the Blitzen Valley. Procuring these materials often meant moving equipment and enrollees closer to the needed resources.

The three CCC camps on Malheur Refuge left behind an incredible legacy of infrastructure that remains today. Initial projects undertaken by the camps included fencing over 200 miles of the Refuge boundary; some of this fence is still in use today. Cattle guards were installed at all access points to the Refuge to prevent trespass by adjacent cattle. At Refuge Headquarters, work began on construction of four stone buildings (two residences, an office, and a barn) to better manage the Refuge. The CCC also extended the telephone lines from the Narrows to Refuge Headquarters, and then on to the communities of Diamond and Frenchglen.

The telephone lines followed improved or new roads. Major portions of Highway 205 south of the Narrows were surveyed and constructed by enrollees from all three camps. This not only improved access to the camps and made transportation of materials more efficient, but also enhanced the transportation network used by Refuge neighbors. The enrollees also improved access to the community of Diamond as bridges were constructed across the Donner und Blitzen River. Along portions of the river channelized by the Eastern Oregon Land and Livestock Company in the early part of the century, enrollees used dozers to sculpt the dredge piles into a network of roads that would traverse the center of the valley. Over 35 miles of road would provide access to the center of the Refuge for better management of the newly acquired lands. Seven bridges were constructed by the CCC along this newly created Center Patrol Road.

As work progressed over the next 7 years, the CCC enrollees constructed five concrete diversion dams on the Donner und Blitzen River. Several of these dams replaced existing smaller wood structures left over from the ranching days. All five dams improved diversion of irrigation water along hundreds of miles of new or revamped irrigation ditches. Major diversion ditches, including

the Buena Vista Canal, the East and West Canals, Ram Ditch, and the Stubblefield Canal, increased the amount of water that could be diverted over a greater distance in the Blitzen Valley. Much of this water was directed to new ponds (the Buena Vista Ponds, Wrights Pond, the Knox Ponds, and Boca Lake) that were crafted from the valley floor.

As transportation improved across the Refuge, the CCC also made significant improvements elsewhere on the Refuge. Two large shop buildings and a residence were constructed at Buena Vista Station to facilitate management of the north end of the valley. At the south end of the valley, major renovations were made to Peter French's White House to improve living conditions for new Refuge employees. Existing ranch buildings at the P Ranch were modified for new Refuge uses. An addition was also added to the back of the Frenchglen Hotel, which became part of the Refuge with the purchase of the Blitzen Valley.

The improved access throughout the valley and better distribution of irrigation water led to increased public use. Four lookout towers were constructed in the last years of the CCC improvements. Two metal towers and two wood towers were placed at strategic locations across the valley for fire and wildlife observation. The most famous of these towers is the metal tower at P Ranch, which is a favorite roost for scores of turkey vultures. The CCC was also responsible for early development of camping facilities at Page Springs Campground.

As the involvement of the United States in World War II loomed, the CCC camps began closing on the Refuge. Young men who served with the CCC at Malheur enlisted in the armed forces and served across the world as the war escalated. Many of the very skilled men from the camps became civilian employees of the military and worked under contract throughout the South Pacific.

5.1.3 Current Knowledge of Local Cultural Resources

Malheur Refuge contains over 300 recorded prehistoric sites and 21 historic sites in a wide variety of habitats. Two prehistoric sites (35HA403 and 35HA1038) and three historic sites (Sod House Ranch, Double-O Ranch, and P Ranch) are listed in the National Register of Historic Places (NRHP). Generally, CCC sites and structures meet the eligibility requirements for inclusion in the NRHP, and three CCC-constructed dams (Sodhouse, Busse, and Page Springs) have been determined eligible for inclusion in the NRHP by the State Historic Preservation Office, though they have not been formally nominated. Prehistoric sites on Malheur, Mud, and Harney lakes in combination are eligible for listing as an Archaeological District in the NRHP. This is also true of prehistoric sites in the Double-O Unit and the Blitzen Valley; however, additional research and investigations would be needed to determine the full extent of their importance before nomination to the NRHP.

Cultural resource inventories began on Malheur Refuge in the early 1970s and have continued into the present. While the protocols used to conduct prehistoric site inventories have varied over the decades, even the earliest work provides important information on the types of prehistoric and historic resources that are, and may be, located on the Refuge. Prehistoric sites vary in age from 9,800 years old to just 120 years old. A variety of site types occur and range from winter villages, summer villages, rock art sites, burial sites, and quarries to small campsites and food processing locales. The locations of these sites indicate that a wide variety of resources in a broad range of habitats were being used for thousands of years by Native Americans before Euro-Americans entered the Harney Basin.

Three historic ranch sites, P Ranch, Sod House Ranch, and Double-O Ranch, provide excellent examples of early ranching (1870-1900) in the Harney Basin. The P Ranch and Sod House Ranch were part of the large French-Glenn Livestock Company holdings and are associated with ranch manager Peter French. The Double-O Ranch was owned and operated by William Hanley, and while only two buildings remain from the ranch era, many of the early ditches used to divert water for livestock grazing and hay operations are still in use today and are moving water to ponds and meadows for wildlife uses. The foundations of six homesteads can be found at various locations on the Refuge. Information is sparse about this period of history on the Refuge. The first recorded homestead claim occurred in the 1860s near Refuge Headquarters, and other claims were deeded to various landowners until the early 1900s.

The Refuge hosted three CCC camps and numerous buildings and infrastructure were constructed by enrollees between 1937 and 1942. The CCC camp sites, buildings, and selected infrastructure (bridges, rubble structures, towers, dams, etc.) are now eligible for listing in the NRHP. Benson Pond has a variety of infrastructure (bridge, rubble structure, ditches, and stone well house) that are excellent examples of CCC work, and mature trees planted by CCC, which, when combined, make the area eligible for listing in the NRHP. The exteriors of the CCC-constructed buildings at Refuge Headquarters and at Buena Vista Station are also eligible for listing. The four CCC-constructed lookout towers have been listed in the National Historic Lookout Register and are also eligible for listing in the NRHP.

5.1.4 Investigations

Archaeological Investigations

Portland State University (PSU) conducted a 3-year project involving survey and limited excavations on the Refuge between 1972 and 1974. Over the course of three summers, Refuge staff identified areas with known but unrecorded archaeological resources, and then PSU conducted surveys of these areas. Over 200 sites were recorded across the Refuge during this phase of investigation.

Headquarters Area: Prehistoric site 35HA403, the Headquarters Site, was listed in the NRHP in 1979 after initial test excavations (Benson n.d.; Thomas 1979,). Since listing, six archaeological investigations have been conducted at the site (Aikens 1983; Aikens and Greenspan 1986; Campbell n.d.; Dugas and Bullock 1994; Minor and Greenspan 1985; Minor and Toepel 1988) as mitigation for a variety of sewer, water, sprinkler, and building relocation projects. Two investigations, Thomas (1979) and Benson (n.d.), were conducted specifically for installation of the existing water system. In 1985, Aikens and Greenspan (1986) examined a series of trench profiles excavated in conjunction with the placement of a new sewer system at Refuge Headquarters, in the vicinity of the maintenance shop. They found that artifact densities increased westward from this area (Aikens and Greenspan 1986:44-45). Test excavations conducted by Intermountain Research in 1993 (Dugas and Bullock 1994) also indicate that artifact densities are higher in the central and western portions (both areas are at higher elevations) of the site. Several features were identified by Intermountain Research during their investigations in the western portion of the site. Radiocarbon dates (Dugas and Bullock 1994) from excavations at the Headquarters site show an early occupation at 4,760 years ago, another period of occupation between 1,040 and 960 years ago, and a more recent occupation around 400 years ago. The presence of storage pits and a wide range of artifacts and other cultural materials indicates intensive occupation of the site during these three time periods. Dugas and Bullock (1994:25) also documented the presence of a wave-cut scarp and beach deposits at an elevation of 4,113.77 feet, indicating a high lake level around 1,000 years ago.

Buena Vista Area: The Buena Vista Site (35HA988), a large habitation site with associated petroglyphs (35HA987), is north of the substation buildings. Ground leveling activities conducted by the CCC during construction of the station may have impacted portions of 35HA988. Auger tests performed in 1979 (Kent 1979) in advance of the installation of a new residential water cistern did not encounter subsurface cultural resources in the project area; however, sparsely distributed surface artifacts were noted at that time at the base of the hill below the residential water cistern. An Earthwatch Field School was conducted by the Service in 1997 to record the extensive petroglyph panels at 35HA987 and to map and excavate stone ring features at 35HA988.

Krumbo Area: As mandated by Section 106 of the NHPA, archaeological investigations must be conducted in advance of realty actions when lands will be transferred out of federal ownership. In 1981, an intensive survey of 1,320 acres (Buck 1981) was conducted for the proposed Krumbo Land Exchange. Sixteen prehistoric sites were identified during this survey. They consisted of low-density lithic scatters representing either hunting camps or stone tool manufacturing sites in advance of hunting expeditions; extensive lithic scatters representing multiple occupations for the purposes of large game hunting and stone tool manufacturing; and small and large sites with ground stone implements. The smaller sites represent seasonally occupied sites used for the exploitation and processing of locally available plants, while the larger sites appear to be multi-purpose areas, occupied seasonally over many years for the collection and processing of plant resources, as well as hunting. This pattern corresponds with the ethnographic pattern of seasonal exploitation of resources at various places in the Harney Basin by the Wada'tika Paiute.

Diamond Swamp Area: Surveys conducted for the 1,220-acre Proposed Dunn Land Exchange (Musil 1990, 1991; Toepel and Minor 1983) in the Diamond Swamp area identified six archaeological sites and two historic sites. Both historic sites consist of house foundations, likely dating from 1892 and 1910, and represent either homesteads or small ranches. Two sites, 35HA1261 (the Dunn Site) and 35HA1263 (the McCoy Creek Site), underwent archaeological excavations to determine NRHP eligibility and were subsequently placed in the NRHP.

The Dunn Site contains three occupation levels. The earliest may date from 7,000 to 10,000 years ago and represents a sparse deposit of artifacts. The next occupation consists of a semi-subterranean house pit dating to 3,255 years ago. The house pit included a central hearth, storage pits, and postholes along the edge of the structure. Cinders from an adjacent eruption at Diamond Craters buried the site around 3,200 years ago. The site was reoccupied between 3,000 and 500 years ago. The Dunn Site house pit is the earliest occurrence of a semi-sedentary occupation site in the Harney Basin and suggests intensification in the exploitation of resources in nearby Diamond Swamp during a period of greater effective moisture in the region.

Three cultural components were identified during excavations at the McCoy Creek Site (35HA1263) (Musil 1991). Component I at the site represents a tool manufacturing site and dates to the early Holocene. Component II is a dense artifact assemblage associated with a series of house floors. This component dates between 1,900 and 900 years ago. The presence of ground stone in this component of the site again reflects an intensification of plant resources usage from the adjacent Diamond Swamp. Bone and shell artifacts include both utilitarian and ornamental items. Aquatic and terrestrial fauna are broadly represented. This component represents a semi-sedentary, if not sedentary, village at the site. Component III, the most recent occupation at the site, consists of the floor of a wickiup structure (a conical shelter constructed from willow poles and covered with brush) dated to 480 years ago and associated artifacts. Wickiups are described in the ethnographic record for the Great Basin and at this site suggest a more mobile occupation with limited use of the site.

Eagles Nest Burn Area: Rehabilitation of lands impacted by a wild land fire in 1983 led to an intensive survey of 775 acres by Heritage Research Associates within the Eagles Nest Burn area. Fourteen sites were identified during the survey and projectile points found within the burn area indicate occupation of the area beginning as early as 7,000 years ago, with an intensification of use around 4,000 years ago.

Lakes Area: Extensive flooding of Malheur, Mud, and Harney lakes began in 1985 and continued into the early 1990s. This precipitated a series of surveys and data recovery projects on the lakes as illegal artifact collection and looting began to occur on sites. Heritage Research Associates conducted archaeological surveys in 1988 and 1989 as islands began to emerge from inundation. Twenty-eight archaeological sites were located and recorded on the Refuge during the surveys. Extensive mapping and artifact collections were conducted at each of the sites, and fourteen sites were revisited for additional artifact collections. Possible house floors and depressions were found at two sites, and a hearth with an associated activity surface was found in a cutbank at a third site. The density and variety of cultural materials at the newly exposed sites was impressive. A total of 1,940 artifacts were collected, including 593 classifiable points and 43 large obsidian biface blades. Partially exposed human burials were located and documented. The distribution of projectile points suggests that widespread occupation of the lakes may not have begun until after 4,000 years ago, and then intensified around 2,000 years ago as semi-sedentary groups focused on resources associated with the lakes and associated marsh.

Excavation and collection of the exposed human remains began in 1989 as illegal looting activities increased on the lakes. Heritage Research Associates was contracted to remove and perform analysis of the remains. All analysis was coordinated with the Burns Paiute Tribe, and only limited invasive analysis was permitted.

Intermountain Research was contracted by the Service in 1991 to undertake geomorphological and archaeological investigations at selected locations on Malheur Lake. The work was intended to establish a conceptual framework for understanding the history of human occupation in the region and to develop baseline data to determine how human use was influenced by the geomorphic and hydrologic history of Harney Basin. Backhoe trenches were excavated at the Harney Lake Dune and at two archaeological sites on Malheur Lake to recover data about the paleoenvironmental history of the area. The stratigraphic profiles of the trenches show a complex history of interbedded layers of lacustrine deposition, soil formation, and eolian deposition, often with substantial gaps between depositional episodes. While showing very ancient lacustrine deposits (120,000-130,000 years old), the trenches also revealed an intermittent record of post-Pleistocene lake stands, and at one site the occurrence of a previously unrecognized deep water stand between 7,400 and 8,400 years ago. This site also contained cultural material that accumulated around the time of this deep water episode.

In 1992, Intermountain Research returned to focus on the excavation of four sites on Malheur Lake. Their investigations showed that sites on eastern islands are younger than sites on northern islands. Differences in faunal assemblages among the four sites also seem best explained by geographical position. Rabbits were more abundant on the site located closest to the lake shore, while muskrats, coots, and fish were more abundant at sites in the lake interior.

In 1994, an Earthwatch Field School was conducted by the Service (Raymond 1994) at sites on the dunes bordering Harney Lake. The field school focused on surveying the entire face of the dune, mapping cultural resources, systematic surface collections, and later limited excavations of tui chub

roasting pit features. The excavations and subsequent radiocarbon dates showed that the sites containing roasting pits were in use around the time of contact with Euro-Americans.

Intermountain Research conducted excavations at the Stubblefield Lookout Tower Site (35HA53) in 1994 to assess the potential of the site to address research issues of cultural sequence, subsistence, seasonality, lithic technology, raw material use, and the record of geomorphic processes and environmental change. The investigations identified a geomorphic and stratigraphic sequence that began with a large paleolake phase and the deposition of beach sediments, followed by a series of soil forming intervals interspersed with lacustrine beach depositions and the accretion of dune sediments. The earliest human occupation of the site occurs around 8,000 years ago during the early Holocene in dune sediments. Two episodes of intense use of the site occurred around 4,500 years ago and again between 600-1,500 years ago when inhabitants of the site were hunting and processing plants at the site.

5.1.5 Looting of Archaeological Resources

The first documented looting of archaeological resources on the Refuge occurred in 1979, soon after the passage of the Archaeological Resources Protection Act (ARPA) of 1979, although anecdotal evidence suggests that it occurred for many years prior to passage of the Act. Refuge law enforcement records indicate an ongoing problem that escalated in the mid-1980s as water levels rose on Malheur Lake and inundated islands and uplands around the lake and expanded into Mud and Harney lakes. Vast expanses of vegetation were removed or eroded from archaeological sites, exposing artifacts, features, and human burials. The Service contracted archaeological survey and scientific collection efforts to salvage scientific data from the sites before they were illegally removed. In 1992, the Refuge hired its first full-time law enforcement officer to address this problem. This full-time presence has resulted in the conviction of a number of individuals under ARPA, but the problem continues and escalates when lake levels fluctuate and inundate archaeological sites.

5.1.6 Historic Resources

Historic sites and features on Malheur Refuge include buildings, corrals, fences, and other features at the NRHP-listed Sod House Ranch, Double-O Ranch, and P Ranch; homestead sites at Brenton Cabin, Wrights Pond, two locations on South Malheur Lake, Rock Island, and Oliver Springs; a line shack at the South Center field; four CCC-constructed lookout towers; CCC buildings at Buena Vista Station and Refuge Headquarters; three CCC camp locations (Headquarters, Buena Vista, and Five Mile); intact CCC-constructed fences; CCC infrastructure: four dams, rubble structures on Stubblefield Canal, East Canal, along the Blitzen River, a CCC-constructed bridge and stone well house at Benson Pond; and historic stands of mature trees at Benson Pond, Refuge Headquarters, Sod House Ranch and P Ranch.

Stabilization and Restoration Needs

Stabilization and restoration plans have been developed and implemented for the P Ranch Long Barn and the Sod House Ranch Long Barn. Deteriorated support posts and beams were repaired or replaced at each barn to stabilize the structures. Repairs were made to doors and gates. A cable system was installed in each barn to prevent further structural movements associated with moist soil conditions, snow loads, and prevailing winds. While the two barns are now structurally sound, minor

repairs will continue to be needed and both barns will require new roofs within the next decade to protect the structures from further decay.

The Buckaroo Bunkhouse at Sod House Ranch has also undergone stabilization and restoration work, and with only minor ongoing repairs will remain in good condition. Similar work is needed at other buildings at Sod House Ranch and at the Double-O Ranch site. The beef wheel and hay derrick at P Ranch also require stabilization and limited restoration work to preserve their integrity. Stabilization and Restoration Plans will be required prior to the initiation of repairs to these buildings.

Minimal repairs and restoration have occurred to the exteriors of the CCC-era buildings at Refuge Headquarters and Buena Vista Station. Lead paint was removed from the exteriors of the buildings at Headquarters in 2003 because of health and safety concerns. Minor structural repairs were made to exterior wood elements at the time of lead removal. Missing terra-cotta roof tiles were also replaced at this time. New casement windows, which match the look of the original CCC windows, were installed on the sunroom at the Buena Vista residence as part of these repairs. The interior wood work, walls, and ceilings at Buena Vista were also stripped of lead paint and returned to their original appearance as part of this project. Kitchen cabinets and light fixtures matching the original plans for the structure were installed to bring the structure back to its original appearance in coordination with the State Historic Preservation Office.

Aluminum and vinyl windows in the CCC-era buildings at Headquarters and Buena Vista were replaced with wood casement windows in 2010 as part of an energy efficiency project. Original CCC-constructed windows on the horse barn and old warehouse were not replaced as part of this project. Exterior doors matching originally constructed doors replaced warped wood CCC doors on several buildings. The restoration activities that have occurred on the exteriors of these CCC buildings have returned them to a condition that makes them eligible for inclusion in the NRHP.

All CCC-era buildings will require periodic maintenance and repair to maintain their historic and structural integrity. CCC-era buildings located at Refuge Headquarters include the main office building; the fire office; the old warehouse building, which houses the Law Enforcement, Archaeology, and Fisheries programs; the conference room building; and the horse barn. At Buena Vista Station, the shop building and house are of the CCC-era, as is the stone well house at Benson Pond. All buildings will require exterior painting and, in some cases, minimal structural stabilization to maintain the integrity of these historic buildings. The stone well house at Benson Pond will require a new wood shake roof and repairs to the window and door.

Historic CCC-constructed Refuge infrastructure remains at several locations on the Refuge. This includes the bridge and rubble structure at Benson Pond, several rubble structures along the East Canal and one along the channelized portion of the Blitzen River, three of the four CCC-constructed diversion dams (Sodhouse, Busse, and Page Springs dams), and the four lookout towers. Care should be taken to preserve these excellent examples of CCC construction techniques and periodic maintenance, and limited restoration and stabilization will be necessary to maintain the integrity of these structures. Mature stands of trees originally planted by the CCC at Benson Pond and Refuge Headquarters are also of importance from a historical perspective and should be preserved through careful trimming to maintain the vigor of the trees.

5.1.7 Museum Property

Archaeological investigations have generated important collections. Over 7,000 artifacts and scientific samples have been accessioned and are curated at the Museum of Natural and Cultural History at the University of Oregon in Eugene. These artifacts and samples were collected between 1970 and 1990 as the result of archaeological investigations carried out on the Refuge. An additional 4,000 artifacts are internally curated at the Refuge and are from archaeological investigations conducted after the 1980s floods and from other small projects conducted by Refuge staff.

Several items related to Peter French's management of the Blitzen Valley portion of the Refuge came into Refuge ownership when the Valley was added to the Refuge. In 1981, these items were loaned to the Harney County Historical Society (HCHS) Museum for display. They include a large safe, hall tree, five framed photos of wildlife, and possibly some other pieces of furniture. They remain in the possession of the HCHS today.

The Benson Memorial Museum at Refuge Headquarters contains an important collection of 100 taxidermy bird mounts and an egg collection that predates the use of DDT in the United States.

5.2 Refuge Facilities

5.2.1 Boundary Fences and Markers

Barbed wire fencing delineates and protects most of the Refuge's 187,756-acre boundary. Where possible, the Refuge has posted boundary signs. Portions of the Refuge where it is transected by public roads (State Highway 205, State Highway 78, Sodhouse Lane, Diamond Lane, P Lane, and Double-O Ranch Road) are fenced, with boundary signs at main entrances or on barbed wire fences delineating the Refuge boundary. The Boundary Hunt Unit is adjacent to Bureau of Land Management (BLM) land, and, because of the rugged landscape and presence of rimrock, marking the Refuge boundary is difficult or impossible, making this area difficult to manage.

5.2.2 Entrances and Access Points

There are nine year-round entrances located on the Refuge: four in the Buena Vista Unit, three in the P Ranch Unit, and two in the Double-O Unit. Five of the year-round entrances in the Buena Vista and P Ranch units are marked with large entrance signs. The eastern entrance to the Double-O unit is marked with an entrance sign.

In the three hunt units (Malheur Lake, Buena Vista, and Boundary hunt units), seasonal entrances or access points are provided. The Malheur Lake Hunt Unit has three entrances: 1) on State Highway 205 near the Narrows pull-out; 2) off State Highway 78 at Lawen, and 3) on the Saddle Butte access. The Boundary Hunt Unit is accessible from numerous points along State Highway 205; however, hunters must access the portion of the Boundary Hunt Unit located southeast of Krumbo Reservoir via the BLM's Moon Hill Road. The Buena Vista Hunt Unit can be accessed from the Center Patrol Road, Sodhouse Lane, Diamond Lane, and State Highway 205.

Fishing access points are provided in the P Ranch Unit from the Center Patrol Road and from the P Ranch along the river dike. The Bridge Creek portion of the fishing area is accessible by pedestrians on the East Canal Road and from the Center Patrol Road at Bridge Creek.

Gates are located at five entrance areas along the Center Patrol Road, three in the Buena Vista Unit and two in the P Ranch Unit. Gates have been installed to minimize impact and disturbance when road conditions are poor, yet allow Refuge staff access for maintenance purposes or wildfire suppression. A gate has also been installed at the Krumbo Reservoir entrance to allow seasonal use for anglers and visitors, and to reduce wildlife disturbance. The gate is open from the fourth Saturday of April until October 31.

5.2.3 Roads and Parking Areas

State Highway 205 bisects the Refuge at the Narrows, continues south through the Blitzen Valley, and crosses through portions of the Refuge's western boundary. Two paved county roads (Diamond Lane and Sodhouse Lane) transect east-west through the Refuge. The Refuge is also crossed by two gravel roads (the Double-O and P Lane roads); the first is maintained by the county and the second by the Refuge. All remaining roads are gravel, Service owned, and maintained by the Refuge. These include the Center Patrol Road, Buena Vista Lane, P Lane, the East Canal Road, the Headquarters road complex, and Malheur Lake access roads. All other motorways are dike tops and unimproved two tracks.

Power line corridors are generally along road rights-of-way or adjacent to them. A major 115 kV transmission line owned by Harney Electric Cooperative bisects Refuge lands at the Narrows and continues to cross portions of the western boundary of the Refuge the length of the Blitzen Valley. State and county roads crossing the Refuge have smaller capacity power lines feeding homes, ranches, irrigation wells, and Refuge facilities.

Approximately 60 miles of unpaved roads are maintained for public access on the Refuge. Most of the unpaved roads are gravel, but small sections are natural dirt surfaces. Mileages are based on the Refuge Road Inventory, and this does not include maintenance roads or dikes that are not open to public access.

There are a variety of parking areas on the Refuge. Five parking areas are routinely maintained and are located at Refuge Headquarters, Sod House Ranch, Buena Vista Overlook, Krumbo Reservoir, and P Ranch. A small parking area for four vehicles at Refuge Headquarters and the Krumbo Reservoir main parking area are paved. Both parking areas are compliant with the Americans with Disabilities Act (ADA). Most parking areas (2-3 vehicle lengths) that are not routinely maintained are associated with wildlife observation and wildlife/nature photography, hunting, and fishing programs. They are located on Center Patrol Road and P Lane, in the Malheur Lake hunt unit (three), and in the Boundary hunt unit southeast of Krumbo Reservoir (one). One vehicle pull-off that can be occupied by at least five vehicles is located on State Highway 205 at the Narrows pull-out.

5.2.4 Trails

There are 10 designated hiking trails throughout the Refuge, which provide over 20 miles for visitors to explore and learn about wildlife and the Refuge, including the nationally recognized Desert Trail.

The Refuge has a Memorandum of Understanding with the Desert Trail Association for the establishment of and maintenance of a hiking trail corridor across the Refuge. This segment of the National Desert Trail runs through the western desert areas of the United States from Canada to Mexico and connects with adjacent segments on BLM-administered areas.

Most of the trails are undeveloped spur trails (≤ 1 mile), and are signed and mapped. Refuge staff, Youth Conservation Corps (YCC), and volunteers maintain three of the 10 hiking trails. Other hiking trails at Benson Pond, Bridge Creek, P Ranch/River Trail, and East Canal are located on maintenance roads and are mowed seasonally. Others, which are not routinely maintained, include the Krumbo Reservoir fishing trail and the National Desert Trail segment.

5.2.5 Administrative Facilities

Administrative facilities located at Refuge Headquarters on the south side of Malheur Lake, 32 miles south of Burns, consist of offices, a small visitor center and gift shop, the George Benson Memorial Museum, a conference room/library, a maintenance shop, and storage areas for maintenance and fire equipment. Five of the buildings at Refuge Headquarters and two buildings at the Buena Vista substation were built by the CCC.

Other buildings located at Refuge Headquarters include public restrooms, hazardous materials storage space, fuel tanks space, and residential housing. Residential housing includes a two-bedroom house for seasonal staff, a fire bunkhouse, a three-bedroom volunteer bunkhouse, a volunteer/RV Park common room, and a laundry and shower/restroom facility.

Government-owned living quarters for Refuge staff are located at the three substations (Buena Vista, P Ranch, and Double-O units). In addition to residences, a maintenance shop, storage areas for equipment, and fuel tanks can be found at the main substation areas. Government-owned housing for the P Ranch substation is located at the South Place maintenance area. A three-bedroom volunteer bunkhouse, equipment storage areas, and fuel tanks are located at the P Ranch proper.

5.2.6 Easements and Rights-of-Way

The Refuge is either adjacent to or bisected by public roads and state highways. Existing and relocated rights-of-way for electric transmission and phone lines, gas lines, and access roads are located throughout the Refuge.

The Saddle Butte access on the north side of Malheur Lake provides access to the Malheur Lake hunt unit. This access is an easement across private property, and public access is only permitted during the state waterfowl season. The condition of the access route significantly changes from year to year due to fluctuating lake levels, making the route tenuous and maintenance of the road difficult.

5.2.7 Dikes, Irrigation, and Water Control Structures

There are hundreds of miles of earthen dikes throughout the Refuge, including water control structures that control water levels for habitat management. Wildlife observation, wildlife/nature photography, interpretation, and environmental education are secondary benefits on some of the dikes accessible to the public (East Canal Road, Bridge Creek fishing access, Brenton Cabin Road, and the River Dike Road).

5.3 Public Use Overview

5.3.1 Open and Closed Areas

The Refuge is open to the public year-round from sunrise to sunset on designated roads and trails. The Center Patrol Road, the Refuge's 42-mile auto tour route, provides the main access to the Blitzen Valley, the most frequently visited portion of the Refuge. Access to the Center Patrol Road is provided at Refuge Headquarters, at the Malheur Field Station, at Buena Vista Station and Diamond Lane, via Krumbo Lane, and at the P Ranch. The Double-O portion of the Refuge is accessed from the North Harney Lake Road and the Double-O Road from State Highway 20.

Most dikes/maintenance roads on the Refuge are closed to public access to reduce wildlife disturbance; however, the public are allowed to use the East Canal Road, the Bridge Creek fishing access, the Brenton Cabin Road, and the River Dike Road for pedestrian access for fishing.

Seasonal wildlife-dependent recreational uses are associated with the historic Sod House Ranch, and the hunting and fishing programs. Sod House Ranch is seasonally open from August 15 to October 15 for historic interpretive and wildlife-viewing purposes. It is closed the remainder of the year to meet wildlife objectives associated with the heron and cormorant rookery nesting in the cottonwood trees.

Hunting and fishing programs are open in designated areas and seasons. Malheur Lake and the Boundary hunt units follow Oregon State seasons, and the Buena Vista hunt unit opens on the third Saturday of November until the end of Oregon State pheasant season. Fishing opportunities at the south loop of the upper Blitzen River, the southern portion of East Canal, and Mud and Bridge creeks are available year-round with special regulations. Krumbo Reservoir is seasonally open to anglers and visitors from the fourth Saturday of April to October 31. Krumbo Reservoir is closed outside of the fishing season to reduce wildlife disturbance.

5.3.2 Annual Recreation Visits

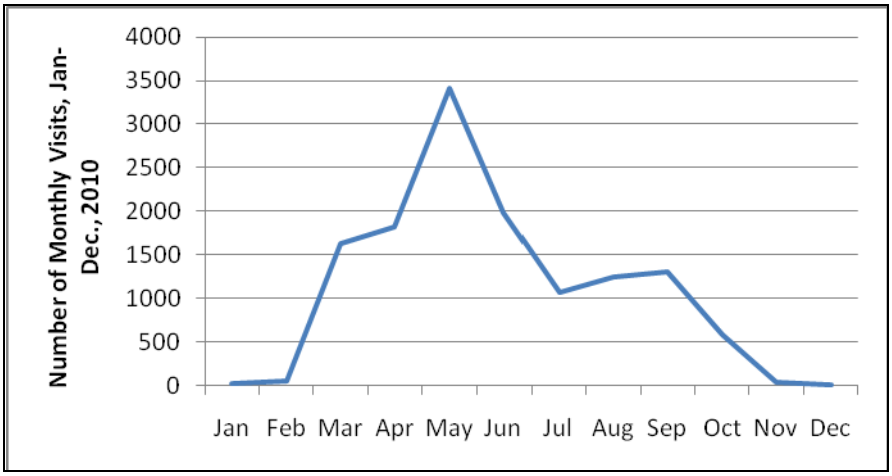
During the 12-month period starting December 1, 2009, and ending November 30, 2010, an estimated 65,600 total daily visits were made to the Refuge. This is not a sum of visits by visit category; this is an estimate of total visits to the Refuge based on door and vehicle counts at the Refuge headquarters, adjusted using mean group size and mean length of visit. Since the average visitor spends almost three days at the Refuge (see discussion below), this would translate into roughly 22,600 visitors at the Refuge per year.

Data Sources Used in Calculating Refuge Visits

During 2010-2011, the Refuge engaged in a set of integrated efforts to better estimate Refuge visitation. These included a door counter, automated vehicle counter, and vehicle counts at hunt sites. Visitor characteristics were deduced from a survey conducted by U.S. Geological Survey (USGS). Each of these sources is described below.

***Door Counter at Visitor Center*:** The Refuge maintained a door counter on one visitor center door at the Refuge headquarters for a full year (January-December 2010). Door counts during this period are shown in Figure 5-1. Door counts were not used directly because of the possibility that counts were

under-estimated or over-estimated (one count could let in multiple visitors, visitors could use different doors, etc.). However, the pattern of door count fluctuation over the year was instructive and was used in conjunction with the vehicle count sample to estimate vehicle counts by month.



Source: Refuge Headquarters door counter records.

Figure 5-1. Monthly visits recorded in Refuge Headquarters visitor center with door counter, January to December 2010.

Headquarters Road Car Counter: A car counter was placed underneath the entrance road to Refuge headquarters. Although the car counter was only operational for about two months, it provided valuable baseline data on total vehicle traffic that could be correlated with the visitor center door counts. Car counts were halved (so that entries and exits were not double counted), and adjusted to subtract staff, volunteer, and contractor entries and exits. Vehicle counts were estimated for the months in which they were not measured, by applying the pattern of Refuge door counts to the adjusted vehicle count data.

Vehicle Counts at Hunt Sites: During the 2010-2011 upland game hunt season, vehicles parked at hunting sites were counted on the opening weekend of the upland game hunt season at the Buena Vista Unit, as well as on nine other days of the hunt season. Opening weekend counts were adjusted based on the judgment of the law enforcement officer that vehicle counts were about half the "normal" activity for opening weekend.

Observation efforts at Malheur Lake Unit and Boundary Hunt Unit were insufficient to use in calculations of upland game hunt visits. Staff was consulted about the approximate number or percent of hunters thought to use these hunt areas, and these were added to the Buena Vista total for the upland game hunt visit estimate.

Waterfowl hunt visits were similarly estimated based on staff consultation rather than vehicle counts.

Visitor Characteristics: At least two studies have been made of Refuge visitors over the years. A study of the economic impact of ecotourism and the demographics of ecotourists was conducted on the Refuge from June 1993 to May 1994 (Kerlinger 1994). A total of 481 questionnaires were completed by visitors. Kerlinger examined visitor demographics (gender, age, income) and activities preferred, as well as the amount of money spent on a visit.

A similar study was completed in 2010-2011 (Sexton et al. 2011) as described above. The USGS partnered with the Refuge System in 2010-2011 to conduct a standardized national survey of visitors at 50 refuges across the country, including Malheur Refuge (Sexton et al. 2011). The goal of the survey was to provide refuge managers, planners, and visitor services specialists with reliable baseline data about refuge visitors and their experiences. Visitor opinions about their visit and various topics of interest were also gathered and analyzed. Some findings from the study are presented in Table 5-1. The full study report can be found in Appendix R of this CCP.

At Malheur, 273 visitors completed the survey for an 88 percent response rate and ±6 percent margin of error. Two different sampling periods were used; the first extended from August 28, 2010, till September 11, 2010. The second extended from May 21, 2011, until June 4, 2011. Survey data yielded valuable information on parameters of visitation, including percent of local and non-local visitors, average group size, the percent of visitors who reported having visited the visitor center, activities visitors engaged in during the previous year while visiting the Refuge, etc. These are summarized in Table 5-1.

Because the survey did not occur during hunting season, it is considered to provide limited information about hunting visitors. In addition, the spring sampling season occurred during a period of time when portions of the Refuge were inundated with unusually high water. This likely drove the percent of visitors using the Auto Tour Route down to below-normal levels.

In addition to the activities reported by Refuge visitors in the USGS survey, a study conducted in 1994 on the Refuge (Kerlinger 1994) found that the "typical" Refuge visitor is also interested in scenery; geology; hiking; and botany. As reflected in Figure 5-1, visitors engage in these activities primarily in the spring, summer, and fall; May is the busiest month of the year.

Table 5-1. 2010-2011 Survey Data: Key Parameters Used in Calculating Refuge Visits

Parameter	Result
Percent non-local visitors	96%
Percent local visitors	4%
Percent of visitors with a group	73%
Percent alone	15%
Mean group size (for those in a group)	5
Mean group size (overall)	3.9
Percent of visitors using visitor center	92%
Mean days per visit	2.9
Visitor Self-Reports: Activities Engaged in at Refuge During Previous 12 Months	
Bird watching	93%
Wildlife observation	87%
Auto tour/driving	62%
Photography	60%
Interpretation	47%

Parameter	Result
Hiking	45%
Environmental education	8%
Fishing	6%
Bicycling	4%
Non-motorized boating	3%
Migratory bird/waterfowl hunting	1%
Special event	1%

Source: Sexton et al. 2011.

Integration of Data in Calculating Current Refuge Visits

The above data sources were used in conjunction to calculate overall visits to the Refuge, per year as well as visits by activity. To calculate Refuge visits per year, the following formula was used.

Total Refuge visits per year	=	Monthly visitor vehicle counts at headquarters (empirical or estimated from door count pattern)	*	Mean group size (overall)	*	Mean days per visit	/	Percent of visitors who visit the visitor center

To calculate Refuge visit by activity, the percent of visitors reporting that they had engaged in that use was used as the primary parameter. This percent was multiplied by the total Refuge visits per year to estimate visits per year, by activity.

Upland game hunt visits were calculated by estimating visits for opening weekend and adding these to estimated mean visitor activity on weekdays and weekends, over the total season. Waterfowl hunt visits are currently estimated as 10 percent of upland game hunt visits. Table 5-2 shows the 2011 number of Refuge visits by key activity.

Table 5-2. Current Number of Refuge Visits Per Year, by Key Activity*

Activity	Current Refuge Visits (2011)
Consumptive Use	
Hunting visits: waterfowl	85
Hunting visits: upland game birds	850
Hunting visits: big game	40
Fishing visits	1,300
Non-Consumptive Use	
Pedestrian visits; hiking and walking	28,000

Activity	Current Refuge Visits (2011)
Auto tour visits	61,000
Boat trail/launch visits	400
Bicycle visits	2,600
Photography visits	52,000
Environmental education visits (non-local visitors)	6,700
Environmental education visits (local)	700
Interpretation visits	52,000
Wildlife observation visits	61,000
Commercial activities	1,000

*Visits are counted per separate visit. Each day of an extended visit is counted as a separate visit.

5.3.3 Accessibility of Recreation Sites and Programs for People with Disabilities

The Refuge provides some accessible facilities for persons with disabilities participating in programs associated with wildlife observation, wildlife/nature photography, interpretation, environmental education, and fishing. Related activities, such as welcome and orientation and the volunteer program also have limited ADA-accessible facilities.

ADA parking is provided at Refuge Headquarters and provides access to the Visitor Center and gift shop, the George Benson Memorial Museum, and public restrooms. Accessible public restroom facilities are also available at Buena Vista, Krumbo Reservoir, and the P Ranch. Other accessible opportunities include an accessible interpretive trail at the Sod House Ranch, an accessible viewing overlook at Buena Vista, and an accessible fishing pier and boat dock at Krumbo Reservoir.

At Refuge Headquarters the volunteer program provides ADA-accessible facilities at the three-bedroom volunteer bunkhouse, the volunteer RV Park common room, and the RV Park laundry and shower/restroom facilities. The fire bunkhouse is also ADA-accessible and serves as overflow housing for temporary staff and volunteers as needed.

5.3.4 Law Enforcement

One full-time law enforcement officer provides law enforcement coverage for the Refuge. Law enforcement officers from other refuges and agencies assist with patrols during periods of high visitation including the opening weekend of pheasant hunting, the opening weekend of fishing at Krumbo Reservoir, and on holiday weekends.

5.4 Wildlife-Dependent Public Uses

The National Wildlife Refuge System Improvement Act passed by Congress in 1997 identified six wildlife-dependent uses (wildlife observation and photography, interpretation and environmental

education, and hunting and fishing) as priority public uses for the National Wildlife Refuge System. These uses are explored below.

5.4.1 Wildlife Observation and Wildlife/Nature Photography

Program Offerings

The cornerstone of the public use program and one of the most popular activities on the Refuge is the wildlife observation and wildlife/nature photography program. Beginning to advanced bird watching is the most common activity under this program because of the diversity and abundance of birds (320 species) and wildlife (58 mammal species) on the Refuge. Rare and incidental bird species are common during the spring migrations and are the main focus for advanced birders. Areas preferred for viewing rare and incidental bird species include Refuge Headquarters and other historic landscapes where cottonwood trees and other non-endemic trees and shrubbery are present, such as Sod House Ranch, Benson Pond, Witzel Homestead, Barnyard Springs, and P Ranch.

Docent-led tours for wildlife observation and wildlife/nature photography occur in conjunction with the annual John Scharff Migratory Bird Festival held in April. Four to six tours are provided by the Refuge's friends group, the Malheur Wildlife Associates, or by volunteers. These tours provide 20-35 festival participants with an opportunity to learn about and experience the Refuge in greater detail. Most of the tours access areas normally closed to the public. The Refuge is also a stop for other tours led during the festival weekend by the Malheur Field Station, the Burns Llama Trailblazers, and other tour operators.

Independent visitors and groups from Audubon chapters and other organizations, such as the Malheur Field Station (see Environmental Education), also organize visits for wildlife observation and wildlife/nature photography on the Refuge, especially during the spring and fall. These informal wildlife observation and wildlife/nature photography opportunities are available on designated roads and hiking trails (see Trails) on the Refuge.

Facilities

Several facilities to assist the wildlife observation and wildlife/nature photography programs are available throughout the Refuge. Located at Refuge Headquarters, an exterior deck, an indoor telescope, and an overlook are available for visitors to view wildlife and the landscape. Another viewing overlook at Buena Vista also provides enhanced views of the surrounding landscape and improves visitor experiences. The Refuge does not have elevated viewing platforms or photography blinds.

The Refuge's 42-mile Blitzen Valley auto tour route (Center Patrol Road) has six designated sites for viewing wildlife: Refuge Headquarters, Buena Vista Ponds and Overlook, Krumbo Reservoir, Benson Pond, Knox Pond, and P Ranch. A number of vehicle pull-offs for viewing wildlife are also available at small ponds, marshes, and impoundments along the Blitzen Valley auto tour route.

5.4.2 Interpretation

Program Offerings

Interpretive features and programs are another popular activity on the Refuge. Visitors have expressed an interest in learning more about the Refuge. Key interpretive themes relevant to the Refuge include the significance of the Refuge for breeding and migratory birds; pre- and post-contact historic events; wilderness; geology; aquatic health; the importance of water; resource challenges faced by management; and the role of the National Wildlife Refuge System. Many of these themes have been emphasized as part of the Refuge's interpretive features and programs. With the use of traditional and modern media, special events, public presentations, and outdoor interpretive panels, visitors are enlightened and connected with the places and resources the Refuge protects.

A variety of interpretive brochures (e.g., the Blitzen Valley Auto Tour Route Self-Guided Interpretive Brochure) are available at the Refuge Headquarters Visitor Center and at five brochure boxes at the Buena Vista and P Ranch unit entrances.

The Refuge also maintains a website (www.fws.gov/malheur) where information about the Refuge can be obtained, including information associated with key interpretive themes, recreational opportunities, and management issues. The most visited web pages on the site are associated with wildlife viewing, recreational opportunities, hunting, and planning a visit to the Refuge, followed by links providing information about where to stay near the Refuge. The Refuge's website statistics are displayed in Figure 5-2 and Table 5-3.

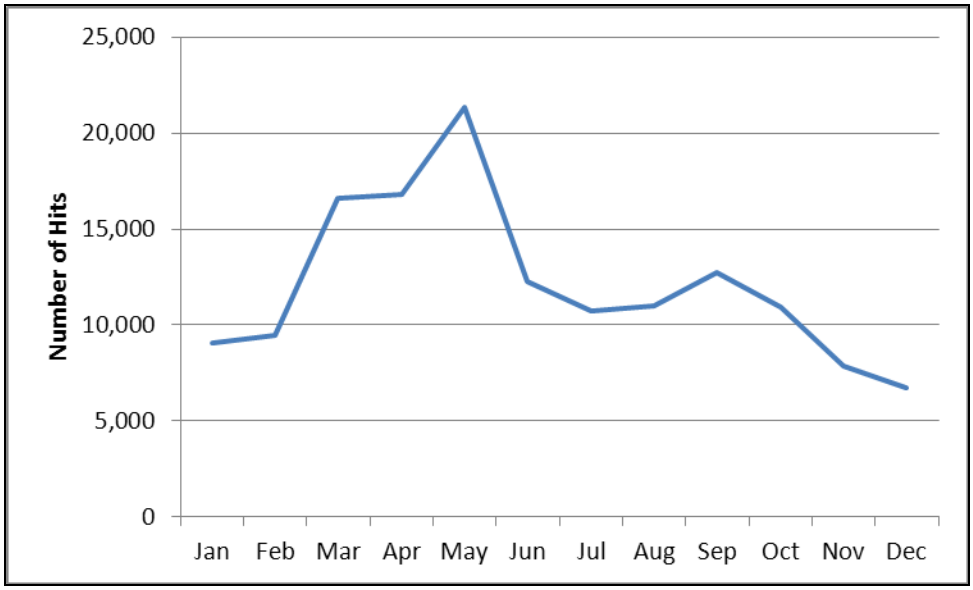


Figure 5-2. Website statistics for monthly visits to the Refuge's website, January to December 2010.

Table 5-3. Website Statistics for Most Popular Pages Viewed by Visitors, January to December 2010

	Top Page	Second Page	Third Page	Fourth Page
Jan	Wildlife	Plan Your Visit	Recreation – Main Page	Bird List
Feb	Wildlife	Recreation – Main Page	Plan Your Visit	Where to Stay
Mar	Recreation – Main Page	Plan Your Visit	Wildlife	Bird List
Apr	Plan Your Visit	Wildlife	Recreation – Main Page	Where to Stay
May	Wildlife	Plan Your Visit	Recreation – Main Page	Where to Stay
Jun	Wildlife	Recreation – Main Page	Plan Your Visit	Where to Stay
Jul	Recreation – Main Page	Wildlife	Plan Your Visit	Where to Stay
Aug	Wildlife	Plan Your Visit	Recreation – Main Page	Where to Stay
Sept	Plan Your Visit	Wildlife	Recreation – Main Page	Where to Stay
Oct	Wildlife	Recreation – Main Page	Plan Your Visit	Hunting
Nov	Hunting	Wildlife	Recreation – Main Page	Plan Your Visit
Dec	Hunting	Recreation – Main Page	Wildlife	Plan Your Visit

The Refuge is involved with and participates in four local special events on and off-Refuge: the John Scharff Migratory Bird Festival (April), Free Fishing Day (June), Invasive Carp Awareness Day and Ranching Heritage Day (August), and the Harney County Fair (September). During these events, docent-led tours (see Wildlife Observation and Wildlife/Nature Photography), booths, and educational materials that connect visitors with places and resources on the Refuge are available.

Public presentations are also given by Refuge staff and volunteers to a variety of visiting groups. Public presentations are scheduled upon request by visiting groups, and are primarily requested between April and October. Four to five staff presentations are requested each year for high school and university classes, and reach about 200 visitors.

Facilities

Refuge Headquarters is the top “wildlife experience point,” as nearly all visitors use the facilities and spend time experiencing wildlife present at the site. The small Visitor Center and gift shop is staffed by Refuge staff and volunteers and provides interpretive brochures and other information. The George Benson Memorial Museum, also located at Refuge Headquarters, aids visitors in the identification of wildlife found on the Refuge using 200 mounted bird specimens.

To enhance visitors' experiences and address key interpretive themes relevant to the Refuge, outdoor interpretive panels are provided at Refuge Headquarters and throughout the Refuge. Other outdoor interpretive panels are located at the Narrows pull-out, Sod House Ranch, the Buena Vista Overlook, the River Trail, and the P Ranch.

5.4.3 Environmental Education

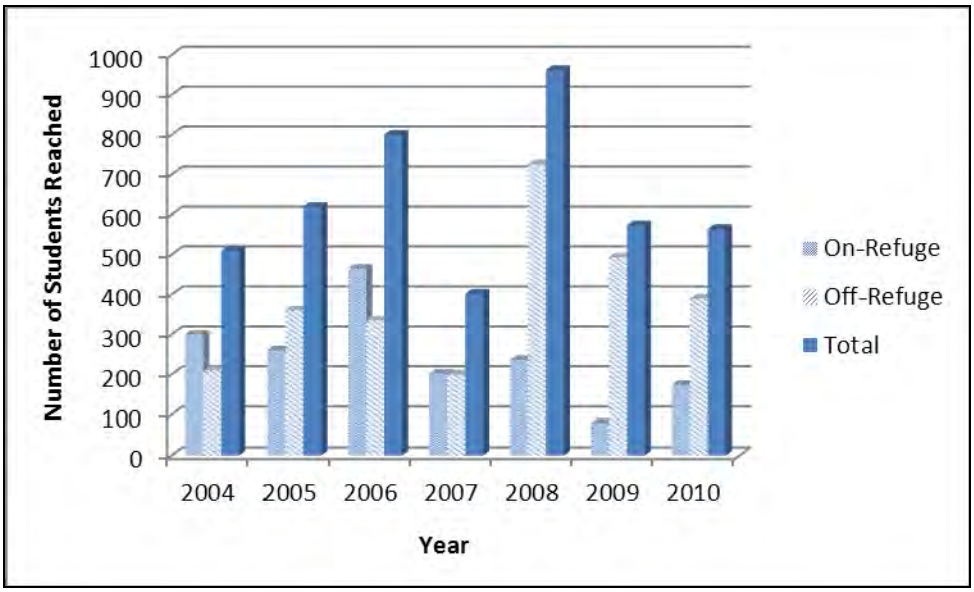
Program Offerings

The environmental education program is based on strategic use of Refuge staff and volunteer time, and Refuge resources. The small environmental education program is conducted on- and off-Refuge to promote an understanding of wildlife, habitat, and resource management objectives and issues. The environmental education program makes every effort to correlate activities with the State Educational Standards and local district curricula for elementary levels as illustrated in Table 5-4.

Table 5-4. Typical Lesson for Students in Grade 1

Subject	Goal	Content	Statement	Performance
• Life Science: Understand structure, functions, and interactions of living organisms and the environment	• Begin to identify what habitats and ecosystems are	• Describe the characteristics, structure, and function of organisms • Explain and analyze the interdependence of organisms in their natural environment	• Recognize similarities and differences between organisms • Describe the basic needs of living things • Describe a habitat and the organisms that live there	• Identify living and non-living things (Grade K-1) • Identify what living organisms need to survive (Grade K-3) • Recognize that the population of a given organism affects its habitats (Grade 1)

The environmental education program also uses existing curricula, such as that provided for International Migratory Bird Day and the Connecting Children with Nature initiative, by using hands-on learning (e.g., photography, painting/drawing). Special events, such as the annual John Scharff Migratory Bird Festival Nature and Heritage Fun Fair, "Conservation through the Arts," and Free Fishing Day, reach over 500 students. Class sizes and activities are dependent on Refuge staff, volunteer, and educator time, and transportation funding. The number of student visits on- and off-Refuge is shown in Figure 5-3.



Source: Refuge records. In 2008, the Refuge celebrated its centennial with an emphasis on reaching out to more students.

Figure 5-3. Number of student visits for environmental education, on- and off-Refuge, 2004 to 2010.

The majority of classes reached by the Refuge are local elementary classes with an emphasis on first and third grades. Visits to the Refuge and special events are primarily conducted between April and June, although the Refuge has at least one class visit at other times of the year from non-local educational organizations. In addition to the Refuge's environmental education program, the Refuge coordinates and assists with local environmental education initiatives as requested.

Malheur Field Station, operated by the non-profit Great Basin Society, has offered educational opportunities and adventures since 1971 and operates an educational and research facility on Refuge lands under a Cooperative Agreement. The facilities of the Malheur Field Station are owned and managed by the Great Basin Society. Malheur Field Station is dedicated to learning in and about the northern Great Basin and offers a variety of educational programs to individuals, families, informal groups, K-12 school groups, colleges, and universities.

Facilities

The Refuge has limited environmental education facilities. Most environmental education activities occur outdoors on the exterior deck and lawn at Refuge Headquarters. The environmental education program also uses the conference room, which can accommodate 20 students, and the George Benson Memorial Museum. Malheur Field Station accommodations include a variety of lodging options, a natural history museum, and classrooms.

5.4.4 Upland Game Hunting

Areas currently open to upland game hunting are described below.

Malheur Lake Hunt Unit

This area consists of 18,000 acres on the north side of Malheur Lake. It is open during the Oregon State pheasant season and according to limits set by the state.

Buena Vista Hunt Unit

This area consists of 22,000 acres in the Buena Vista Unit. It is open from the third Saturday of November to the end of the Oregon State pheasant season and according to limits set by the state. The opening date has been designed to minimize conflicts with fall-staging sandhill cranes.

Upland game in the Buena Vista hunt unit is one of the Refuge's most popular hunts. Ring-necked pheasants, an introduced species, provide quality hunting opportunities on the Refuge; opportunities off-Refuge in the surrounding area are limited. The Refuge has no maintenance or production objectives for exotic species, and pheasants are not stocked.

Boundary Hunt Unit

This area includes Refuge lands located on the west side of State Highway 205 and several small tracts of Refuge lands southeast of Krumbo Reservoir in the vicinity of Krumbo Creek. This area is open during the Oregon State pheasant season and according to limits and regulations set by the State.

Facilities

No facilities are maintained or managed expressly for this program. The Saddle Butte access road, four parking areas, and various vehicle pull-offs (see Infrastructure and Administrative Facilities) are used during the hunting season on the Refuge.

5.4.5 Waterfowl Hunting

Areas currently open to waterfowl hunting are described below.

Malheur Lake Hunt Unit

Eighteen thousand acres on the north side of Malheur Lake are open during the Oregon State waterfowl season and according to limits set by the State. Seasonal closures can occur to protect waterfowl populations when water levels drop and the lake acreage falls below 10,000 acres. Non-motorized or electric boats are permitted during the hunt season.

Invasive carp have become successfully established in Malheur Lake and in the Blitzen and Silvies river systems. Their feeding behavior has eliminated or severely reduced an important waterfowl food source (sago pondweed), and as a result waterfowl use on Malheur Lake has been reduced. The Refuge's waterfowl hunt is perceived as being of poor quality.

Boundary Hunt Unit

The area west of Highway 205 and the Krumbo Creek area are open during Oregon State waterfowl season, according to the limits and regulations set by the State.

Facilities

No facilities are maintained or managed expressly for this program. Saddle Butte access road, four parking areas, and various vehicle pull-offs (see Infrastructure and Administrative Facilities) are used during the hunting season on the Refuge. Temporary hunting blinds may be constructed, but must be removed daily.

5.4.6 Other Hunting

In addition to upland game and waterfowl hunts, the Boundary Hunt Unit is open to deer, pronghorn, coyote, and rabbit hunting. This unit, west of Highway 205 and the Krumbo Creek area, is open during the Oregon State seasons and according to limits set by the State. The Boundary Hunt Unit is adjacent to BLM land, and, because of the rugged landscape and presence of rimrock, marking the Refuge boundary is difficult or impossible, making this area difficult to manage. Hunters may take all State-allowed species.

Facilities

No facilities are maintained or managed expressly for this program. Hunters access this area via State Highway 205 or via BLM-administered roads.

5.4.7 Fishing Program

Areas currently open to fishing are described below.

South Fishing Loop

Located in the south part of the Blitzen Valley, this area includes the Blitzen River from below the Page Springs Dam to the confluence of Bridge Creek with the River, the southern portion of East Canal to Bridge Creek, and Mud and Bridge creeks. The loop is open year-round to pedestrian access. This fishery has special trout regulations per the State of Oregon.

The south fishing loop is a popular fly-fishing area for native redband and naturalized rainbow trout, and fishing is typically desirable when sediment in the water coming from Steens Mountain settles and the water column becomes clear.

Krumbo Reservoir

The Krumbo Reservoir is open from the fourth Saturday of April until October 31 for drive-in access. Non-motorized or electric boats are permitted during the fishing season. Closure for the remainder of the year eliminates conflicts with management objectives by limiting wildlife disturbances.

The Krumbo Reservoir fishery was established in 1959 as a two-story fishery consisting of largemouth bass and rainbow trout. Triploid rainbow trout are stocked twice a year by the Oregon Department of Fish and Wildlife (ODFW). The Reservoir provides a reliable fishing opportunity in Harney County and is perceived as a quality fishing opportunity by the local community and out-of-area anglers. On average, 12- to 24-inch rainbow trout are caught, and anglers are known to be successful. As is typical of desert lakes, fishing is best in spring and fall when the weather and water are cool.

Facilities

South fishing loop: No facilities are maintained or managed expressly for this program. A public restroom and parking are available at P Ranch. Walk-in access is via East Canal Road to the convergence of Bridge Creek with the East Canal, and along the River and Bridge Creek trails.

Krumbo Reservoir: One ADA-accessible fishing pier, a concrete boat ramp, two vault toilets, a floating boat dock, one paved and one gravel parking lot, and two covered picnic tables are located at the Reservoir. The launch and parking area has capacity for 24 boat trailer parking spaces, one ADA-accessible boat trailer parking space, nine single parking spaces, and one single ADA-accessible parking space.

5.5 Other Refuge Uses

5.5.1 Hiking, Horseback Riding, Bicycling, and Cross-Country Skiing

Hiking occurs regularly on the Refuge trails identified in Section 5.2.4. Horseback riding, bicycling, and cross-country skiing occur infrequently. These activities are currently allowed only on Refuge roads open to vehicular traffic.

5.5.2 Commercial Public Use

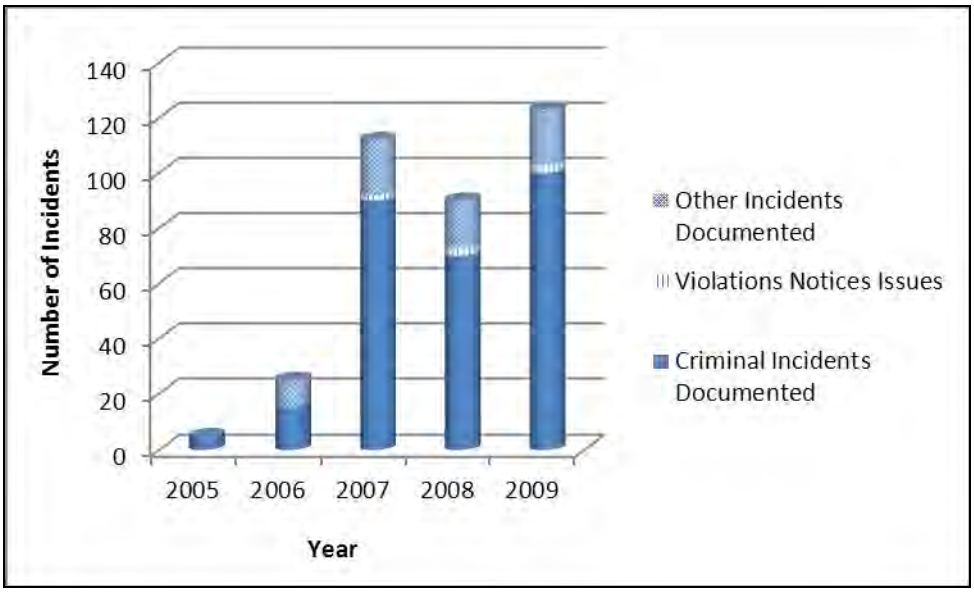
Commercial public uses include those activities where monetary gain is realized through recreational activities. These uses occur occasionally on the Refuge and include commercial photography and commercial guided tours and trail ride operations. These activities are generally limited to portions of the Refuge already open to the public, such as designated roads, trails, and hunting and fishing areas. The scale of commercial activities conducted each year on the Refuge is currently unknown. Commercial outfitters are required to obtain a special use permit, but the Refuge has been unable to enforce this provision because of the large size of the Refuge and multiple access points.

5.5.3 All-Terrain Vehicles

All-terrain vehicle use occurs infrequently on the Refuge. This activity is limited to designated roads open to vehicle traffic. The operator must have a valid driver’s license and possess a valid Oregon all-terrain sticker, and the all-terrain vehicle must have a muffler and brake lights.

5.6 Illegal Uses

The Refuge has been affected by wildlife poaching, off-road vehicle use, trespassing cattle, looting of archaeological sites, and fishing and hunting violations. Target shooting and vandalism of entrance, boundary, and directional signs is also a problem. Over 1,300 law enforcement field hours were documented in the 2009 RAPP Station Report. Cooperative relationships with other law enforcement organizations have improved the effectiveness of law enforcement on the Refuge. Violations, criminal incidents, and other incidents are shown in Figure 5-4.



Source: Refuge records.

Figure 5-4. Violation and incidents documented, 2005 to 2009 RAPP Station Report.

5.7 Area Outdoor Recreational Opportunities and Trends

5.7.1 Nearby Recreational Opportunities

The BLM manages about 60 percent of the lands within the county, and the USFS manages an additional 20 percent. Forests in the northern part of the county, the Refuge in the middle of the county, Steens Mountain and the associated Steens Mountain Wilderness Area (SMWA) to the south, Diamond Craters Outstanding Natural Area, several wild and scenic river (WSR) segments (e.g., the Donner und Blitzen WSR), and several scenic byway tour routes provide a wide variety of recreational opportunities for the county's residents and visiting recreationists.

Recreational opportunities and activities include hunting, fishing, camping, picnicking, wildlife/landscape viewing, geological sightseeing, horseback riding, biking, cross-country skiing, snowmobiling, high-altitude running, historic buildings, and hot springs. Over 300 species of birds migrate through the county each spring and their importance is acknowledged with the annual John Scharff Migratory Bird Festival, held in April. In addition, Harney County is known for having some of the lowest levels of ambient light in the nation, which provides excellent star-gazing opportunities (Harney County Chamber of Commerce [HCCC] 2010).

The Steens Mountain Cooperative Management and Protection Area, managed by BLM, draws an estimated 44,000 visitors to the area each year. Popular activities include camping, picnicking, sightseeing, and exploring the open country on foot and horseback. Bicycling, fishing, and hunting are also popular. Cross-country skiing, snowshoeing, and limited snowmobiling are winter favorites. Some activities within the Cooperative Management and Protection Area, such as motorized access for winter recreation and organized group functions, may require a special use permit from BLM.

BLM provides a popular campground at Page Springs along the boundary of the southern part of the Refuge, as well as dry camping on lands adjacent to the Refuge. Several local businesses provide camping and lodging near the Refuge.

In addition to the recreational activities mentioned above, a private hunt club is located adjacent to the Refuge, and private outfitters/guides offer opportunities for personalized tours or other activities. ODFW also manages a hunter access program on private lands adjacent to the Refuge that is open according to state regulations for hunting and fishing.

5.7.2 Regional and State Recreation Factors and Trends

Oregon Parks and Recreation Department (OPRD) began an Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP) planning process in September 2005 (OPRD 2008). OPRD has taken a more proactive approach in addressing a limited number of previously identified and defined issues. Key findings from the 2003-2007 SCORP and the 2005-2014 statewide trails planning efforts identified a number of important demographic and social changes facing outdoor recreation providers in the coming years, including:

- Rapidly aging Oregon population
- Fewer Oregon youth learning outdoor skills
- Increasingly diverse Oregon population
- Oregon's physical activity crisis

Following completion of the research studies, key recommendations were divided into two categories: statewide recommendations and local recommendations. Statewide recommendations are relevant for all recreation providers across the State of Oregon as described in Table 5-5. Local recommendations apply to those high-priorities counties and/or cities identified in SCORP research projects.

Table 5-5. 2008-2012 Oregon SCORP Statewide Recommendations

Rapidly Aging Oregon Population	Fewer Oregon Youth Learning Outdoor Skills	Increasingly Diverse Oregon Population	Oregon's Physical Activity Crisis
• Develop a trails website to facilitate recreational trail use • Develop a marketing plan to encourage outdoor recreation participation of baby boomers • Create an interagency	• Develop a youth outdoor programming framework and funding source to focus youth programming efforts toward set key objectives • Develop a menu of after-school programs that are linked to current education standards and key	• Encourage organizational cultural change within public recreation agencies and organizations to effectively address the diversity issue • Create a pilot project to identify how to increase under-represented population access	• Develop a marketing plan to encourage Oregonians to become physically active by using park and recreation facilities and services • Develop and institutionalize the statewide trails website and add information about physical activity–related recreation programs and facilities following completion of the recreational trails work • Work with medical community to get outdoor recreation

Rapidly Aging Oregon Population	Fewer Oregon Youth Learning Outdoor Skills	Increasingly Diverse Oregon Population	Oregon's Physical Activity Crisis
volunteer information website or other communications medium to match boomer volunteers with recreation or natural resource projects • Facilitate the development of local senior walking clubs • Identify ways to fund accessible trails in remote settings	objectives in the youth outdoor programming framework • Develop a "Let's Go Camping" marketing campaign targeting adults with children to get parents outdoors with their children • Create a new Outdoor Recreation Section within the Oregon Recreation and Park Association	to outdoor sports fields • Develop recommendations for addressing language barriers to encourage under-represented populations' use of outdoor recreation facilities and programs • Create a customer service training module related to serving the outdoor recreation needs of an increasingly diverse population	participation information into medical offices and physician referrals • Identify ways to fund recreation maintenance and facility development on school grounds • Develop a strategy to strengthen the role of parks and recreation agencies in the state's Safe Routes to Schools grant program • Create a pilot program to identify how to increase under-represented populations' access to outdoor sports fields • Identify ways to fund and maintain bicycle trails on Oregon Department of Transportation rights-of-way

5.8 Social/Economic Environment

Much of the socioeconomic data presented in this chapter is derived from data compiled for the 2010 North Steens 230-kV Transmission Line Project Draft Environmental Impact Statement (TLDEIS) prepared by the Burns District BLM (BLM 2010). A portion of that project includes Malheur Refuge, making information contained in the TLDEIS relevant to this CCP.

5.8.1 Environmental Justice

In February 1994, President Clinton issued Executive Order 12898, requiring that all Federal agencies seek to achieve environmental justice by "identifying and addressing … disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations." Environmental justice is defined as the "fair treatment for people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies."

Additional guidance from the President's Council on Environmental Quality (CEQ) clarifies that environmental justice concerns may arise from effects on the natural and physical environment that produce human health or ecological outcomes, or from adverse social or economic changes.

The evaluation of environmental justice issues is mandated and regulated at the Federal level, and compliance with the National Environmental Policy Act (NEPA) requires analysis of environmental justice effects. As such, environmental justice is considered part of the NEPA process.

The key social and economic parameters addressed here are race/ethnicity and measures of social and economic well-being, including per capita income, poverty rates, and unemployment rates. Each of these is addressed in the sections below.

5.8.2 Regional Economic Setting

Malheur Refuge is located in southeastern corner of Oregon in Harney County. Towns located near the Refuge include the agricultural communities of Diamond (15 miles distant), Frenchglen (immediately adjacent), and Crane (40 miles distant), and Burns/Hines (35 miles distant).

The economics of the area are evenly divided between private industry (livestock production, tourism, retail, transportation, etc.) and government (federal, state, and local) employment.

5.8.3 Population and Income

Population

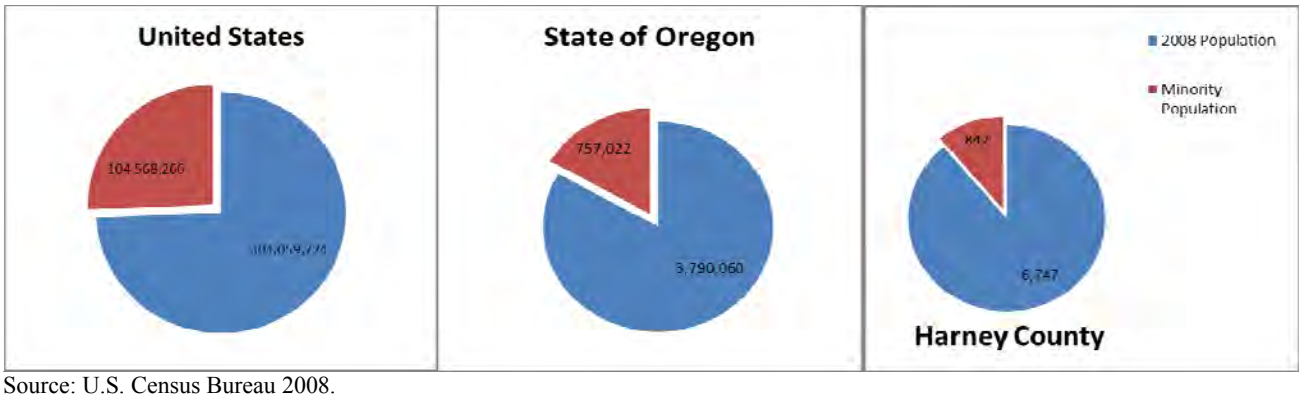
Table 5-6 shows the population estimates and past trends for Harney County, as well as the Burns and Hines communities. As shown in Table 5-6, the 2010 population of Harney County accounts for only a fraction of a percent of the population of Oregon. The two cities of Burns and Hines house the majority of the county's population.

Table 5-6. Local and Regional Population Estimates and Characteristics

	Residents	Persons per Square Mile	Population Percent Change 2000-2010
State of Oregon	3,831,074	40	12%
Harney County	7,422	>1	−2.5%
Principal towns near Refuge			
Burns	2,806	N/A	
Hines	1,563	N/A	

Source: U.S. Census Bureau 2011.

Minority Populations: Figure 5-5 presents relative population and minority percentages for the county, state, and nation based on 2008 population estimates by the U.S. Census Bureau. In 2008, Harney County's minority population was 842 residents and represented 12 percent of the total population. The Harney County minority population continued to reflect relatively fewer minority residents compared to Oregon, which was comprised of 20 percent minorities in 2008, and the United States, comprised of 34 percent minorities in 2008.



Source: U.S. Census Bureau 2008.
Notes: Minority is defined as Black and African American, American Indian and Alaskan Native, Asian, Native Hawaiian and Other Pacific Islander, Hispanic/Latino, or any person of two or more races.

Figure 5-5. Regional minority composition.

Personal Income

Median Family Income: The U.S. Department of Housing and Urban Development defines low income as less than 80 percent of the median family income for the area, subject to adjustment for areas with unusually high or low incomes or housing costs.

The median household income documented in 2007 for Oregon was $35,143, whereas the median household income for Harney County was $28,238, which is approximately 80 percent of the statewide level.

Per Capita Income: As presented in Table 5-7, per capita income in Harney County is about $7,000 less than that in Oregon and $10,000 less than that in the United States. This low per capita income indicates the presence of low-paying employment opportunities in the county.

The annualized rate at which per capita income grew between 2001 and 2007 within the county (5%) is greater than the state or national rate of 3.9 percent and 4.4 percent, respectively (U.S. Bureau of Economic Analysis 2009). A low per capita income in a community indicates the presence of low-paying employment opportunities.

Table 5-7. Per Capita Personal Income

	2001	2007	Annualized Rate of Change (%)
Harney County	21,706	28,238	5.0%
Oregon	28,530	35,143	3.9%
United States	30,582	38,615	4.4%

Source: U.S. Bureau of Economic Analysis 2009.

Poverty Rates: Poverty rates represent the percentage of an area's total population living at or below the poverty threshold established by the U.S. Census Bureau. Based on 2000 Census data, the poverty rate was 11.8 percent in Harney County and 11.6 percent in the State of Oregon (13.4

percent based on 2008 estimates). According to the 2000 Census, the poverty rate for children aged 17 years or less in Harney County was 12.9 percent (Table 5-8).

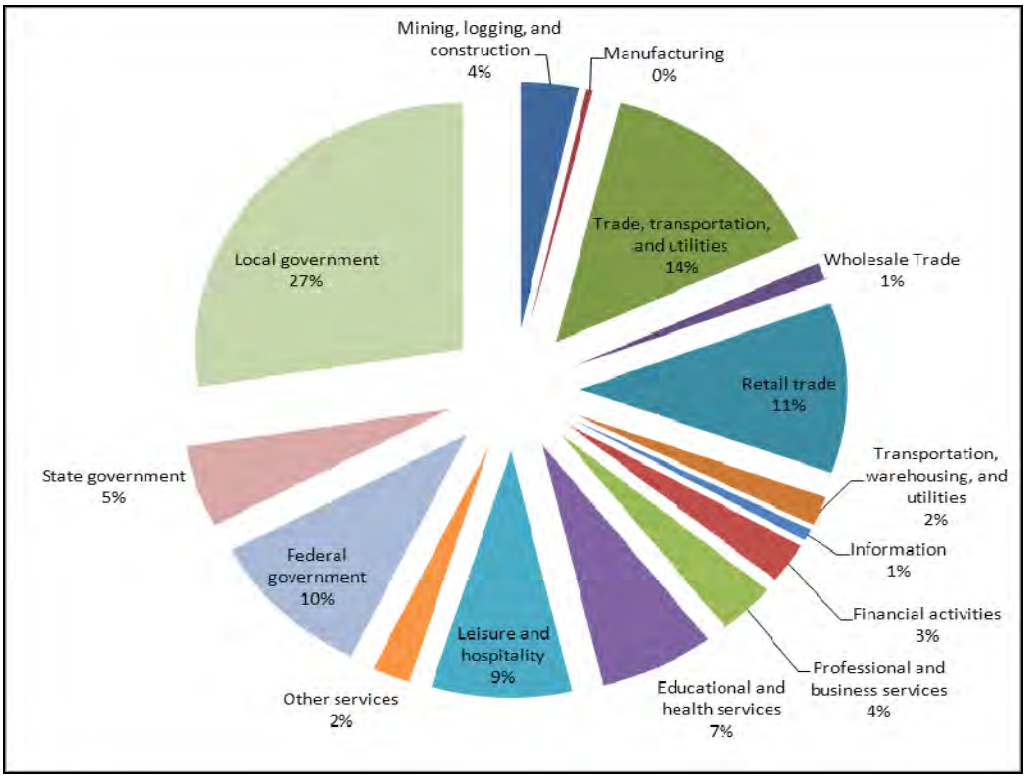
Table 5-8. Poverty Rates at Local, County, and State Scales

Area	Per Capita Income	Median Household Income	Poverty Rate	Child Poverty Rate	% Difference in Poverty Rate Compared to Harney County	% Difference in Child Poverty Rate Compared to Harney County
Burns City	$20,756	$34,105	12.3%	8.7%	4.2%	−32.5%
Hines City	$20,192	$52,347	9.9%	10.7%	−16.0%	−16.9%
Harney County	$20,673 ($21,706 in 2001) ($28,238 in 2007)	$39,605	11.8%	12.9%	0.0%	0.0%
State of Oregon	$26,789 ($28,530 in 2001) ($35,143 in 2007)	$52,346 ($49,863 in 2008)	11.6% (13.4% in 2008)	14.7%	−1.4%	14.0%

Sources: Unless otherwise stated, the source of data presented in this table is the 2000 Population and Housing Census (U.S. Census Bureau 2000a, 2000b, 2000c). For the sake of consistency, all dollar values in this table are converted to 2009 dollars, such as the values for per capita income and median household income.
Other sources: U.S. Bureau of Economic Analysis 2009; U.S. Census Bureau 2009.

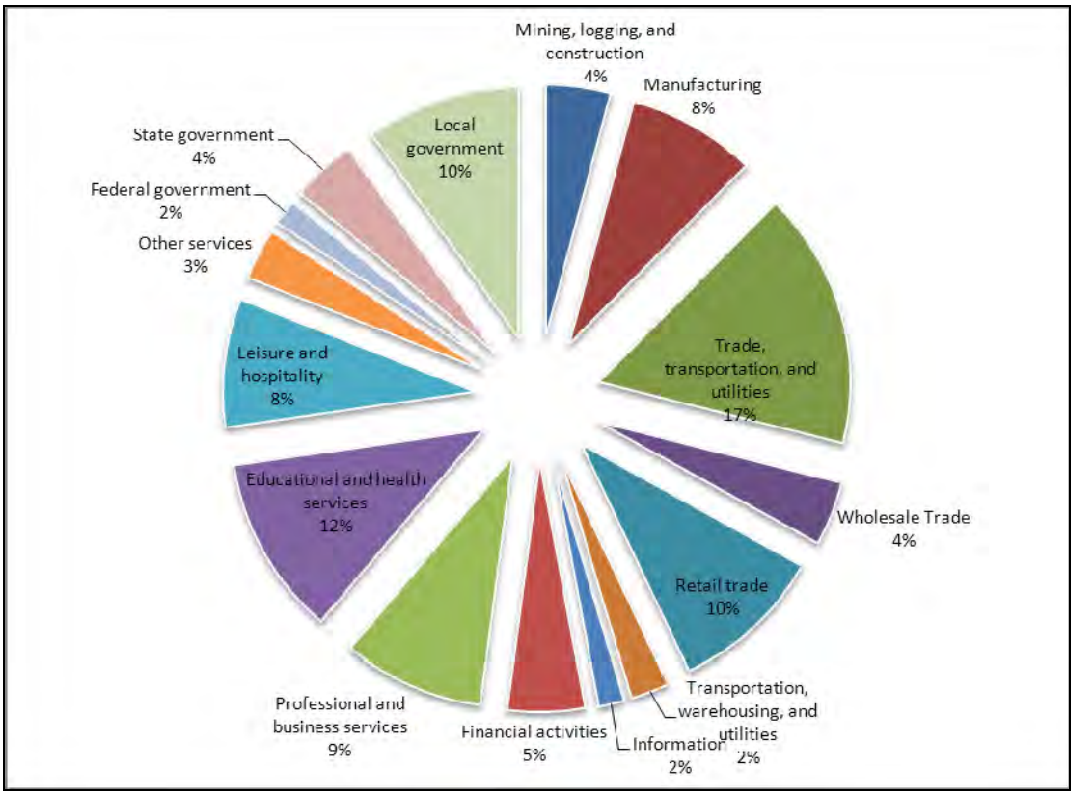
5.8.4 Employment and Business

Jobs by Industry and Sector: Industry-specific employment information provides an important insight into the makeup of a regional economy. Total nonfarm employment in Harney County was 2,220 jobs in November 2009 (Oregon Employment Department 2009). Nonfarm employment in the county is evenly divided between private employment (50 percent) and government employment (50 percent). Comparatively, private employment constitutes 81 percent of Oregon's nonfarm employment, with government accounting for only 19 percent of Oregon's nonfarm employment. The industrial category employing the most people in Harney County is local government with 32 percent of the workforce, compared with only 12 percent statewide. The trade, transportation, and utilities industry is the largest private employer in Harney County with 370 employees constituting 17 percent of the employment countywide. Figures 5-6 and 5-7 show the relative contributions of each industry to total employment for Harney County and the State of Oregon, respectively.



Source: Oregon Employment Department 2009.

Figure 5-6. State of Oregon non-farm employment.



Source: Oregon Employment Department 2009.

Figure 5-7. State of Oregon nonfarm employment.

Job Trends: Statewide, a 25 percent decrease occurred in the manufacturing industry, though at a significantly lower rate than in Harney County (96 percent) (Oregon Employment Department website). Other industries experiencing significant losses or gains are presented in Table 5-9 below.

Table 5-9. Nonfarm Employment Trends by Industry, 2001 to November 2009

	Harney County			Oregon		
	2001	**Nov 2009**	**% Change**	**2001**	**Nov 2009**	**% Change**
Total nonfarm employment	2,580	2,220	−14%	1,605,500	1,626,800	1%
Total private	1,380	1,110	−20%	1,323,700	1,321,500	0%
Mining, logging, and construction	90	90	0%	89,800	83,300	−7%
Manufacturing	240	10	−96%	215,700	162,800	−25%
Trade, transportation, and utilities	430	370	−14%	320,800	320,100	0%
Wholesale trade	30	30	0%	74,800	75,300	1%
Retail trade	340	290	−15%	189,200	190,900	1%
Transportation, warehousing,	50	50	0%	56,800	53,900	−5%

	Harney County			Oregon		
	2001	Nov 2009	% Change	2001	Nov 2009	% Change
and utilities						
Information	40	20	−50%	39,900	34,700	−13%
Financial activities	70	70	0%	95,200	93,200	−2%
Professional and business services	70	90	29%	177,100	180,600	2%
Educational and health services	160	180	13%	178,800	229,200	28%
Leisure and hospitality	230	220	−4%	149,600	160,300	7%
Other services	50	60	20%	56,700	57,300	1%
Government	1,200	1,110	−8%	281,800	305,300	8%
Federal government	260	260	0%	30,000	29,000	−3%
State government	160	140	−13%	72,500	79,900	10%
Local government	770	710	−8%	179,400	196,400	9%

Source: Oregon Employment Department 2009.

In addition to a changing industry profile, Harney County has faced a reduction in jobs. Between 2001 and November 2009, 360 jobs were lost in Harney County, a decrease of 14 percent. In comparison, the number of state jobs increased by 1 percent, or 21,300 employees, over the same time period (Oregon Employment Department 2009).

Although not classified as a separate industry, there are numerous businesses in the retail and services sectors in Harney County that serve the tourism and recreation economy. In particular, the accommodation and food services, and the arts, entertainment, and recreation sectors are supported by the spending of recreation visitors. As indicated in Table 5-10, the Oregon Employment Department does not report the individual total employment in these industries, instead presenting the combined data for these two industries. In November 2009, an estimated 220 employees were employed in the Harney County leisure and hospitality sectors. Employment in these sectors has remained fairly constant in the county, fluctuating between 220 and 260 employees since 2001. Tourism is also important to the Harney County economy.

Earnings by Industry: Federal non-military government employment accounts for the highest per employee earnings of any industry in Harney County with an average earning of $85,141 per industry employee (earnings include wage and salary disbursements, supplements to wages and salaries, and proprietors' income) (U.S. Bureau of Economic Analysis 2009). This figure trails State and national per employee earnings for the industry by $8,423 and $13,703, respectively. With the average State/local government employee earning $43,552 in the county, the industry is the second highest earning industry per employee. The county employee earnings in state and local government also trail the state and national earnings. Detailed information on employee earnings by industry is presented in Table 5-10.

Employees residing in Harney County earn less than similar employees in every industry elsewhere in the state or nation. The differences can be substantial, ranging up to $55,771 for finance workers. State and local government is the greatest employer in the county and accounts for the greatest total employee earnings of any industrial category in the county. Due to undisclosed data at the county level, it is impossible to compare employee earnings by industry across the county, state, and national levels in all industries in 2007. At the state and national level, the highest employee earnings are in the utilities industry, with average earnings of $141,268 per employee and $157,166 per employee, respectively. Employment and earnings in the utilities industry are not disclosed at the county level (U.S. Bureau of Economic Analysis 2009).

Table 5-10. Employment and Earnings by Industry for Harney County and Oregon

	Harney County			Oregon		
Industry	**Earnings ($1,000s)**	**Employees**	**Per Employee Earnings**	**Earnings ($1,000s)**	**Employees**	**Per Employee Earnings**
Farm earnings	$9,738	877	$11,104	$1,192,358	67,660	$17,623
All nonfarm earnings	$113,161	3,574	$31,662	$97,541,631	2,252,383	$43,306
Forestry, fishing, related activities, and other	$2,814	177	$15,898	$1,448,996	35,770	$40,509
Mining		<10		$226,283	3,681	$61,473
Utilities	(D)	(D)		$701,752	4,964	$141,368
Construction	(D)	(D)		$6,745,644	150,561	$44,803
Manufacturing	(D)	(D)		$14,437,333	217,114	$66,497
Wholesale trade	$1,343	54	$24,870	$6,378,920	89,537	$71,243
Retail trade	$9,050	493	$18,357	$6,885,871	255,349	$26,967
Transportation and warehousing	(D)	(D)		$3,392,809	68,813	$49,305
Information	$1,333	39	$34,179	$2,816,534	42,724	$65,924
Finance and insurance	$1,774	67	$26,478	$4,930,999	85,602	$57,604
Real estate and rental and leasing	$1,707	87	$19,621	$1,915,803	89,921	$21,305
Professional, scientific, and technical services	$2,571	103	$24,961	$6,942,550	128,427	$54,058
Management of companies and	$0	0		$2,755,874	31,849	$86,529

	Harney County			Oregon		
Industry	**Earnings ($1,000s)**	**Employees**	**Per Employee Earnings**	**Earnings ($1,000s)**	**Employees**	**Per Employee Earnings**
enterprises						
Administrative and waste services	$873	98	$8,908	$3,388,650	125,923	$26,910
Educational services	(D)	(D)		$1,011,154	50,770	$19,916
Health care and social assistance	(D)	(D)		$10,645,180	242,233	$43,946
Arts, entertainment, and recreation	(D)	(D)		$773,380	51,204	$15,104
Accommodation and food services	(D)	(D)		$3,021,903	161,529	$18,708
Other services excluding public administration	$3,194	205	$15,580	$3,080,219	125,347	$24,574
Federal, non-military government	$20,519	241	$85,141	$2,725,141	29,126	$93,564
Health care and social assistance	(D)	(D)		$10,645,180	242,233	$43,946
Military government	$732	19	$38,526	$548,005	12,378	$44,272
State and local government	$34,537	793	$43,552	$12,768,631	249,561	$51,164

Source: U.S. Bureau of Economic Analysis 2009.

5.8.5 Local Tax Revenues

The principal sources of tax revenue in Harney County are income taxes and property taxes. Oregon does not collect sales taxes. The total employment income for Harney County in 2006 was $91,948,000, generating $4,741,000 in state income taxes. Over $90 billion in total income in Oregon in 2006 generated over $5 billion in tax revenues for the state (State of Oregon 2010). Income and income tax statistics for Harney County and Oregon are presented in Table 5-11.

Property assessed value and tax revenues are presented in Table 5-11. The property tax rate in Harney County is over 1 percent lower than the Oregon average rate. Harney County generated over $5.5 million in property tax revenue from total assessed property value of $382 million in the county (State of Oregon website 2009).

Table 5-11. Regional Income and Income Tax Statistics

	Harney County	Oregon
Total income	$91,948,000	$90,213,382,000
Total income taxes	$4,741,000	$5,150,942,000
Overall income tax rate	5.2%	5.7%
Net assessed value of properties	$382,191,276	$271,355,283,098
Total property taxes	$5,547,000	$4,279,042,000
Property tax rate	14.51%	15.77%

Source: Oregon Department of Revenue.

Refuge Revenue Sharing Act

Counties receive payments in lieu of taxes from the USFWS under the Refuge Revenue Sharing Act. Payments are determined based on two criteria:

1. On acquired land, the greatest amount calculated on the basis of 75 cents per acre, three-fourths of 1 percent of the appraised value, or 25 percent of the net receipts produced from the land, and

2. On land withdrawn from the public domain, 25 percent of net receipts and basic payments under Public Law 94-565, payment in lieu of taxes on public lands.

Table 5-12 shows the in lieu of taxes payments to Harney County between 2002 and 2010.

Table 5-12. In Lieu of Taxes Payments to Harney County, 2002 to 2010

Payment Year	Tax Year	Paid to Harney County
2002	2001	$93,449
2003	2002	$46,106
2004	2003	$79,443
2005	2004	$89,719
2006	2005	$83,038
2007	2006	$80,295
2008	2007	$75,842
2009	2008	$75,842
2010	2009	$75,842

5.8.6 Lifestyle and Social Values

Harney County was incorporated in 1889 and is very rural. The county was first explored by fur trappers and traders, and was then settled by cattle ranchers who were attracted to the abundance of

bunchgrass for grazing. Many of the area ranches are still owned by members or descendants of the original homestead families, and cattle ranching, raising sheep, and hay production remain important parts of the economy in the county. An important part of the rural lifestyle and community identity is derived from the undeveloped and open landscape of much of the county.

5.8.7 Refuge Impact on the Local Economy

Visitors to Malheur Refuge spend money on food, lodging, equipment, transportation, and other expenses, which creates jobs within the local economy. The effect of recreational expenditures on the local economy is explored in detail in Chapter 6, Section 6.6, of this CCP.

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Sage sparrow
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Chapter 6 Environmental Effects

This chapter provides an analysis of the environmental consequences of implementing the alternatives described in Chapter 2. Impacts are described for the main aspects of the environments described in Chapters 3 through 5, including physical, biological, cultural, paleontological, and socio-economic resources. The alternatives are compared "side by side" under each topic, and both the adverse and beneficial effects of implementing each alternative are described. The overall cumulative effect on the environment from implementing the various alternatives is summarized in Section 6.8. More detailed assessments of the Refuge's cumulative effects for relevant impact topics are presented section by section.

In addition, Appendix B contains compatibility determinations (CDs) for the following uses:

- Wildlife Observation, Photography, and Interpretation
- Environmental Education
- Waterfowl Hunting
- Upland Game Hunting
- Fishing
- Commercial Tours and Photography
- Grazing and Haying
- Plant Gathering of Culturally Important Plants
- Research, Scientific Collecting, and Surveys
- Farming

Many of the actions described under the alternatives would require additional funding or staff, none of which is guaranteed at this time. The alternatives are analyzed under the assumption that funding would be available to implement the actions as described.

Contained in these CDs is additional information specific to the effects of these uses. This chapter summarizes the CDs but does not repeat all of the information contained in the CDs.

Many of the actions described under the alternatives would require additional funding or staff, none of which is guaranteed at this time. Although implementation will be contingent on the availability of such funding, the lack of funding at this time is not factored into the effects analysis. In other words, the alternatives are analyzed under the assumption that funding would be available to implement the actions as described.

Effects are described in terms of the change from current conditions. Except where environmental conditions are markedly deteriorating or improving, Alternative 1, the no-action alternative (current management), is generally considered to have a neutral effect in the following analysis because minimal or no changes to management programs would occur under this alternative. Actions in the other alternatives are judged positive or negative relative to Alternative 1.

The judging of effects in this final comprehensive conservation plan/environmental impact statement (CCP/EIS) is based upon relevant scientific literature, existing databases and inventories, consultations with other professionals, personal knowledge of resources based on field visits, and experience.

Some beneficial effects as well as negative effects are expected. The terms shown in the graphic and identified below were used to describe the scope, scale, and intensity of effects on natural, cultural, and recreational resources. When interpreting these terms, *moderate* is a higher magnitude than *minor*, which is of a higher magnitude than *slight*. The word *neutral* is used to describe a negligible or unnoticeable effect compared to the current situation.

- **Neutral or Negligible.** Resources would not be affected, or the effects would be at or near the lowest level of detection. Resource conditions would not change or would be so slight that there would not be any measurable or perceptible consequence to a population, wildlife or plant community, recreational opportunity, visitor experience, cultural resource, or social or economic conditions.
- **Minor.** Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreational opportunity, visitor experience, cultural resource, or social or economic conditions. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.
- **Moderate.** Effects would be readily detectable and localized, with notable consequences to a population, wildlife or plant community, recreational opportunity, visitor experience, cultural resource, or social or economic conditions. Mitigation measures would be needed to offset adverse effects and would be extensive, moderately complicated to implement, and probably successful.
- **Significant (major).** Effects would be obvious and would result in substantial consequences to a population, wildlife or plant community, recreational opportunity, visitor experience, cultural resource, or social or economic conditions within the local area and region. Extensive mitigation measures may be needed to offset adverse effects and would be large-scale in nature and very complicated to implement; they also may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as:

- **Short-term or temporary.** This is an effect that generally would last less than 1 year or season.
- **Long-term.** This is a change in a resource or its condition that would last longer than a single year or season.

Ideally, effects from management actions (including habitat manipulations and public use actions such as increasing program availability or access) would be measured or predicted in terms of wildlife outcomes. Measures for wildlife outcomes may include reproductive success, population rate of growth, incidence of disease, change in survivorship, and so on. However, reliable scientific information on these sorts of outcomes is typically far scarcer than scientific information that correlates wildlife abundance to habitat descriptors. Therefore, unless otherwise documented, wildlife response in this document is assumed to be correlated with the quality of the habitat obtained. In other words, wildlife associated with or using a particular habitat would be assumed to benefit or not depending on the projected future condition and availability of the habitat. It is also important to note that actions that may change habitat type may support some species at the expense of others.

6.1 Effects Common to All Alternatives

***Integrated pest management (IPM)*:** Potential effects to the biological and physical environment associated with the proposed site-, time-, and target-specific use of pesticides (Pesticide Use Proposals [PUPs]) on refuge lands would be evaluated using scientific information and analyses documented in "Chemical Profiles" (see Appendix G for additional information on IPM). These profiles provide quantitative assessment/screening tools and threshold values to evaluate potential effects to species groups (birds, mammals, and fish) and environmental quality (water, soil, and air). PUPs (including appropriate best management practices [BMPs]) would be approved where the Chemical Profiles provide scientific evidence that potential impacts to refuge biological resources and physical environment are likely to be only minor, temporary, or localized in nature. Along with the selective use of pesticides, PUPs would also describe other appropriate IPM strategies (biological, physical, mechanical, and cultural methods) to eradicate, control, or contain pest species in order to achieve resource management objectives.

The effects of these non-pesticide IPM strategies to address pest species on refuge lands would be similar to those effects described elsewhere within this chapter, where these strategies are discussed specifically as habitat management techniques to achieve resource management objectives on the refuge. For example, the effects of mowing to control invasive plants in an improved pasture would be similar to the effects summarized for situations where mowing would be specifically used to provide short-grass foraging habitat for wintering geese.

Based on scientific information and analyses documented in Chemical Profiles, most pesticides allowed for use on refuge lands would be of relatively low risk to non-target organisms as a result of low toxicity or short-term persistence in the environment. Thus, potential impacts to refuge resources and neighboring natural resources from pesticide applications would be expected to be minor, temporary, or localized in nature.

6.2 Effects to the Physical Environment

6.2.1 Effects to Hydrology

Under all alternatives, riverine habitats would be managed similarly to past management direction. A primary objective of this CCP under Alternative 2 is the development of an integrated wetland/riverine rehabilitation plan, with implementation of pilot projects occurring under Alternative 3. Objectives 13b and 13c described in Chapter 2 provide specifics regarding the assessment of hydrological features on Malheur Refuge and the implementation of pilot projects to assess river and wetland response to rehabilitation efforts.

Under both action alternatives, facilities to serve the public would increase; however, these facilities are not expected to affect the local hydrology in any way. Effects to natural hot and cold springs, as well as groundwater levels on the Refuge are not expected under any of the three alternatives.

6.2.2 Effects to Water Quality

As discussed in Chapters 1 and 3, the State of Oregon maintains water quality standards used to list Oregon waters as 303(d) impaired. These standards include bacteria, chlorophyll a, dissolved oxygen, pH, phosphorus, temperature, total dissolved gas, toxic substances, and turbidity (Hinck et

al. 2010, in draft). Standards for some organic and inorganic contaminants also are included in Oregon water quality standards. Oregon has narrative standards for aquatic weeds or algae, biological criteria, and sedimentation (ODEQ 2007).

The water quality discussion below focuses on Refuge operations and potential water quality impacts stemming from pollutants, sediment, or elevated water temperatures.

***General pollution control*:** The Service has policies regarding pollution control at all of its facilities, including wildlife refuges. These policies direct all Service employees 1) to comply with all applicable environmental laws and regulations; 2) to reduce pollution; 3) to inventory and properly treat or handle any hazardous substances; and 4) to clean up or remove hazardous materials on contaminated sites. These policies are discussed in the Service's manual in the 500 Series (U.S. Fish and Wildlife Service [USFWS] 2011). The Refuge would comply with these policies under all alternatives.

***Effects from carp control*:** The primary focus of Alternative 2 and a co-priority of Alternative 3 will be to improve the aquatic health of lakes and associated wetlands, primarily through aggressive control of common carp. Carp activity has had a major adverse impact on turbidity of the Refuge's lacustrine and wetland habitats, dating back to the early 1950s. If the carp control plans are successful, water clarity, temperature, and nutrient loading under Alternatives 2 and 3 in lacustrine and wetland areas should be improved. Under Alternative 1, opportunistic carp control through the use of rotenone and periodic dewatering would be used; however, these tools have only temporary effectiveness in reducing carp, with temporary improvements to water clarity.

***Effects from water management*:** A study conducted by Mayer et al. (2007) assessed the water quality impacts associated with refuge water and habitat management (irrigation of meadows, grazing, surface and subsurface return flows from both wetlands and agricultural fields, and dam operations) through measurement of a variety of water quality parameters at several different sites. Roy et al. (2001) also collected water quality information on the Blitzen River between July and September in 1999.

Mayer et al. concluded that irrigation and wetland return flows contribute water lower in dissolved oxygen (DO) and higher in biological oxygen demand (BOD) to the Blitzen River and may be responsible (together with higher downstream temperatures) for the low levels of DO found in the downstream portions of the river. In the study, return flows are also implicated as a potential source of nutrients for the river, including total phosphorus (P) and total nitrogen (N), as concentrations of these nutrients were found to be higher in return flows than in the main stem of the river. Both Roy et al. and Mayer et al. found conductivity increasing from upstream sites to downstream sites. Mayer et al. concluded that changes in conductivity measured throughout the summer pointed to the contribution of irrigation return flows. Turbidity was found to be generally related to flow, increasing with high flows and decreasing with low flows. However, late-summer increases in turbidity were documented at downstream sites near Grain Camp and Sodhouse dams. The study authors hypothesized that dam openings in late July mobilize sediments trapped behind dams, releasing them into the river and increasing turbidity at that time. Hence, water management at the refuge contributes some pollutants to the riverine system. It is not known how much variance there is in the present situation compared to a natural system, with the exception that certain pulses in nutrients related to management actions (e.g., opening of the dams in late July) result in a modified water quality pattern.

Water quality impacts similar to the present will continue under Alternatives 2 and 3 in the riverine system. Because these impacts will be the same as Alternative 1, these alternatives would be considered to have a minor negative effect on water quality.

***Effects from grazing*:** Effects from grazing on water quality are explored in the Grazing/Haying CD (Appendix B). In general, grazing effects to water quality are expected to be minimal. Conclusions are based partly on a recent study that investigated water quality in the Blitzen River (Mayer et al. 2007). Measurements of *E. coli* in the Blitzen River were well below the state standard at all sites measured in a recent study (Mayer et al. 2007). Though the study discontinued measurements of *E. coli* before the grazing season commenced, this was not seen as a methodological flaw because water is not present when cattle are grazing (Mayer 2011); therefore, any waste produced by the cattle would not enter Refuge water supplies during this period. Bare ground may be exposed in some areas subject to rake-bunch grazing, but water quality impacts stemming from this are minimal as sediments are expected to settle out in the shallowly flooded wet meadows prior to irrigation waters re-entering the river system (Mayer 2011).

***Effects from riverine work*:** Short-term water quality impacts may also result from direct disturbance associated with Blitzen River pilot projects undertaken under Alternatives 2 and 3. Such impacts would likely be limited to an increased mobilization of sediment from in-stream work, with a short-term increase in turbidity directly downstream of the pilot sites.

***Effects from cropland management*:** Permanently vegetated buffers between farm fields and streams would capture a majority of natural runoff and lessen any potential adverse impacts to water quality on the Refuge.

Effects from integrated pest management (IPM): Herbicide use will be similar under all alternatives and would be used to prevent unwanted invasives. Temporary impacts to water quality may occur from the use of herbicides; however, appropriate buffers (as described on chemical labels) would be used to limit chemical entry into water bodies. See the IPM Appendix (Appendix G) for more information.

***Effects from public recreational projects*:** New public recreational facilities would be constructed on a total of 9.9 habitat acres under Alternative 2 and 3.3 habitat acres under Alternative 3. Construction on already developed sites will impact an additional 0.16 acre under Alternative 2 and 0.14 acre under Alternative 3. The construction activities associated with these facilities could result in temporary and minor increased erosion potential and reduced slope stability, and could temporarily increase turbidity in the Blitzen River or its tributaries downstream of the project, particularly during precipitation events.

Through the implementation of BMPs and various erosion controls, short-term adverse water quality impacts during and following construction would be minimized.

Overall effects: Overall, Alternatives 2 and 3 would be expected to result in moderate and minor beneficial effects to water quality, respectively, with most of the water quality improvements being attributed to carp control.

6.2.3 Effects to Air Quality

Air quality over refuges is occasionally subject to temporary, localized negative impacts. These arise primarily from prescribed burning for habitat management. In addition, dust is generated from traffic on unpaved roads during dry conditions and from discing associated with cropland farming. Traffic from visitors also generates vehicle exhaust.

Under all alternatives, the amount of prescribed fire would be expected to remain the same as at present. Impacts would be short term and would occur primarily when visitation is at a minimum. Traffic from visitors is expected to slightly increase under Alternatives 2 and 3, resulting in the potential for increased dust.

Overall, effects to air quality are expected to be negligible, because in the context of the thinly populated region, atmospheric inputs of smoke and particulates from refuge management actions or public use are vanishingly small.

6.2.4 Effects to Visual Quality

Effects to visual quality are expected to be negligible to minor negative under Alternatives 2 and 3 and neutral under Alternative 1. Vistas from key points will be maintained, and no views would be blocked. The only potential effect would be the possible disruption of the landscape horizon line with the addition of the viewing tower at the airboat launch. Other actions under the alternatives would result in negligible change to their landscape character.

6.3 Effects to Wildlife and Habitats

6.3.1 Effects to Lacustrine Habitat and Associated Species

Priority resources of concern identified for this habitat during the CCP process includes canvasback, sago pondweed, northern shoveler, tui chub, and white pelican (Section 4.3.1).

Effects from habitat actions

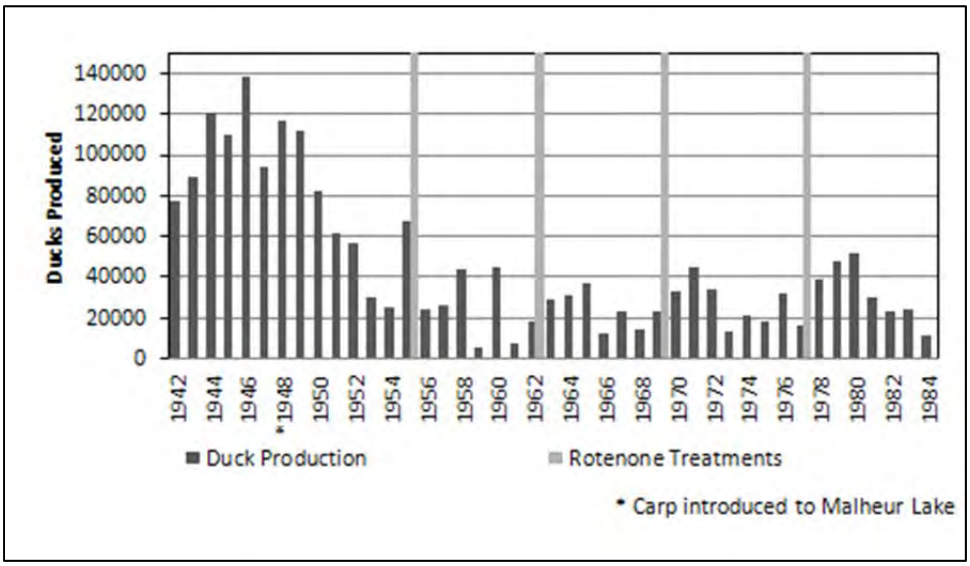
Each of the alternatives would maintain all existing lacustrine habitat on the Refuge (500-110,000 acres) with no specific management actions aimed at increasing or decreasing overall acreage.

The primary focus and top priority of Alternative 2 and co-priority of Alternative 3 will be to improve the aquatic health of lakes (and associated wetlands), primarily through aggressive control of common carp. Under Alternative 1, opportunistic carp control through the use of rotenone at lower lake levels would be used, as has been the case for many years.

***Carp threshold – anticipated effects to vegetation and wildlife*:** Under Alternatives 2 and 3, a comprehensive, science-based approach to carp control would be initiated to reduce the carp population to the targeted threshold of 100 pounds of carp per acre, a threshold level based on the work of Bajer et al. (2009). That study, which examined changing carp densities in a recently restored 300-hectare (ha) Midwestern lake, found that although a carp biomass of 30 kg/ha had no discernible effects on vegetative cover (which exceeded 90%) or waterfowl (which exceeded 150,000 individuals during fall censuses), the increase in carp biomass to 100 kg/ha was associated with a 50

percent decrease in both vegetative cover and waterfowl. A further increase in carp biomass to over 250 kg/ha coincided with a decrease in the vegetative cover to 17 percent of the lake's surface and a decline in waterfowl use to 10 percent of its value when carp were absent. Carp effects to aquatic plants varied, with species less sensitive to uprooting and poor light penetration faring better than other plant species. Overall, the increase in carp biomass could explain 93 percent of the variation in waterfowl abundance decline during the 4 years studied. Although the lake studied is significantly smaller than Malheur Lake, the threshold value is the only known threshold from a field study correlating carp biomass, vegetative response, and waterfowl use. Exclosure studies have documented vegetative effects only at much higher carp biomass levels. The work of Robel (1961), Crivelli (1983), and Miller and Crowl (2006) (all cited in Bajer et al. 2009) demonstrated that carp biomass measuring 500 kg/ha may be required to cause a 50 percent loss in vegetation. Therefore the threshold adopted in Objective 1a is considered ambitious but conservative (reasonably likely to result in the desired outcome if achieved).

Although thresholds were not established in the past, carp control has been attempted on Malheur Lake and other Refuge water bodies before, with promising, though temporary, results for duck production, as illustrated in Figure 6-1.



Source: Malheur Refuge data, compiled by Gary Ivey

Figure 6-1. Duck production at Malheur National Wildlife Refuge.

It is not known at this time if the Refuge will be able to achieve its targeted carp control threshold, or how closely the results obtained by Bajer et al. (2009) would hold true at Malheur. However, at least a partial restoration of historical levels of hemi-marsh and submergent plant communities is expected to be attained if carp control thresholds are successfully reached and maintained. A positive response by hemi-marsh and submergent plant communities would lead to improved water quality, a more diversified invertebrate community, increased use by waterfowl, shorebirds, and other water/wetland-dependent wildlife, and improved habitat for native fish.

***Effects from different approaches to carp control*:** Under Alternatives 2 and 3, a variety of approaches may be used at Malheur Refuge (following further assessment) to achieve the stated target and restore vegetative cover. Approaches may include non-selective removal or exclusion

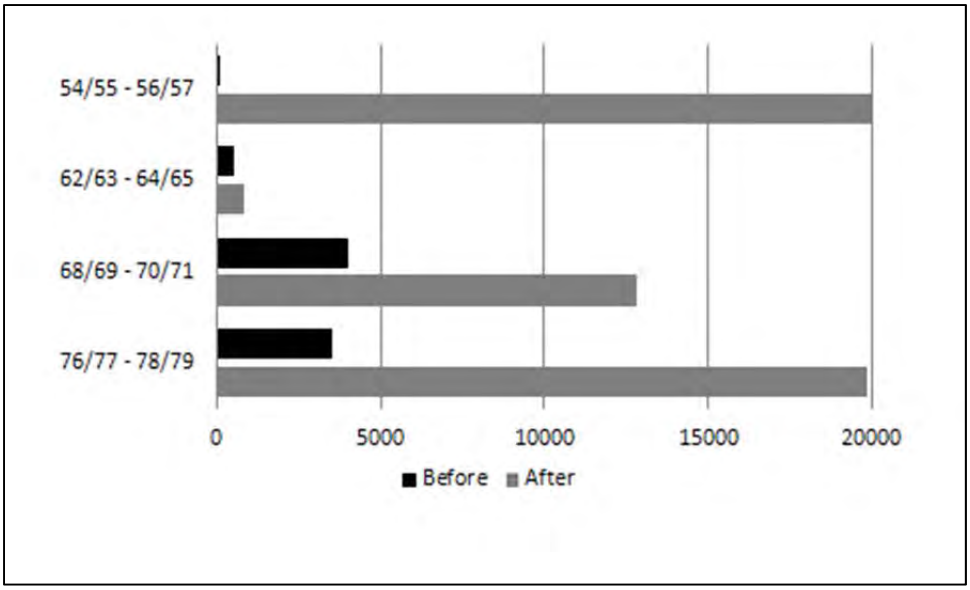
devices such as the application of piscicide; use of barriers; or water manipulation. Selective devices such as commercial harvest and recreational angling may also be used. Chemo-attractants or chemo-repellents may be used in conjunction with any of these methods. This EIS specifically examines the effect of usage of piscicide (specifically rotenone), angling, and chemo-attractants/chemo-repellents. Commercial harvest was examined in a Compatibility Determination published in 2009 and the effects from that CD are summarized here without further analysis of the use. Barriers could encompass a wide range of potential designs. Since at this time, there is no design in place, barriers are not analyzed in this EIS. Water manipulation is unlikely to be used as a tool for the Refuge's lacustrine habitats due to the sheer size of the lakes and the lack of a place to transfer water to. It is not analyzed in this section, but water manipulation as a habitat management strategy is analyzed in Section 6.3.4 (Effects to Palustrine Marsh, Meadow, and Open Water Wetland Habitats and Associated Species) and Section 6.3.14 (Effects to Threatened, Endangered, or Candidate Species). Effects from the other methods are described below.

Piscicide: Piscicides are chemicals that kill fish. Rotenone is a natural substance derived from several tropical and sub-tropical plants. It is a broad-spectrum piscicide that is toxic to most fish over the range at which it is toxic to carp. For carp, it is known to be toxic to juvenile and adult fish. An overview of the effects of rotenone is available in a U.S. Bureau of Reclamation (USBR) document developed for a Bonita Creek (Arizona) project (USBR 2010). Fish eggs are much more resistant to rotenone treatments than larval or adult stages. For example, newly fertilized rainbow trout eggs were 41 to 106 times more resistant; salmon eggs are 10 times more resistant than the fish; and carp eggs are 50 times more resistant (Oregon Department of Fish and Wildlife [ODFW] date unknown).

Although both fish and aquatic macroinvertebrates are highly susceptible to rotenone (Skaar 2001), most macroinvertebrate populations quickly recover to pretreatment levels (Lennon 1970; Schnick 1974b). Gill-breathing amphibians (i.e., frog and toad tadpoles and larval salamanders) are also adversely affected (Hamilton 1941). Amphibian adults and reptiles are less sensitive than fish and should not be harmed when rotenone is applied at concentrations typically used in fisheries management (Farringer 1972). Fall applications of rotenone reduce or eliminate impacts on amphibians because most species are in the adult stage of development.

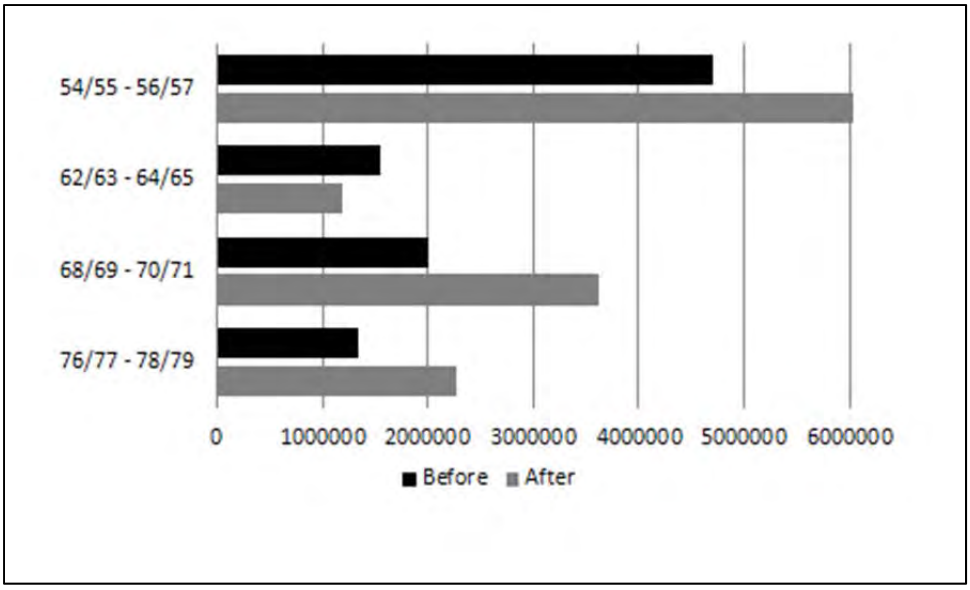
Rotenone is very unstable in the environment (half-life measured in days) and completely breaks down within 1 to 4 weeks depending on pH, alkalinity, temperature, dilution, and exposure to sunlight (Schnick 1974). It also adsorbs strongly to organic matter in sediment and is rapidly degraded (Dawson et al. 1983). Rapid neutralization (oxidation) occurs when rotenone is mixed with potassium permanganate or sodium permanganate (Engstrom-Heg 1971; Finlayson et al. 2000). Inert ingredients in the liquid formulation of rotenone consist of petroleum hydrocarbons as solvents and emulsifiers (primarily naphthaline, methylnaphthalenes, trichloroethylene, and xylenes). Studies of residual concentrations in water treated with liquid formulations indicate that solvent levels are below toxic thresholds (Ling 2003).

Rotenone was the primary piscicide used in the past on Malheur Lake. At Malheur Lake specifically, carp control using rotenone resulted in dramatic increases 2 years after most treatments in sago pondweed, diving duck use, and tundra swan use, as illustrated in Figures 6-2, 6-3, and 6-4.



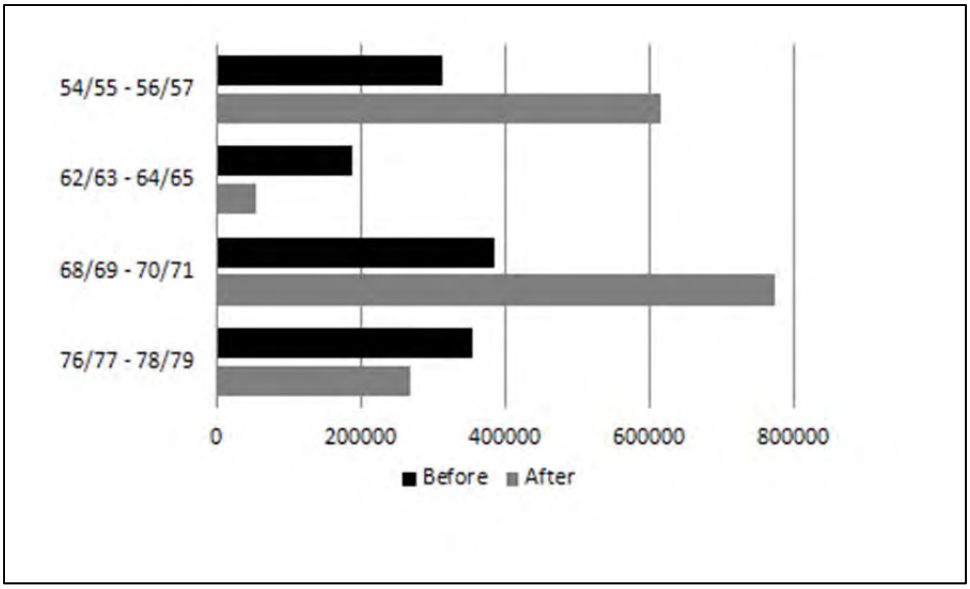
Source: Malheur Refuge data, compiled by Gary Ivey

Figure 6-2. Sago pondweed acreage averages for Malheur Lake 2 years before and 2 years after rotenone treatments.



Source: Malheur Refuge data, compiled by Gary Ivey

Figure 6-3. Diving duck use day averages for Malheur Lake 2 years before and 2 years after rotenone treatments.



Source: Malheur Refuge data, compiled by Gary Ivey

Figure 6-4. Tundra swan use day averages for Malheur Lake 2 years before and 2 years after rotenone treatments.

Commercial Harvest: Commercial harvest has the potential to be an important tool in the control of carp at Malheur Lake. It has been successfully used in several locations, including Utah Lake, Utah. Meronek et al. (1996) conducted a review of fish control projects and found that success rates for physical removal methods ranged from 33 percent to 57 percent. A recently released study (Weber et al. 2011) modeled the effect of commercial harvest of carp on size structure, abundance, and egg production, recruitment, and growth. The study found exploitation simulations in which a 575-mm (22.6 inches) length restriction represented commercial gear selectivity. Simulated common carp size structure declined modestly (9%-37%) in all simulations. The abundance of common carp declined dramatically (28%-56% of starting levels) at low levels of exploitation (0%-20%), but exploitation greater than 40 percent had little additive effect, the final populations only being reduced 49 percent to 79 percent despite high exploitation (>90%). At a moderate level of exploitation (40%), maximum lifetime egg production was reduced to 77 percent to 89 percent of starting levels, indicating the potential for recruitment overfishing. Exploitation further reduced common carp size structure, abundance, and egg production when simulations were not size selective.

Commercial harvest was explored in a Refuge CD signed in 2009. If used, fishing would be limited to seasons and locations that would minimize disturbance to lake wildlife and native fish. In addition to the likely positive effects of reducing carp abundance, egg production, and size structure, commercial fishing may lead to negative short-term impacts on water quality (increased turbidity) and the aquatic habitat (benthic disturbance).

Non-commercial Angling: This method may include bow-hunting or other methods used by recreational anglers to catch fish. Fishing effects are explored in the Fishing CD in Appendix B. This method is likely to have negligible effects on the population of carp in Malheur Lake, due to the huge population in existence there and the small number of anglers likely to participate.

Chemo-attractants and/or Chemo-repellants: These may be used in conjunction with one or more of these techniques. Pheromones (as a particular class of natural chemo-attractants and repellents) are

recognized as potent modulators of behavior (and physiology) that may be effectively used to attract, repel, or guide fish movement, and/or disrupt normal mating behavior (Sorensen and Stacey 2004). When developed and deployed together with other techniques as part of an integrated approach, they may have the potential to greatly increase the efficiency of control efforts (Sorensen and Stacey 2004). A variety of different pheromones are produced by any individual species, some of which are species-specific and others not (Sorensen 2006). According to Sorensen and Hoye (2007), "Pheromones have the distinct advantages of being potent, easy and potentially inexpensive to produce and apply, and environmentally benign" (see also Sorensen and Vrieze 2003; Twohey et al. 2003). However, as discussed by Sorensen and Hoye (2007), the challenge of isolating and applying pheromones for any species is likely to be considerable. In the case of the sea lamprey migratory pheromone, it took a large team over 16 years to identify three components at a cost of over a million dollars. Therefore, use of pheromone technology (except experimentally) may be premature, since pheromones used for pest control in the United States are considered "pesticides" by the Environmental Protection Agency (EPA) and must pass through the normal pesticide registration process. In addition, the normal procedures prior to use of a pesticide would apply, requiring considerable time and funds. Experimental use in the research phase must also have a special permit. Effects would need to be further developed in a pesticide use proposal (PUP) (see Appendix G).

Effects from public recreational use

Of the recreational activities supported at the Refuge, only guided (docent-led) wildlife observation activities and hunting (waterfowl and upland gamebirds) would regularly occur on or directly adjacent to lacustrine habitats under Alternatives 2 and 3. The footprint of new facilities to be built in this habitat type would be 0 acres under Alternative 2 and 0 acres under Alternative 3.

***Effects from wildlife observation, photography, interpretation, and environmental education*:** Alternatives 2 and 3 would include opportunities for group kayaking or canoeing on Malheur Lake under the guidance of a docent. Compared to Alternative 1, where there is no group use of the lake, this activity has the potential to cause disturbance to wildlife using this resource and habitat. However, due to the large size of the lake and the fact that tours conducted in non-motorized boats would be unable to penetrate very far into the lake, impacts to wildlife using this portion of the lake are expected to be minimal. As discussed under the CD for wildlife observation, wildlife photography, and interpretation (Appendix B), wildlife tends to be most disturbed by human presence at distances less than 100 m. Except in the unusual years that the lake is very low, the vast amount of undisturbed lacustrine habitat on the Refuge would provide adequate haven for wildlife. Careful scheduling of the tours around sensitive wildlife seasons and resource areas, limiting the group size to a manageable and sustainable size, and providing public education to inform visitors of ethical and least intrusive methods to wildlife viewing and photography would reduce impacts.

***Mortality and disturbance from waterfowl hunting*:** With expanded access to a portion of the south side of Malheur Lake, the number of harvests on the Refuge as a whole would be expected to increase to 250 ducks and 200 geese annually. The majority of these would likely come from Malheur Lake. The estimated harvest from Malheur Lake would be the same under Alternative 3. These estimated harvests represent a tiny fraction of a percent of the total mid-winter population of wintering ducks and geese in the Survey Unit and the State of Oregon, and an even smaller fraction of the Pacific Flyway population. Even under the Preferred Alternative 2 harvest estimation, the duck and goose harvested would be less than 2 percent of the mid-winter survey population at the Survey Unit scale of Klamath, Lake, and Harney counties. The overall impacts from the harvest estimates would be minor to negligible.

As management activities work to control carp in Malheur Lake over the next 15 years, it would be expected that eventually the number of nesting birds in this area would increase and consequently the number of hunters and harvests would also increase. There are many unknowns in carp control, and an accurate estimate of waterfowl to be harvested under this scenario cannot be predicted at this time.

During the hunt season, other birds using the area (such as migrating waterbirds, shorebirds, and raptors) may be disturbed. Some migrating passerines may be disturbed from noise and human presence associated with waterfowl hunting on Malheur Lake and upland game hunting in the vicinity and on the edges of the Lake; however, since most birds will have already migrated through the area by the time hunting begins, disturbance levels would be expected to be minor overall.

On the whole, although disturbance would increase from present levels under both Alternatives 2 and 3, impact to lacustrine habitats from recreational uses is expected to be minimal to minor under both alternatives. See the CDs (Appendix B) for greater detail.

Overall effects: Overall, a moderate to significant positive effect would occur for lacustrine habitat and associated species under Alternative 2 and a moderate positive effect for Alternative 3, with most of the impact attributable to carp control efforts. The effect from Alternative 3 is expected to be less than Alternative 2 because the emphasis on carp control is not as strong.

6.3.2 Effects to Riverine Habitat and Associated Species

Priority resources of concern identified for this habitat during the CCP process include redband trout (Section 4.3.2).

Effects from habitat actions

Under Alternative 1, the 55-mile riverine system on the Refuge with six dams and numerous diversions would be maintained in its current condition. Although willows are relatively abundant along the banks of the Blitzen River, canals, and tributaries, stream shade is limited as the willow cover only occasionally shades the full water body. The stream is channelized on a large portion of its length, and incision and disconnection from the floodplain are noted issues (Salant et al. 2010).

***Effects from river restoration*:** Alternatives 2 and 3 call for the creation of an integrated wetland/riverine rehabilitation plan for the Blitzen Valley following data collection, model development, and the implementation of pilot studies. The intended outcomes of the riverine plan would be to enhance habitat for native fish, to enhance water quality within the river, to provide for greater floodplain connectivity, and to improve the extent and quality of riparian habitat.

Under both Alternatives 2 and 3, limited pilot projects would occur prior to completion of the plan. Under Alternative 3, mostly planning for future rehabilitation would occur during the life of the CCP. Under Alternative 2, some planning for future rehabilitation would occur; however, implementation of the plan would depend on successful carp control on the Refuge.

Under both Alternatives 2 and 3, the exact actions undertaken under an integrated wetland/riverine rehabilitation plan are unknown at this time. Moreover, implementation of such a plan is conditioned on achieving adequate carp control in Alternative 2, while plan completion will not begin under Alternative 3 until the close of the 15-year CCP time frame. Due to these limitations and conditions, effects due to implementation of the plan are not analyzed in this draft CCP/EIS. Essentially, the

river system will continue to be managed the same as under Alternative 1. Limited pilot projects undertaken under either Alternative 2 or Alternative 3 may have temporary and localized positive or negative effects, which will be studied and compiled under research accompanying the pilot projects. Such projects may seek to accomplish Objective 2a attributes such as increasing river sinuosity, enhancing riparian habitat and shading along the river corridor, and increasing bank stability, which would benefit native riverine species such as the redband trout and may benefit riparian associated species as well. However, the intent of the pilot projects is largely to test hypotheses about effects and to document results in localized areas. For example, if floodplain connectivity is restored in a defined section of the river, both positive effects (such as an increase in riparian habitat) and negative effects (such as increased entrainment of fish) would be monitored and documented. Only if results are generally positive and if the project is considered feasible to expand to a larger area will funding will be pursued to broaden the extent of rehabilitation. Therefore, during the CCP, the effects to redband trout and other aquatic fish and wildlife should be beneficial, but only in a minor way.

Effects on Riverine Habitats from Flood Irrigation: The Refuge, in coordination with ODFW, currently maintains a year-round minimum flow in the river for the benefit of aquatic species (see Section 3.3.2).

Based on a 4-year study undertaken on the Blitzen River in 2002-2005 (Mayer et al. 2007), the diversion of water for the irrigation of meadows and filling of wetlands consumes a total of 47,000 to 63,000 acre-feet over approximately 36,000 acres between April and September each year, resulting in consumptive use of approximately 53 percent to 78 percent of the total spring/summer inflow from the riverine system itself. If examined over the total calendar year, the consumptive use for irrigation accounted for 45 percent to 59 percent of the total annual inflow. When spread out over the area of irrigated land in the Blitzen Valley, the consumptive use rate averages 1.3 to 1.7 acre-feet/acre for the April to September season and 1.3 to 1.9 acre-feet/acre for the water year, a rate considered quite comparable to irrigation consumption rates for agricultural products (Mayer et al. 2007). While this water is technically taken out of the river and hence is unavailable for riverine species, it is not completely dissimilar from an unmanaged river in which flooding would cause the river to overflow its banks into off-channel habitats. The water currently diverted is made available to palustrine habitats, resulting in benefits to a different suite of species (these are explored in Section 6.3.4). There have been no demonstrable changes in mean annual streamflow for the last 100 years (Salant et al. 2010). Historically, inundation of the valley during spring floods created large natural seasonal wetlands (Salant et al. 2010), as well as numerous braided channels with abundant riparian habitat that likely existed in the spaces between channels (Beckham 1995). Some of these features are evident on historical aerial photos. Thus, although it is impossible to determine exactly how much the current situation has altered the amount of water that typically stays in-stream, under a natural scenario, it is clear that abundant supplies of water were available in off-channel habitats in a typical year, and these would have supported riparian and wetland habitats similar in many respects to what is seen today.

The effects of diverting water on riverine water quality are discussed in Section 6.2.2.

***Effects from public recreational use*:** The main recreational uses affecting riverine habitats are fishing, hunting, and wildlife observation and photography that occur along streamside hiking trails. These uses are explored in greater detail in the CDs (Appendix B). The footprint of new facilities to be built in the riverine habitat type would be 0 acres under Alternative 2 and 0 acres under Alternative 3.

Compared to Alternative 1, expanded access would be provided to riverine fishing areas near the Headquarters and along East Canal Road under Alternative 2. Expanded access and facilities under Alternative 2 would likely result in increased usage of this habitat type, causing some additional disturbance. Shoreline activities related to stream fishing, upland bird hunting, and waterfowl hunting, such as human noise, would cause some birds to flush and go elsewhere. Waterbirds and waterfowl in particular use shorelines seasonally for resting, feeding, and nesting. However, trail enhancements along the south loop may also benefit the surrounding habitat by concentrating users on a formal trail instead of social trails that are not regulated.

Alternative 3 would be similar to Alternative 2, except that access along East Canal Road would remain walk-in only. Under Alternative 3, visitors would be permitted free roam access to areas of the Refuge currently closed; free roam access would extend from August 15 to the fourth Friday of October in the Buena Vista Unit, and from August 15 to March 1 in the P Ranch Unit. Although the number of visitors who use the free roam areas would likely be few, there could be some additional fall, winter, and early spring disturbance to riverine habitats and species from roaming visitors under Alternative 3, compared to Alternatives 1 and 2.

Rivers and streams are sensitive to sedimentation that sometimes results from human activity and overuse of natural surface areas. Direct impact to soil and water from recreational uses was explored in the CDs (Appendix B) and found negligible for most uses. Fishing use and the expansion of fishing areas under Alternatives 2 and 3 may present some minor impact to soil and water, compared to Alternative 1.

Overall, given the amount of riverine habitat on the Refuge, negative effects from recreational use to riverine habitat are considered negligible to minor under Alternatives 2 and 3, and over the 15-year term of the CCP.

***Overall effects*:** Overall, for riverine habitat and associated species, a neutral to minor negative effect for both Alternatives 2 and 3 is expected, largely attributable to increased access to the riverine areas.

6.3.3 Effects to Woody Riparian Habitat and Associated Species

The priority resources of concern identified for this habitat during the CCP process include willow flycatcher and yellow warbler (Section 4.3.3).

***Effects from habitat actions*:** Under Alternative 1, 800 to 1,000 acres of woody riparian habitat in the Blitzen Valley would be maintained and managed under current management direction, with ongoing efforts to improve and promote riparian shrub health. Under Alternatives 2 and 3, that acreage would be increased to 1,000 to 1,500 acres, with similar goals to improve and promote riparian shrub health. Management actions that would be undertaken in or may affect this habitat include: active planting and seeding, livestock exclusion using temporary and permanent fencing, use of IPM to control invasive plant species, stimulating new growth and suckering in decadent stands through prescribed fire or mechanical means, and flood irrigation.

Alternatives 2 and 3 provide for a 20 percent to 50 percent increase in woody riparian habitat when compared to the current management alternative (Alternative 1). These acres will provide nesting habitat for many additional pairs of riparian-dependent passerines. Therefore, Alternatives 2 and 3 would be expected to result in a small localized increase in populations of focal species (i.e., yellow warbler, willow flycatcher), as well as mammals such as beaver and mule deer.

Planting and Seeding: These actions may improve the availability of riparian habitat and the diversity of species found in riparian areas, although these are not guaranteed, as past plantings of riparian species have sometimes failed (see Biological Review).

Fencing out Livestock: Livestock are often attracted to the browse, shade, and water found in or near riparian areas. If permitted, livestock tend to concentrate in such areas, which may initiate a variety of impacts, including reducing or eliminating riparian vegetation, channel aggradation or degradation, widening or incisement of stream channels, changing stream bank morphology, and lowering surrounding water tables (Platts 1986). Woody riparian habitats and large mosaics of upland areas (e.g., dry meadow, sagebrush lowland) found adjacent to or interspersed within wet meadow treatments will either be excluded by means of fencing or monitored annually to ensure that these areas are not negatively impacted by grazing treatments.

Fencing can interfere with the movement of wildlife or create entanglements, leading to mortality or altered movements for birds and mammals (Christianson 2009). In a 1-year study in Colorado and Utah surveying 1,046 km of fences, Harrington and Conover (2010) measured ungulate mortality rates at 0.25 mortalities/km for the wire fences studied, with 0.08 mule deer mortalities/km, 0.11 pronghorn mortalities/km, and 0.06 elk mortalities/km. Mortalities were highest in August, when fawns were weaned, and juveniles were eight times as likely as adults to suffer mortality. At the Refuge, smooth wire is used as the bottom wire on all fences and is placed at a standard height to minimize impacts to pronghorn antelope. Observations at the Refuge have confirmed that most pronghorn cross under the fences rather than through with these adaptations. Therefore, though some fence impacts should be expected, overall, effects to large mammals would be considered relatively minor.

Prescribed Fire or Mechanical Disturbance: Much of the information in this section is summarized from Dwire and Kauffman (2003). Prescribed fire would be undertaken for the purpose of stimulating shrubs and trees to produce new growth. Most willow species respond to browsing by beaver and fluvial disturbances through coppice sprouting from stems, as well as production of root suckers (Rood et al. 1994); mechanical disturbance would be expected to have similar effects. These adaptations also contribute to regeneration following fire (Dwire and Kauffman 2003). Common riparian shrubs, such as alder, birch, currant, wild rose (*Rosa* spp.), and snowberry sprout from stumps, root crowns, and belowground stems following fire (Adams et al. 1982; Miller 2000; Stickney 1986). Most riparian sedge and grass species recover rapidly following light surface fires, through regeneration from roots and rhizomes (Racine et al. 1987). Willows, cottonwoods, and numerous herbaceous species can establish in high densities on burned riparian sites via post-fire arrival of light, windborne seeds. In Hells Canyon, Idaho, Havlina (1995) found densities of Scouler's willow to be as high as 400,000/ha on burned upland sites 4 years following severe stand-replacing fires. Fluvial delivery of seeds and vegetative propagules to streamside sites during flood events can also increase recolonization of burned areas (Johansson et al. 1996; Shafroth et al. 2002).

Because the occasional use of habitat management methods such as prescribed fire and mechanical disturbance would be expected to maintain and reinvigorate riparian stands, they would be expected to promote the habitat qualities needed by yellow warbler and willow flycatcher, the two focal species associated with woody riparian habitat. As described in Section 4.3.3, willow flycatcher generally resides in riparian habitat with native shrub cover measuring > 1 m for 40 percent to 80 percent (Altman and Holmes 2000). Fencing out livestock, IPM methods, and planting and seeding would also ensure that the cover is maintained over time.

Effects from IPM: See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** The main recreational uses affecting woody riparian habitat are fishing, upland game bird and waterfowl hunting, and wildlife observation and photography that occurs along streamside hiking trails and roads bordering woody riparian habitat. These uses are explored in greater detail in the CDs (Appendix B). The footprint of new facilities to be built in this habitat type would be 0 acres under Alternative 2 and 0 acres under Alternative 3.

Recreational disturbance is expected to be similar to that occurring for riverine habitat (see Section 6.3.2), except that most of the species relying on woody riparian habitat would be less affected by disturbance associated with free roam activities than riverine habitat and its associated species. The reason for this is that the woody riparian habitat associates and resources of concern are generally migratory passerines, which would not be very active or present in the habitat during fall, winter, or early spring (the seasons when free roam would be permitted).

Under all alternatives, the number of recreationists is not expected to increase greatly over the 15-year term of the CCP. In sum, the effect from public recreational use to this habitat under Alternatives 2 and 3 would be neutral.

***Overall effects*:** Based on an assessment of habitat management and public use factors, both Alternatives 2 and 3 would result in moderate positive effects to woody riparian habitat, due mostly to the increase in acreage of this habitat over the CCP time frame.

6.3.4 Effects to Palustrine Marsh, Meadow, and Open Water Wetland Habitats and Associated Species

Priority resources of concern identified for palustrine wetland habitats during the CCP process include: eared grebe, ruddy duck, and smartweed for palustrine open water/emergent (semipermanent flooded wetland impoundment); cinnamon teal, sandhill crane, and bobolink for palustrine emergent (temporarily flooded wet meadow); and yellow-headed blackbird and sandhill crane for palustrine emergent (seasonally flooded marsh associated with wet meadow) (Sections 4.3.4-4.3.6).

***Effects from habitat actions*:** Under both action alternatives, the total amount of marsh, meadow, and open water habitat on the Refuge would remain at current levels. Under Alternatives 2 and 3, the Refuge would strive to increase the overall temporarily flooded wet meadow acreage and enhance diversity of meadow/marsh complexes, with an associated decline in acres of palustrine emergent seasonally flooded marsh associated with wet meadow.

Under both action alternatives, Refuge wetlands would be managed to encourage healthy and diverse wetland plant communities through flood irrigation and water management, periodic prescribed fire, mowing, haying, grazing (rake-bunch and experimental), and IPM, seeding, discing, and grain farming. All habitat management actions would be the same under both Alternatives 2 and 3 in these habitat types.

The action alternatives (2 and 3) are similar in their proposed treatments of wetlands and associated wildlife. Each alternative uses a suite of tools and treatment-timing strategies to meet identified attributes under Objectives 4a, 4b, and 4c. The variety of treatments helps provide conditions for a wide range of species (ranging from ruddy ducks to bobolinks), including reproductive habitat for

some species (i.e., duck nesting in idle meadows or shorebird nesting in treated meadows) and foraging habitat for others (Ivey 2011).

***Effects of flood irrigation/water management*:** Water management and flood irrigation enable growth of the meadow and marsh plant communities used by species foraging and nesting in these communities. As detailed in Sections 4.3.1, 4.3.4, and 4.3.6, marshes provide nesting and escape cover for a variety of ducks and waterbirds. Untreated meadows provide nesting cover for ground nesting ducks and other birds, but treated meadows are preferred for nesting by shorebirds. A range of vegetation heights provides for the diversity of nesting sites needed for species ranging from shorebirds to waterfowl to passerines.

Open water impoundments are the primary habitat for the Refuge's population of trumpeter swans, used for both breeding and foraging. They provide brood water for nesting ducks and provide overwater nesting substrate for a large variety of wetland birds. They also provide foraging habitat for migrating waterfowl and serve as night roosts for staging sandhill cranes and Canada geese. They serve migrant shorebirds when they are being flooded or drawn down and provide very shallow or moist mudflats. Filling of the ponds and maintaining open water similarly maintains habitat required by the suite of species that use this habitat.

Under all alternatives, drawdown of open water impoundments (seasonal drying) would be practiced as needed. This serves to reduce the abundance of invasive species such as carp, and to promote growth of "moist soil" plant species favored by waterfowl, such as smartweeds, beggars tick, and red goosefoot. The seeds of these plants only germinate under specific conditions that expose them to the right combinations of moisture, air, and sunlight during the growing season. These conditions may be promoted in wetlands through slow drawdowns of ponds and wetlands.

***Effects of grazing, mowing, and haying*:** Mowing and associated rake-bunch grazing or haying would occur primarily in the wet meadow portion of this habitat type and would be managed the same under both Alternatives 2 and 3 as described in Appendix K. Meadows serve as resting and foraging sites for territorial greater sandhill cranes, Canada geese, waterfowl, white-faced ibises, other waterbirds, raptors, and wild ungulates. Short vegetative heights, which can be provided through treatment with grazing or mowing, provide early spring foraging habitat for cranes, waterfowl, and other waterbirds. The fall treatments set the stage for early soil warming, providing food availability in the form of invertebrates and new vegetation. These foods are high in protein that is needed by birds for egg formation (Ivey 2011).

Grazing or haying would initially take place over approximately 60 percent of the wet meadow habitat acreage each year on average. These tools provide the ability to manage meadows for a range of vegetation heights, which provides for the nesting needs of a diversity of species ranging from shorebirds to waterfowl to passerines (see Section 4.3.4). The annual timing of treatment broadly prescribed would be orchestrated around wildlife susceptibility (for example, mowing after August 10 greatly reduces crane colt mortality).

For birds that require residual (untreated) vegetation for nesting, wet meadows left untreated each year on the Refuge would provide for their needs. Birds that prefer tall vegetation may not nest in a treated area until the spring following the regrowth of the vegetation. Other species (e.g., gadwall) nest late enough in the spring that they don't require residual cover from prior growing seasons but readily use new vegetation in drier sites of meadows that were treated the prior year (Ivey 2011).

Grazing and haying can also effectively discourage early nesting birds such as mallards from nesting in sites that may get flooded out as irrigation waters arrive (Ivey 2011).

Grazing, mowing, and haying effects are explored in detail in the CD (Appendix B). In general, treatment of the wet meadow type results in short stubble habitat in early spring, which then provides for the foraging needs of numerous migrating species during spring. It also serves as useful shorebird nesting habitat, waterfowl pairing and pre-nesting habitat, and foraging habitat for cranes during nesting season. Certain passerines such as bobolink also benefit from grazing, haying, and mowing practices. There would be some negative aspects to this practice, including the temporary loss of waterfowl nesting habitat the year after treatment, but overall the practice under both Alternatives 2 and 3 would be expected to result in a minor to moderate beneficial benefits to a wide suite of avian species.

***Effects of prescribed fire*:** Fire may be used in emergent marsh, meadows, and wetland habitats at the Refuge to open and thin emergent vegetation, remove decadent material, and stimulate herbaceous production and diversity. All of these are intended to improve the value of the habitat for wildlife species. In addition, fire is used to reduce hazardous fuels. Prescribed fires have little direct immediate effect on wildlife as they are usually conducted in the winter when marsh vegetation is dormant, migrants are absent, and reptiles and amphibians are in winter hibernation. However, the following year, nesting structure will likely be altered enough that individual birds will move to other suitable habitat for the next growing season (see Appendix Q). This effect normally disappears by the second year after the burn. Ivey (2007) found that burning had a negative effect on the nesting success of greater sandhill cranes but only during the season following the burn.

Up to 25 percent of the Refuge acreage in these habitats may be burned in any one year, but usually the acreage burned would be less, due to budget and ecological constraints. Depending on its intensity and duration, fire can result in increased shoot density and increased aboveground standing mass for the following two years or kill the roots and meristematic tissue.

As described in detail in Appendix Q, fire can promote the spread of some noxious weeds, including reed canarygrass, and special techniques, including deep flooding in the following spring, are required to mitigate this possibility. Fire equipment scars and the need to create fire lines can create the conditions for colonization by invasive species, including Canada thistle and perennial pepperweed. Up to a 30 percent increase in pepperweed at the Refuge has been observed after the use of fire (see Appendix Q). Fire lines that require mowing are required to prevent prescribed fires spreading into upland habitats.

***Effects of seeding, discing, and grain farming*:** This practice would occur in selected areas as needed from time to time. Grain farming can be a useful tool for combating persistent weed issues and influencing plant community succession in wetlands. Sandhill cranes, Canada geese, and dabbling ducks benefit from grain farming since they use grain to build their fat reserves before fall migration. Farming activities do have the potential to deplete the soil seed bank of native species over time, but since this activity is foreseen to be an occasional management practice, soil seed bank depletion is unlikely to occur.

Effects from IPM: See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** The main recreational uses affecting open water, emergent, and wet meadow palustrine habitats are wildlife observation and photography, environmental

education, fishing, and hunting. These uses are explored in greater detail in the CDs (Appendix B). The footprint of new facilities to be built in this habitat type would be up to 8 acres under Alternative 2 (mostly stemming from improvements that would be made to the south fishing loop trail system and the environmental education shelter and learning area near Headquarters) and 3 acres under Alternative 3.

Because birds tend to concentrate in these habitats and are often highly visible, attracting human attention, wildlife using these habitats are likely more subject to human disturbance from wildlife observation and photography than wildlife found in other Refuge habitats. As discussed in the CD for wildlife observation, photography, and interpretation, during migration and nesting season, visitors engaged in these uses most often would access and explore the Refuge by vehicle, thus minimizing pedestrian disturbance, which can have a greater impact than disturbance from vehicles.

Group size is a potential concern, particularly with tour and educational groups or docent-led activities. As explored in the CD, at least one study (Beale and Monaghan 2004) showed that both numbers of people and distance matter in determining disturbance effects.

Under Alternatives 2 and 3, certain sites and areas would experience higher level of use due to increased access for fishing, wildlife observation, and hunting. Impact may be concentrated at certain sites. For instance, Krumbo Reservoir would remain open to access in the wintertime, during a season when wintering birds use this and other open water habitats. However, the number of visitors to the Reservoir during the winter months would be significantly lower than during the spring, summer, or fall months. With the low number of birds present, low visitor use levels, and availability of additional wintering habitat and sanctuary, it is expected that year-round access at Krumbo Reservoir would have minor impacts. As another example, permanent photography blinds would be erected under Alternative 2 at three sites and at one site under Alternative 3. Under Alternative 3, photographers would be allowed or encouraged to use temporary photo blinds at other locations during the periods that free roam options are in effect. Temporary photography blinds may mitigate impacts to wildlife at sites that would otherwise be highly disturbed by people on foot, but may also cause temporary disturbance (compared to permanent blinds) as photographers choose sites, erect the blinds, etc. For instance, photographers erecting temporary photo blinds on Mud Creek brood pond would likely cause disturbance to wildlife at this site due to the small acreage of the pond, an absence of alternative cover for wildlife disturbed by human activities, and no adjacent areas for disturbed wildlife to move to when disturbed.

Increased disturbances to these habitats may result from the expanded waterfowl hunting opportunity under Alternative 2 (which would be allowed in the Buena Vista Unit) during fall and winter. As discussed in the Waterfowl Hunting CD (Appendix B), waterfowl hunting in palustrine habitats located in the Buena Vista Unit could result in redistribution of waterfowl and waterbirds at the Refuge. However, disturbance to non-target species from hunting is considered minor to negligible. Hunting seasons do not coincide with the nesting season, so reproduction would not be reduced by hunting. Encounters with other taxa, such as reptiles and amphibians, invertebrates, and small mammals, in the early fall would be few and should not have cumulative negative effects on Refuge populations. It is also important to keep in mind that hunting already occurs in the Buena Vista Unit for upland game, so the addition of a waterfowl hunt in this unit under Alternative 2 would only add an incremental amount of disturbance to the disturbance that already exists.

Compared to Alternatives 1 and 2, disturbance potential would also be heightened under Alternative 3, which would allow free roam wildlife observation and photography during fall, winter, and early

spring in designated portions of the Refuge. Similar to the reasoning presented for hunting, fall, winter, and early spring disturbance for these habitats is generally of less concern because wildlife would not be engaged in critical breeding activities during these seasons. However, some staging areas or migration areas may be temporarily affected. Key stipulations will be in place to minimize visitor impacts, and the Refuge would have authority to limit human activities where disturbance levels become excessive.

***Overall effects*:** Based on an assessment of habitat management factors, and public use factors, Alternatives 2 and 3 should result in neutral to minor benefits to palustrine habitats and associated species on the Refuge, with habitat management benefits expected to outweigh potential disturbance effects from public use.

6.3.5 Effects to Dry Meadow Habitat and Associated Species

***Effects from habitat actions*:** Under each of the alternatives, the Refuge would protect and maintain all existing dry meadow habitats on the refuge (4,500 to 5,500 acres) for the benefit of nesting migratory birds (e.g., cinnamon teal, northern pintail, savannah sparrow) and a diverse assemblage of other species (e.g., small mammals). No new acres would be added under any alternative.

Management actions that would be undertaken in or may affect this habitat include: prescribed fire, IPM, mowing, haying, rake-bunch grazing, and experimental grazing.

Manipulation of vegetation to meet the desired characteristics of dry meadow habitat as identified in Objective 4d would be used to stimulate vertical nesting structure (Cornely et al. 1982) and deter successional shifts away from desirable conditions (i.e., shrub encroachment could be controlled through the use of prescribed fire).

The action alternatives (2 and 3) are similar in their proposed treatment and involve a minimum use strategy involving the use of fire and/or haying/rake-bunch grazing depending on site-specific needs and the condition and species composition of neighboring habitat types. These treatments will normally occur outside periods of wildlife species vulnerability (staging/nesting/fledging).

***Effects from prescribed fire*:** Prescribed fire would be used to control sagebrush encroachment from adjacent upland habitats and to stimulate a favorable forb response. Fire has the potential to exacerbate weeds such as pepperweed and would be avoided where pepperweed poses a threat. The positive and negative effects of prescribed fire in dry meadows would be similar to those described in Section 6.3.4 and Section 6.3.6.

Mechanical treatments can be advantageous on weed-prone sites since the amount of resources (e.g., nutrients) released by this management action is less than prescribed fire. If mowing is not feasible due to the presence of rocks, shrub stumps, etc., then late-season grazing may be implemented.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from mowing, haying, and grazing*:** Mowing, haying, or grazing would occur occasionally in this habitat type and would be managed the same under both Alternatives 2 and 3. These tools provide the ability to manage meadows for a range of vegetation heights, which provides for the nesting needs of a diversity of species ranging from shorebirds to waterfowl to passerines (see Section 4.3.4). Grazing, mowing, and haying effects are explored in detail in the CD (Appendix B).

***Effects from public recreational use*:** The main recreational uses affecting dry meadow habitats are wildlife observation and photography, environmental education, fishing, and hunting. These uses are explored in greater detail in the CDs (Appendix B). The footprint of new facilities to be built in this habitat type would be 0 acres under Alternative 2 and 0 acres under Alternative 3.

Disturbance factors would be somewhat similar to those associated with recreation in palustrine habitats (see Section 6.3.4); however, disturbance in these habitats would be expected to be quite a bit smaller in magnitude, partly because the dry meadow habitat type is so limited in extent on the Refuge (compared to the palustrine type). In addition, drier habitats attract a lower abundance and diversity of species.

***Overall effects*:** Based on an assessment of habitat management factors and public use factors, each of the three alternatives will have a neutral effect to dry meadow habitat and associated species on the Refuge. Overall, dry meadow habitats will continue to be managed to protect and enhance existing habitat on the Refuge under all three alternatives.

6.3.6 Effects to Salt Desert Scrub Habitat and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of salt desert scrub habitat (40,000 acres) on the Refuge would remain unchanged. Periodic weed control and limited prescribed disturbance (e.g., fire) are the only active management tools that would be used in this habitat. Throughout the life of the CCP, the goal is to protect and maintain salt desert scrub for the benefit of breeding migratory birds (e.g., sage thrasher, sage sparrow) and other native wildlife species (e.g., kangaroo rats, grasshopper mouse).

***Effects from prescribed fire*:** Prescribed fire in this habitat was studied by Young (1987), who found that fire had a significant species-specific influence on vegetation structure and community function. Increases in aboveground production were noted for 1 to 2 years following treatment in a majority of sites. His findings suggested a return to preburn status within 3 to 5 years.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from public recreational use**:* The main recreational uses affecting salt desert scrub habitats would be wildlife observation/photography and upland game hunting/waterfowl hunting. The footprint of new facilities to be built in this habitat type would be 0.3 acre under Alternative 2 and Alternative 3, mostly stemming from the addition of a boardwalk and viewing platform for visitors to view Harney Lake.

Hunters may traverse and pursue upland game birds within salt desert scrub habitats, causing disturbance to other species in the process. Increased disturbances to these habitats relative to Alternative 1 may result from the expanded waterfowl hunting program under Alternative 2 (which would be allowed in the Buena Vista Unit during fall and winter). However, disturbance to non-target species from hunting is considered minor to negligible. Hunting seasons do not coincide with the nesting season, so reproduction would not be reduced by hunting. Encounters with other taxa, such as reptiles and amphibians, invertebrates, and small mammals, in the early fall would be few and should not have cumulative negative effects on Refuge populations. It is also important to keep in mind that hunting already occurs in the Buena Vista Unit for upland game, so the addition of a waterfowl hunt in this unit under Alternative 2 would only add an incremental amount of disturbance to the disturbance that already exists.

Except where docent-led tours may occur on an infrequent basis, disturbance to habitat or wildlife in this habitat type from wildlife observation and photography under Alternative 2 is expected to be negligible (see CDs, Appendix B). Compared to Alternatives 1 and 2, disturbance potential would be somewhat increased under Alternative 3, which would allow free roam wildlife observation and photography during fall, winter, and early spring in designated portions of the Refuge. Since people are unlikely to concentrate in salt desert scrub habitats, impacts from disturbance to this habitat are expected to be minimal. In addition, similar to the reasoning presented for hunting, fall, winter, and early spring disturbance for these habitats is generally of less concern because wildlife would not be engaged in critical breeding activities during these seasons.

***Overall effects*:** Based on an assessment of habitat management factors, and public use factors, overall Alternatives 2 and 3 will have a neutral effect on salt desert scrub habitat.

6.3.7 Effects to Sagebrush Lowland Habitat and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of sagebrush lowland habitat (4,300 to 4,500 acres) on the Malheur Refuge would remain unchanged. Aside from periodic weed control and limited prescribed disturbance (e.g., fire), this habitat type would require a limited amount of active management. Throughout the life of the CCP, the goal is to protect and maintain lowland big sagebrush habitats (e.g., basin big sagebrush, Wyoming big sagebrush, basin wildrye, Indian ricegrass, Sandberg's bluegrass, bottlebrush squirreltail, etc.) for the benefit of ground nesting migratory birds (e.g., gadwall, short-eared owl, meadowlark) and a diverse assemblage of native species (e.g., small mammals).

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from prescribed fire*:** Prescribed fire in sagebrush type habitats was reviewed for the Service by PBS&J (2011)(Appendix Q). Depending on fire severity, sagebrush can be killed directly by surface fires, and may take 25 years or substantially longer (depending on the species) to recover. However, fire may cause other shrubs such as rabbitbrush to resprout and prosper.

Native perennial response varies tremendously, with some species responding well and others not responding well. Exotic annual grasses, especially cheatgrass and medusahead, are reduced immediately, but rapidly recolonize and out-compete native perennial grasses and herbaceous species. As summarized in PBS&J (2011), such sites may "type-convert" to annual grasslands, facilitating future fires and eliminating residual or newly established sagebrush. This effect is not seen where fire has minimal effects on the native perennial herbaceous component and sources of noxious weed propagules are limited.

Short- and long-term effects to wildlife are similar to those described in Section 6.3.4. However, a review by PBS&J (2011) indicates that recovery of nesting habitats used by some passerines may be slower than what would be seen post-burn in palustrine-type habitats. For reptiles and amphibians, ground debris and leaf litter are important as habitat, and this type of material may accumulate slowly after a burn, thus having longer-term effects on the recolonization for these species.

Mosaic burning in smaller patches is suggested as a way to mitigate negative post-burn responses and to facilitate recovery and response.

***Effects from public recreational use*:** The main recreational uses affecting sagebrush lowland habitats would be wildlife observation/photography and upland game hunting/waterfowl hunting. The footprint of new facilities to be built in this habitat type would be 0 acres under Alternative 2 and 0 acres under Alternative 3. Effects would be similar to effects under salt desert scrub (see Section 6.3.6).

***Overall effects*:** Based on an assessment of habitat management factors and public use factors, Alternatives 2 and 3 will have a neutral to minor negative effect on sagebrush lowland habitat and associated species.

6.3.8 Effects to Sagebrush Steppe Habitat and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of sagebrush steppe habitat (15,500 acres) on the Malheur Refuge would remain unchanged. Aside from periodic weed control and limited prescribed disturbance (e.g., fire), this habitat type requires a limited amount of active management. Under Alternatives 2 and 3, proposed habitat actions in sagebrush steppe communities include: adding diversity to crested wheatgrass monocultures; mimicking natural disturbance processes in sagebrush communities using mechanical and chemical methods to promote bunchgrasses and forbs; and seeding of desirable grasses and forbs. These actions would be expected to result in a minor beneficial effect on the sage thrasher and other sagebrush-dependent species.

***Effects from prescribed fire*:** See Section 6.3.7.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** The main recreational uses affecting sagebrush steppe habitats would be wildlife observation/photography. The footprint of new facilities to be built in this habitat type would be 0.1 acre under Alternative 2 and 0 acres under Alternative 3.

Except where docent-led tours may occur on an infrequent basis, disturbance to habitat or wildlife in this habitat type from wildlife observation and photography under Alternative 2 is expected to be negligible (see CDs, Appendix B). Compared to Alternatives 1 and 2, disturbance potential would be somewhat heightened under Alternative 3, which would allow free roam wildlife observation and photography during fall, winter, and early spring in designated portions of the Refuge. People are less likely to concentrate in sagebrush steppe habitats so this is likely a negligible concern. In addition, similar to the reasoning presented for hunting, fall, winter, and early spring disturbance for these habitats is generally of less concern because wildlife would not be engaged in critical breeding activities during these seasons.

***Overall effects*:** Based on an assessment of habitat management factors, and public use factors, Alternatives 2 and 3 will have a neutral to minor beneficial effect on sagebrush steppe habitat and associated species.

6.3.9 Effects to Dune Habitat and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of dune habitat (6,300 acres) on Malheur Refuge would remain unchanged. Periodic weed control would constitute the only regular active management technique used in this habitat type. Habitat actions that protect, maintain,

and enhance the composition and structure of dune habitat in its desired condition would have a long-term minor beneficial effect on the sage sparrow and other wildlife species that use this habitat type.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** The main recreational uses affecting dune habitat would be wildlife observation/photography/interpretation. Under Alternatives 2 and 3, a short boardwalk with viewing platform will be constructed on the north side of Harney Lake, which would affect 0.1 acre of dune habitat. The boardwalk would be fenced along its entire length to prevent people from straying into the dunes.

Except for the rare docent-led tours that may venture into dune habitat (see Wildlife Observation, Photography, and Interpretation CD in Appendix B), no other use would occur in dune habitat. As described in the CD, docent-led tours would be limited to 20 per year throughout the Refuge. Therefore, entry in this habitat would be expected to be very rare. Thus, effects to dune habitat from recreational use would be considered negligible under Alternatives 2 and 3.

***Overall effects*:** Based on an assessment of habitat management and public use factors, Alternatives 2 and 3 will have a negligible to minor beneficial effect on dune habitat.

6.3.10 Effects to Playa Habitat and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of playa habitat (29,000 acres) on Malheur Refuge would remain unchanged. Fluctuating hydrologic conditions would remain the same as present, that is, the Refuge would take measures for retention of hypersaline conditions where appropriate (avoiding dilution caused by fresh water irrigation and recharge through springs or natural overland flow).

Periodic weed control would constitute the only regular type of active management. These management actions would be anticipated to have a neutral to minor beneficial effect on the snowy plover and other wildlife species that use this habitat type.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** Under all alternatives, no new facilities, including roads and trails are proposed in playa habitats. As a closed area, access would not be permitted for the general public, and would be expected only from very occasional special use permit access to docent groups or photographers under Alternatives 2 and 3. As described in the Wildlife Observation and Photography CD (Appendix B), docent-led tours would be limited to 20 per year throughout the Refuge. Therefore, entry in this habitat would be expected to be very rare. Thus, public uses, except for a very limited potential for disturbance from the adjacent road and new boardwalk, will be expected to have a negligible effect.

***Overall effects*:** Based on an assessment of habitat management and public use factors, Alternatives 2 and 3 will have a neutral to minor beneficial effect on playa habitat.

6.3.11 Effects to Cropland Habitat and Associated Species

***Effects from habitat actions*:** Under both action alternatives, the amount of small grain (e.g., wheat, barley) cropland habitat on Malheur Refuge would increase to between 80 and 1,000 acres. Under Alternative 1, cropland would remain at or near 80 acres. Grain farming in the Blitzen Valley plays an important role in meeting Refuge objectives for fall maintenance of greater sandhill cranes, and the acres projected to be managed as cropland were calculated based on the population figures and needs for the Refuge's fall-staging greater sandhill cranes (Ivey 2009). Canada geese and some dabbling ducks also benefit from grain farming since they use grain to build their fat reserves. The Farming CD in Appendix B provides detailed analysis of the effects of cropland farming on the Refuge under this proposed CCP.

***Effects from IPM*:** See Section 6.1 for effects from IPM.

***Effects from public recreational use*:** Under all alternatives, no new facilities, including roads and trails, are proposed in cropland habitats. Wildlife observation, photography, interpretation, hunting, and environmental education could result in disturbance to wildlife using cropland habitat (see CDs, Appendix B). Under Alternative 3, free roam access, which would begin on August 15 in the Buena Vista Unit, would have a moderate to significant negative impact on staging sandhill cranes using the croplands prior to migration. The croplands are near the Center Patrol Road and may be easily accessed by visitors on foot under a free roam management scenario.

***Overall effects*:** Based on an overall assessment of habitat management factors and public use factors Alternative 2 would be expected to have a moderate benefit to wildlife using these habitats. Although these habitats are important, they are only part of the needs of greater sandhill cranes provided by the Refuge. Alternative 3 would have a neutral to minor beneficial effect, with the increase in acres under Alternative 3 outweighing the disturbance effects associated with free roam activities.

6.3.12 Effects to Cold and Hot Springs and Associated Species

***Effects from habitat actions*:** Under all three alternatives, the amount of cold and hot springs and associated pools and vegetative habitats (230 to 250 acres) on the Refuge would remain unchanged. Under Alternatives 2 and 3, strategies to protect cold and hot springs include: securing/adjudicating groundwater rights; protecting spring habitat from undesirable, preventable disturbance; and controlling invasive species. Some springs are known to provide a stable, permanent source of water for spotted frog breeding, feeding, and winter refugia. These actions, which would assist in protecting, maintaining, and enhancing spring habitat in its desired condition, would have a minor to moderate beneficial effect on spotted frogs and other wildlife species that use this habitat type.

***Effects from IPM*:** See section 6.1 for effects from IPM.

***Effects from public recreational use*:** Under all alternatives, no new facilities, including roads and trails are proposed in spring habitats. Although these sites are fairly subtle and hard to distinguish on the landscape during much of the year, free roam activities, including wildlife observation, and photography under Alternative 3, as well as upland and waterfowl hunting under both alternatives, could result in habitat disturbance or disturbance to wildlife in and around springs during the free roam period. Since these areas tend to remain ice-free, they do provide important wintering sites for some species.

***Overall effects*:** Based on an assessment of habitat management factors and public use factors, overall effects to cold and hot springs under both Alternatives 2 and 3 are likely to be minor but positive, with habitat management actions outweighing potential public use effects.

6.3.13 Effects to Cliffs, Rimrock, and Outcropping

No effect is expected to cliffs, rimrock, and outcropping habitat under Alternatives 1 and 2, as no active management or public use is expected in this habitat type. Under Alternative 3, a limited amount of public disturbance could occur in this habitat with the addition of free roam. Overall, a negligible to minor negative effect would be expected to this habitat under Alternative 3.

6.3.14 Effects to Threatened, Endangered, or Candidate Species

Columbia Spotted Frog

Spotted frogs have been documented in limited areas on the Refuge (Engle 2001; Pearl et al. 2010; Rombough and Engler 2010). It is unclear at this time if the Refuge population is part of the Great Basin distinct population, which is the Federal candidate species, or if they belong to the Oregon population (not listed as a candidate).

***Effects from habitat actions*:** Spotted frogs are aquatic specialists and more dependent on permanent aquatic habitats than other ranid species (Ammon 2002; Perkins and Lentsch 1998). Habitat factors affecting the presence of frogs were analyzed and modeled by Welch and McMahon (2005). Their results suggested that spotted frogs are more likely to occur in ponds that do not shrink in size seasonally, maintain relatively constant seasonal water temperature, and have high emergent vegetation cover. Under both action alternatives, the amount of permanent wetland and riverine habitat available to the Great Basin Columbia spotted frog would remain near current levels, though emergent vegetation may decrease by up to 2,000 acres. Water manipulation (drying of seasonal wetlands and the occasional drying of "permanent" wetlands) may have a negative effect on frogs. However, these manipulations will likely occur at approximately the same rate as under current management (Alternative 1), so although these treatments may pose some risk to undiscovered frogs, the effect would be neutral relative to Alternative 1.

Under both action alternatives, Refuge wetlands would be managed to encourage healthy and diverse wetland plant communities through periodic prescribed fire, haying, rake-bunch grazing, and the use of chemical and biological control agents. Prescribed fire is explored in more detail in Section 6.3.4, and integrated pest management actions (IPM) is explored in more detail in Section 6.1, while haying and rake-bunch grazing are explored in the CD covering these uses (Appendix B). Management actions such as these may have short-term effects on individual frogs but is not expected to harm the habitat or existing populations over the long term.

***Effects from public use actions*:** Effects to the frog from public use under Alternative 2 are analyzed in the CDs (see Appendix B). Effects from wildlife observation, photography, and interpretation, environmental education, waterfowl and upland game hunting, and commercial uses were considered negligible, while effects from fishing were considered minor. Effects would be largely the same under Alternative 3, with a slightly higher likelihood of impact from wildlife observation and photography free roam areas, since this type of use has a higher possibility of causing some habitat trampling or direct mortality to frogs that may be handled by the public.

***Overall effects*:** Based on an assessment of habitat management factors and public use factors, effects on the Columbia spotted frog would be considered neutral under Alternative 2 and neutral to minor negative under Alternative 3.

Greater Sage Grouse

***Effects from habitat actions*:** As discussed in Section 6.3.8, under all three alternatives, the amount of sagebrush steppe (15,500 acres) and sagebrush lowland (4,300-4,500 acres) habitat available to the greater sage grouse would remain unchanged. Aside from periodic weed control and limited prescribed disturbance (e.g., fire), these habitat types do not require a significant active management. Under Alternatives 2 and 3, proposed habitat actions in sagebrush steppe communities include: adding diversity to crested wheatgrass monocultures; mimicking natural disturbance processes in sagebrush communities using mechanical and chemical methods to promote bunchgrasses and forbs, and seeding of desirable grasses and forbs. These habitat actions would be beneficial but would be generally negligible to the conservation of the species over its range.

***Effects from public use actions*:** Decreasing numbers of greater sage grouse are considered to be tied to habitat fragmentation and loss, so locating public facilities away from habitats that support this species and increasing specific public education can assist in raising awareness and preventing undue impacts to the species. Under the proposed CCP, 0 acres of new facilities are proposed in habitats preferred by sage grouse. If off-trail use results in unacceptable adverse effects to sage grouse or their habitat, the Refuge would limit use to the trails. Hunting of greater sage grouse on the Refuge is not permitted and would not be permitted over the life of the CCP. Minor disturbance to sage grouse is expected during hunting season as hunters with dogs pursue other upland game birds including pheasant, quail, and partridge.

***Overall effects*:** Based on an assessment of habitat management factors and public use factors, Alternatives 2 and 3 would have a negligible effect on sage grouse.

6.4 Effects to Cultural, Historical, and Paleontological Resources

The National Historic Preservation Act (NHPA) of 1966, as amended, establishes the Federal Government's policy on historic preservation and the programs through which that policy is implemented. An impact to cultural resources would be considered significant if it adversely affects a resource listed on or eligible for listing on the National Register of Historic Places (NRHP). In general, an adverse effect may occur if a cultural resource would be physically damaged or altered, isolated from the context considered significant, or affected by project elements that would be out of character with the significant property or its setting. Title 36 CFR Part 800 defines effects and adverse effects on historic resources.

Alternatives 2 and 3 would open portions of the Refuge to new or expanded uses, and would increase opportunities for the illegal collection of cultural resources, and vandalism and looting of archaeological sites.

Prior to implementing all ground-disturbing projects, applicable cultural resource compliance investigations would be undertaken. If cultural resources are found, appropriate procedures and protocols would be followed to protect them. Whenever possible, impacts to resources would be avoided or mitigated. Mitigation options, in addition to site avoidance, would include relocating or

redesigning facilities and data recovery using either collection techniques or in-situ site stabilization protection.

Under Alternatives 2 and 3 cultural resource and paleontological protection would be strengthened by the development, in cooperation with partners, of step-down management plans for administrative sites where historic or prehistoric resources are present, and for archaeological and paleontological resources. Interpretation of historic sites would be expanded through the development and implementation of site-specific interpretive plans. The areas in which Native Americans may collect plant materials for traditional uses would be expanded; however, use is not expected to go up. This use would be administered under special use permits. Collecting areas would be specified so as to minimize conflicts with wildlife. Monitoring and inventory of archaeological resources would increase as part of step-down management plan implementation.

6.5 Social Effects

The Social Effects section assesses how management actions under each alternative could affect quality opportunities for each of the Refuge System's priority public uses (hunting, fishing, photography, wildlife observation, environmental education, and interpretation) are evaluated. In addition, opportunities for non-wildlife-dependent recreation are examined, as is the extent of illegal uses. The section also includes an assessment of the change in Refuge user numbers expected under each of the alternatives.

6.5.1 Effects to Opportunities for Quality Hunting

The Refuge would continue to explore opportunities to transfer the Boundary hunt unit (the portion of the Refuge west of State Highway 205 and southeast of Krumbo Reservoir) to the Bureau of Land Management (BLM). However, hunting opportunities would remain in this area; they would just be managed by BLM instead of the Service.

***Effects from habitat actions*:** Alternatives 2 and 3 would improve native habitat conditions as compared to Alternative 1. This emphasis could result in enhanced opportunities for sighting and harvesting upland game birds and waterfowl. If carp control is successful, the effect could be particularly pronounced for waterfowl. Alternative 2 would be expected to have a higher likelihood of improving opportunities for hunters to harvest waterfowl.

***Effects from public recreational usage*:** Under Alternative 2, opportunities for upland game hunting would be enhanced by access improvements and extending the season in the Buena Vista hunt unit.

A variety of new opportunities would also be added for waterfowl hunting under Alternative 2, with two new areas added, promotion of a youth waterfowl hunt, ADA-accessible facilities added for disabled waterfowl hunters, and improved access to existing waterfowl hunt areas. Each of these measures would increase opportunities for hunting on the Refuge.

Under Alternative 3, the upland game and waterfowl hunts would be managed as under Alternative 2, with the exception of the addition of waterfowl hunting in the Buena Vista Hunt Unit, which would not be added. ADA-accessible facilities would also not be developed under Alternative 3. However, the Service would explore opportunities to create a youth hunt at Double-O Unit, which is considered a promising area to hunt. Essentially, Alternative 3 also increases opportunities, but focuses on a

different audience and a different style of hunting to increase opportunities for a wider variety of hunters.

***Overall effects*:** Overall, moderate beneficial effects would occur for visitor opportunities to enjoy hunting under Alternative 2, and minor beneficial effects would be expected under Alternative 3, with the difference in effect due largely to the area of the Refuge open to hunting.

6.5.2 Effects to Opportunities for Quality Fishing

***Effects from habitat actions*:** Both alternatives involve improvements to aquatic health primarily through aggressive control of invasive common carp. This will have positive impacts on native fish, amphibians, and reptiles, as well as other wildlife and plants that are dependent on aquatic resources. As carp populations decrease, an ecological balance will return to the aquatic habitat that will positively aid the native fish to flourish. Native fishes would compete less with carp for aquatic invertebrates, other food sources, and habitat. Plant species that have been unable to grow due to carp feeding behavior would increase in extent and vigor. Although most of the carp control efforts will be focused on Malheur Lake and the Refuge impoundments and wetlands (none of which are open to fishing), the potential exists for these carp actions to have positive impacts on species like redband trout, which use Malheur Lake for part of their life cycle. Thus, indirectly, fishing opportunities may be enhanced in the Blitzen River, though the magnitude of this impact is uncertain.

***Effects from public recreational usage*:** No changes would occur to fishing opportunities under Alternative 1; hence, it has a neutral effect. Under both Alternatives 2 and 3, fishing opportunities along the Blitzen River, the southern portion of East Canal, and Mud and Bridge creeks would be substantially improved due to markedly increased access. More stream miles would be accessible by vehicle, and trail crossings would create better access for fishing (a new pedestrian crossing at Bridge Creek would enhance fishing access to the 7 miles of Bridge Creek located west of the East Canal to its confluence with the Blitzen River). A new late-summer bank-fishing opportunity would be provided along with a parking area at Sodhouse Lane to the bridge on Boat Landing Road. Enhanced information would be available to fishing visitors. In addition, year-round access would be provided at Krumbo Reservoir for boating and fishing in coordination with state seasons. Each of these measures would increase public fishing opportunities.

Under Alternative 3, fishing opportunities would be similar to those under Alternative 2, with the exception of access along the East Canal, which would remain walk-in only. Pedestrian crossings over waterways would also not be established in the south fishing loop. Walk-in access on East Canal Road, however, would expand opportunities for solitude and appreciation of the landscape in conjunction with fishing. At Krumbo Reservoir, the fisheries would be managed as under Alternative 2; however, only walk-in access would be available from November 1 through the fourth Friday of April to provide opportunities for solitude. Hence, Alternative 2 would provide only a minor increase in fishing opportunity compared to Alternative 1.

***Overall effects*:** Overall, a moderate beneficial effect would occur for visitor opportunities to enjoy fishing under Alternative 2 and a minor beneficial effect for Alternative 3, due primarily to differences in access as explained above.

6.5.3 Effects to Opportunities for Quality Wildlife Observation and Photography

***Effects from habitat actions*:** Alternatives 2 and 3 seek to improve the aquatic health of lakes and wetlands including the development of a comprehensive riverine/wetland rehabilitation plan for the Blitzen River and its tributaries. The result of these actions would be positive with an eventual increase in quality native habitats. These improvements would result in enhanced opportunities to observe native wildlife, plants, and fish. Under all alternatives, there would be occasional short-term negative effects to visitors as habitat management activities are conducted, but due to the extent that these tools improve habitats for a variety and abundance of wildlife, the long-term effect should be positive for this use.

***Effects from public recreational usage*:** Alternative 2 provides a moderate increase in non-consumptive recreational opportunities at the Refuge. These opportunities arise through an emphasis on increased trails and viewing facilities, improved access including vehicle pull-outs, viewing overlooks and elevated viewing platforms, and an increase in docent-led tours. In addition, seasonal pleasure boating would be permitted at Krumbo Reservoir outside of the fishing season to enhance wildlife viewing. Alternative 3 would provide a smaller increase in non-consumptive recreational opportunities than Alternative 2, with less emphasis on developed facilities. However, Alternative 3 provides more areas for free roam access for wildlife observation and photographers than is currently available.

***Overall effects*:** Overall, a moderate positive effect would occur for visitor opportunities to enjoy quality wildlife observation and photography for both Alternatives 2 and 3, with slightly different user groups enhanced in each alternative.

6.5.4 Effects to Opportunities for Quality Environmental Education

***Effects from habitat actions*:** Alternatives 2 and 3 seek to improve the aquatic health of the lakes and wetlands and include the development of a comprehensive riverine/wetland rehabilitation plan for the Blitzen River and its tributaries. It is anticipated that these improvements would result in an increase in quality of native habitats, which would in turn enhance opportunities to observe native wildlife, plants, and fish, and would have an overall positive impact on environmental education opportunities.

***Effects from public recreational usage*:** Under Alternatives 2 and 3, environmental education would be provided, but with more strategic use of Refuge staff time and resources. Strategies would include coordinating efforts with other environmental education initiatives. Existing modules from national and regional programs, such as Junior Duck Stamp, International Migratory Bird Day, etc., would be used as Refuge staff and volunteers become available. An outdoor environmental education shelter and learning area at Refuge Headquarters would be built to assist with the existing environmental education program and other environmental education initiatives. However, the number of students served is projected to remain approximately the same.

***Overall effects*:** Overall, a minor beneficial effect would occur for environmental education opportunities under Alternatives 2 and 3, compared to Alternative 1.

6.5.5 Effects to Opportunities for Quality Interpretation

***Effects from habitat actions*:** Alternatives 2 and 3 seek to improve the aquatic health of the lakes and wetlands and include the development of a comprehensive riverine/wetland rehabilitation plan for the Blitzen River and its tributaries. It is anticipated that these improvements would result in an increase in quality of native habitats, which would in turn enhance opportunities to observe native wildlife, plants, and fish and would have an overall positive impact for quality interpretation opportunities.

***Effects from public recreational usage*:** Under Alternatives 2 and 3, interpretive features and programs would have a high priority. Key interpretive themes would include the significance of the Refuge to breeding and migratory birds, pre- and post-contact historical events, wilderness, geology, aquatic health, water importance, resource challenges, and the importance of the National Wildlife Refuge System. A stronger emphasis would be placed on developing and using modern media. The George Benson Memorial Museum at Refuge Headquarters would be enhanced with interpretive panels to connect visitors with the places and resources that the Refuge protects. Additional outdoor interpretive panels would be placed at key field sites and would focus on the themes of improving aquatic health and associated management activities, and weaving historical events with the ecology of the Refuge. Special events and public presentations by Refuge staff and volunteers would be expanded and promoted to enhance visitors' experiences. In addition, docent-led tours would be conducted at different locations on a seasonal basis under both alternatives.

***Overall effects*:** Overall, a moderate beneficial effect would occur for quality interpretation opportunities for both Alternatives 2 and 3, due to notable increases in interpretive offerings at the Refuge.

6.5.6 Effects to Opportunities for Non-wildlife-dependent Recreation

Under Alternative 2, increased access for boating would be implemented, which would provide minor increases in opportunity for non-wildlife-dependent recreation.

6.5.7 Projected Refuge Visits in 15 Years, by Alternative

Table 6-1 displays visitation by use. The current number of Refuge visits is displayed, as well as the expected visits that would occur by the end of CCP implementation for each of the three alternatives.

Table 6-1. Estimated Refuge Visits at the End of 15 Years by Key Activities*

Activity	Current Refuge Visits (2011)	Alternative 1: Projected Visits by 2027	Alternative 2: Projected Visits by 2027	Alternative 3: Projected Visits by 2027
Consumptive Use				
Hunting visits: waterfowl	85	85	180	180
Hunting visits: upland game birds	850	850	1,000	1,000
Hunting visits: big game	40	40	0	0
Fishing visits	1,300	1,300	1,750	1,300

Activity	Current Refuge Visits (2011)	Alternative 1: Projected Visits by 2027	Alternative 2: Projected Visits by 2027	Alternative 3: Projected Visits by 2027
Non-Consumptive Use				
Pedestrian Visits; Hiking and Walking	28,000	28,000	38,000	44,000
Auto Tour Visits	61,000	61,000	82,000	82,000
Boat Trail/Launch Visits	400	400	500	400
Bicycle Visits	2,600	2,600	2,700	2,700
Photography Visits	52,000	52,000	71,300	71,300
Environmental Education Visits (non-local visitors)	6,700	6,700	9,000	9,000
Environmental Education Visits (local)	700	700	800	800
Interpretation Visits	52,000	52,000	71,000	71,000
Wildlife Observation Visits	61,000	61,000	82,000	82,000
Commercial Activities	1,000	1,000	1,150	1,150

* Visits are counted per use, which does not necessarily mean a visitor makes a separate visit to engage in each use. For visitors who stay multiple days (the vast majority), each day of an extended visit is counted as a separate visit.

Projected changes in visitation by use over the next 15 years were estimated by multiplying current use by an annual average change factor over a 15-year horizon, based on the following considerations:

- Changes in recreational programs, facilities, and resources under each alternative
- Changes observed in visitation at Malheur Refuge over the last 15 years (Refuge staff experience/judgment)
- Broader trend data by use from 1987 to 2002, presented for southeast Oregon in the Oregon SCORP Report (Oregon Parks and Recreation Department 2003)
- Trend data by use compiled nationally by the Outdoor Foundation for the period 2000-2009 (or in some cases 2008-2009) (Outdoor Foundation 2010)

Alternative 2 provides a moderate increase in non-consumptive recreational opportunities at the Refuge compared to the present. These opportunities arise primarily through an emphasis on increased trails and viewing facilities and increased offerings of interpretive and educational programs. Although the new facilities projected are relatively modest, the opportunities provided by the facilities and the program changes (for example, a new viewing tower on Malheur Lake and potential docent-led kayak tours on Malheur Lake) will create enhanced access that has not been available at Malheur Refuge for many years. Overall, a 4 percent annual increase is projected for most non-consumptive uses.

Alternative 3 would provide a similar increase in non-consumptive recreational opportunities as compared to Alternative 2, but the emphasis in Alternative 3 is to promote "free roam" activities, allowing visitors to walk on Refuge roads and diketops. Aside from this, the major difference in recreational programs between Alternatives 2 and 3 lies in the hunting programs. Under Alternative 2, waterfowl hunters would have access to the Buena Vista Unit. This opportunity is not available under Alternative 3, but Alternative 3 would potentially create a youth hunt opportunity. These are different opportunities, but are thought to balance each other out in terms of expected changes in visitation after 15 years, with the increase due to access available at Buena Vista Unit considered equivalent (for visitation) to the increase due to access at Double-O Unit for the youth hunt.

6.5.8 Amount of Illegal Use

Trespass into closed areas, illegal collection of archaeological and paleontological resources, cattle trespass, poaching, illegal collection of natural resources, and illegal drug activity occur on the Refuge. Some of the same Refuge qualities that attract legitimate refuge visitors—solitude, remoteness, open public spaces, hunting and fishing access, and minimal human interference—also attract individuals seeking places for illegal activities. Under all the alternatives, illegal activities will be curbed to create a safe environment for visitors. Continued cooperation with local and Federal law enforcement agencies will continue to deter illegal activities while promoting visitor safety, security, and preservation of cultural and paleontological resources.

6.5.9 Environmental Justice

Since CCP implementation is expected to result in generally positive effects on the human environment, Alternatives 2 and Alternative 3 pose little risk of resulting in disproportionate adverse effects on human health, economics, or the social environment.

6.6 Economic Effects

6.6.1 Approach to Estimating Economic Effects

From an economic perspective, Malheur Refuge provides a variety of environmental and natural resource goods and services used by people either directly or indirectly. The use of these goods and services may result in economic impacts to both local and state economies. The various services the Refuge provides can be grouped into five broad categories: (1) maintenance and conservation of environmental resources, services, and ecological processes; (2) production and protection of natural resources such as fish and wildlife; (3) production and protection of cultural and historical sites and objects; (4) provision of educational and research opportunities; and (5) outdoor and wildlife-related recreation. People who use these services benefit in the sense that their individual welfare or satisfaction level increases with the use of a particular good or service.

One measure of the magnitude of the change in welfare or satisfaction associated with using a particular good or service is economic value. *Economic value* is the economic trade-off people would be willing to make in order to obtain some good or service. It is the maximum amount people would be willing to pay in order to obtain a particular good or service minus the actual cost of acquisition. In economic theory this is known as *net economic value* or *consumer surplus*. In the context of this report, estimates of the economic value of particular recreational activities are used to determine the aggregate value of recreational use of Malheur Refuge.

Aside from the effect on the individual, the use of a good or service usually entails spending money in some fashion. These expenditures, in turn, create a variety of economic effects collectively known as *economic impacts*. Economic impacts refer to employment, employment or labor earnings, economic output, and Federal, local, county, and state tax revenue that occur as the result of Refuge activities. To estimate the total economic activity, employment, employment income, and federal and state taxes generated by Refuge activities, this report uses IMPLAN[1], a regional input-output model and software system. The following is a list of terms and definitions that are commonly used in economic impact analysis (Miller and Blair 1985; Minnesota IMPLAN Group, Inc. 2004).

Definitions of Economic Terms

- *Economic output* includes three types of effects: direct, indirect, and induced effects. Direct effects are the expenditures associated with a particular activity (such as Refuge visits, budget expenses, and grazing and haying activities). "Indirect effects result from changes in sales for suppliers to the directly-affected businesses (including trade and services at the retail, wholesale and producer levels). Induced effects are associated with further shifts in spending on food, clothing, shelter and other consumer goods and services, as a consequence of the change in workers and payroll of directly and indirectly affected businesses" (Weisbrod and Weisbrod 1997:11). Indirect and induced effects represent multiplier effects. Both job income and tax revenue are derived from total economic output (aggregate sales). For example, labor costs are paid out of total sales revenue for a company, as are taxes. To add taxes and job income to output would double-count economic impacts.
- *Jobs* and *job income* include direct, indirect, and induced effects in a manner similar to economic output. Employment includes both full-time and part-time jobs, with a job defined as one person working for at least part of the calendar year, whether that is one day or the entire year.
- *Tax revenues*[2] are shown for business taxes, income taxes, and a variety of taxes at the local, state, and national level. Like output, employment, and income, tax impacts include direct, indirect, and induced tax effects.

Limitations of the Analysis: A comprehensive economic profile (baseline) of the Refuge and estimates of the economic effects of alternative management strategies would address all applicable economic effects associated with the use of Refuge-produced goods and services. However, for those goods and services having nebulous or non-existent links to the marketplace, economic effects are more difficult or perhaps even impossible to estimate. Some of the major contributions of the Refuge to the natural environment, such as watershed protection, maintenance and stabilization of ecological processes, and the enhancement of biodiversity, would require extensive on-site knowledge of biological, ecological, and physical processes and interrelationships even to begin to formulate economic benefit estimates. This is beyond the scope of this report.

This report focuses on a limited subset of Refuge goods and services, primarily those directly linked in some fashion to the marketplace, such as recreation use, Refuge budget expenditures, grazing, and

[1] "IMPLAN … was originally developed by the USDA Forest Service in cooperation with the Federal Emergency Management Agency and the USDOI Bureau of Land Management to assist the Forest Service in land and resource management planning" (Minnesota IMPLAN Group, Inc. 2004). First developed in 1979, IMPLAN data and software was privatized in 1993 by the Minnesota IMPLAN Group, Inc. For additional information, see www.implan.com. For additional information on input-output modeling, see Miller and Blair (1985).

[2] The overall tax rate is about 13.7 percent of economic output and includes direct, indirect, and induced tax effects nationwide. The tax rate is calculated within the economic modeling software used to estimate economic impacts.

haying. It should be kept in mind that the emphasis on these particular market-oriented goods and services should not be interpreted to imply that these types of goods and services are somehow more important or of greater value (economic or otherwise) than the non-market goods and services previously discussed.

For this report, three types of economic impacts are addressed: (1) impacts associated with annual consumer expenditures on Refuge-related recreation; (2) impacts associated with Refuge expenditures; and (3) impacts associated with grazing and hay removal. The economic impacts are presented as annual impacts over a 15-year time period. For Alternatives 2 and 3, the analysis presents the impacts that would result assuming that all management objectives are implemented and achieved. Note that funds are not currently present to implement all objectives and strategies identified; however, the analysis for Alternatives 2 and 3 assumes that funding would manifest.

6.6.2 Recreational Activities Effects on Local Economic Indicators

Overview: As discussed in Chapter 5, Malheur Refuge receives visitors from across North America and the world. Nearly half of Refuge visitors come from outside the State of Oregon. Nearly all visitors stay more than one day. Various independent groups organize regular trips to Malheur Refuge, especially during the spring. The Refuge is also a partner for the John Scharff Migratory Bird Festival each spring and is a stop for organized tours and independent visitors during the festival weekend. Spending by recreational visitors visiting the Refuge impacts the local economy, by creating jobs and generating tax revenue.

Economic impacts for the recreation baseline and alternatives are addressed in this section. Two types of information are needed to estimate the economic impacts of recreational visits to the Refuge: (1) the amount of recreational use on the Refuge by activity; and (2) expenditures associated with recreational visits to the Refuge. Recreational use (both current and future under the different alternative scenarios) was estimated by Refuge staff. Expenditure patterns used in this report were obtained from the 2011 National Wildlife Refuge Visitor Survey (Sexton et al. in draft) and the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior et al. 2007). These expenditures include only travel-related expenses, including food, lodging, transportation, and other miscellaneous travel-related expenses. With this information, total expenditures for each activity can be estimated. These expenditures, in turn, can be used in conjunction with regional economic models to estimate industrial output, employment, employment income, and tax impacts associated with these expenditures. The economic impact area for recreational activities is defined as Harney County, Oregon. It is assumed that visitor expenditures occur primarily within the County.

The economic impacts from recreation expenditures estimated in this report are gross area-wide impacts. Information on where expenditures may occur locally and the magnitude and location of resident and non-resident expenditures (resident and non-resident relative to the geographical area of interest) is not currently available. Generally speaking, non-resident expenditures bring outside money into the area and thus generate increases in real income or wealth. Spending by residents is simply a transfer of expenditures on one set of goods and services to a different set within the same area. In order to calculate net economic impacts within a given area derived from resident expenditures, much more detailed information would be necessary on expenditure patterns and visitor characteristics. Since this information is not currently available, the gross area-wide estimates are considered the maximum impact of total resident and non-resident spending in Harney County.

The economic impacts of non-resident spending represent a real increase in wealth and income for the area (for additional information, see Loomis 1993:191).

Alternative 1: Under Alternative 1, there would be no changes to the recreational activities offered at the Refuge. All programs would continue to follow current management goals. Malheur Refuge currently offers a variety of wildlife-dependent public uses, including hunting, freshwater fishing, and many non-consumptive activities.

Table 6-2 shows the visitation for Malheur Refuge in 2010. The Refuge had 71,675 visits in 2010. (Most of these represent a full visit-day of 7 hours; however, local environmental education visits are estimated at only 4 hours each). Since the average length of stay for a Malheur Refuge visitor is nearly 3 days, it is important to distinguish clearly between visitors and visits.

Wildlife observation visits represented 85 percent of all visits. Most visitors partaking in wildlife observation spend an average of nearly 3 days at the Refuge. Wildlife observation visits include activities such as auto tours, hiking, photography, and boating. In addition to recreational visits (non-consumptive activities, hunting, and fishing), the Refuge also had 7,400 environmental education visits. The environmental education program provides education opportunities to both the surrounding community and non-residents. Environmental education opportunities for residents do not contribute to the local economic impacts because the events typically do not bring visitors who are spending money toward travel-related goods and services. However, environmental education opportunities for non-residents do contribute toward local economic impacts.

Table 6-2. Alternative 1: FY 2010 Visitation

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	2,440	58,560	61,000
Other recreation	0	1,000	1,000
Environmental education	700	6,700	7,400
Hunting:			
Waterfowl	77	9	85
Other migratory birds	0	0	0
Upland game	425	425	850
Big game	20	20	40
Fishing: Freshwater	650	650	1,300
Saltwater	0	0	0
Total Visitation	**4,312**	**67,364**	**71,675**

Visitor recreation expenditures for 2010 are shown in Table 6-3. Total annual expenditures were approximately $3.6 million, with non-residents accounting for about $3.5 million or 98 percent of total expenditures. Expenditures associated with non-consumptive activities accounted for 98 percent

of all expenditures, followed by hunting and fishing at 2 percent. Under Alternative 1, these annual expenditures are expected to continue in a similar pattern and magnitude.

Input-output models were used to determine the economic impact of expenditures on the Refuge's local economy. The estimated economic impacts are expected to occur in the local area of Harney County, Oregon. It is assumed that visitor expenditures associated with Refuge visits occur primarily within this county. Table 6-4 summarizes the local economic effects associated with recreation visits. Final demand totaled $3.5 million, with associated employment of 51 jobs, $1.0 million in employment income, and $518,000 in total tax revenue. The economic output is less than annual expenditures due to leakage outside Harney County, meaning that Harney County does not manufacture or support all the services and products that are purchased. Therefore, some of the expenditures "leak" to other areas.

Table 6-3. Alternative 1: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	$35.4	$3,095.4	$3,130.8
Other recreation	–	$52.9	$52.9
Environmental education	–	$354.2	$354.2
Total non-consumptive	**$35.4**	**$3,502.5**	**$3,537.8**
Hunting:			
Waterfowl	$1.8	$0.7	$2.6
Other Migratory Birds	–	–	–
Upland Game	$7.5	$31.9	$39.3
Big Game	$0.4	$0.8	$1.2
Total Hunting	$9.7	$33.4	$43.1
Fishing:			
Total Fishing	$11.5	$18.6	$30.2
Total Expenditures	**$56.6**	**$3,554.5**	**$3,611.1**

Table 6-4. Alternative 1: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Non-Residents	Total
Final demand	$55.8	$3,479.6	$3,535.4
Jobs	1	50	51
Job income	$16.2	$1,014.8	$1,030.9
Total tax revenue	$7.7	$510.2	$518.0

Alternative 2: Under Alternative 2, recreational opportunities would increase by further developing the visitor experience with additional birding, fishing, and hunting opportunities. Management under this alternative would be focused on expanding developed facilities and programs for casual visitors and beginning-moderate to advanced birders.

Table 6-5 shows that approximately 95,880 visits are expected under Alternative 2. Visitors would partake in a variety of recreational opportunities, interpretation programs, and environmental education. Wildlife observation visits would represent the majority of all visits. Most visitors partaking in wildlife observation spend an average of nearly 3 days at the Refuge. Wildlife observation visits include activities such as auto tours, hiking, photography, and boating. In addition to recreation visits (non-consumptive activities, hunting, and fishing), the Refuge also would support 9,800 environmental education visits. The environmental education program provides education opportunities to both the surrounding community and non-residents. Environmental education opportunities for residents do not contribute to the local economic impact because the events typically do not bring visitors who are spending money toward travel-related goods and services. However, environmental education opportunities for non-residents (guided tours) do contribute toward local economic impacts.

Under Alternative 2, recreation visits are projected to increase by 33 percent at the end of 15 years, compared to Alternative 1. Refuge staff estimates that 94 percent of recreational visitors would travel from outside Harney County. As in Alternative 1, nearly all recreational visitors would participate in non-consumptive activities such as wildlife observation, hiking, auto tours, and photography. Three percent of visitors would participate in hunting and fishing combined. Visitor recreation expenditures associated with Alternative 2 are shown in Table 6-6. Total annual expenditures would be about $4.8 million, with non-residents accounting for about $4.7 million or 99 percent of total expenditures. Expenditures associated with non-consumptive activities would account for 99 percent of all expenditures, followed by hunting and fishing at less than 1 percent.

Input-output models were used to determine the economic impact of expenditures on the Refuge's local economy under Alternative 2. The estimated economic impacts are expected to occur in the local area of Harney County, Oregon. It is assumed that visitor expenditures occur primarily within this county. Table 6-7 summarizes the local economic effects associated with recreation visits. Under Alternative 2, final demand would total $4.7 million, with associated employment of 68 jobs, $1.4 million in employment income, and $694,200 in total tax revenue. The economic output is less than annual expenditures due to leakage outside Harney County, meaning, Harney County does not manufacture or support all the services and products that are purchased. Therefore, some of the expenditures "leak" to other areas.

Table 6-5. Alternative 2: Annual Refuge Visitation

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	3,280	78,720	82,000
Other recreation	0	1,150	1,150
Environmental education	800	9,000	9,800
Fishing:			
Waterfowl	126	54	180

Activity	Residents	Non-Residents	Total
Other migratory birds	0	0	0
Upland game	500	500	1,000
Big game	0	0	0
Fishing:			
Freshwater	875	875	1,750
Saltwater	0	0	0
Total Visitation	5,581	90,299	95,880

Table 6-6. Alternative 2: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	$47.6	$4,161.1	$4,208.7
Other recreation	$0.0	$60.8	$60.8
Environmental education	$0.0	$475.7	$475.7
Total non-consumptive	**$47.6**	**$4,697.6**	**$4,745.2**
Hunting:			
Waterfowl	$3.0	$4.5	$7.6
Other migratory birds	–	–	–
Upland game	$8.8	$37.5	$46.3
Big game	–	–	–
Total hunting	**$11.9**	**$42.0**	**$53.9**
Fishing:			
Total fishing	**$15.5**	**$25.1**	**$40.6**
Total Annual Expenditures	**$74.9**	**$4,764.7**	**$4,839.7**

Table 6-7. Alternative 2: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Non-Residents	Total
Final demand	$73.8	$4,664.4	$4,738.2
Jobs	1	67	68
Job income	$21.4	$1,360.2	$1,381.6
Total tax revenue	$10.2	$683.9	$694.2

Alternative 3: Under Alternative 3, management for wildlife viewing, photography, and interpretation would be similar to Alternative 2, but there would be less emphasis on developed facilities and more emphasis on self-guided and off-trail experiences. Visitation related to non-consumptive activities would increase, while hunting and fishing visitation would remain about the same as under Alternative 1.

Table 6-8 shows that approximately 95,430 visits are expected under Alternative 3. Visitors would partake in a variety of recreational opportunities, interpretation programs, and environmental education. Wildlife observation visits would represent the majority of all visits. Most visitors partaking in wildlife observation spend an average of nearly 3 days at the Refuge. Wildlife observation visits include activities such as auto tours, hiking, photography, and boating. In addition to recreation visits (non-consumptive activities, hunting, and fishing), the Refuge also would support 9,800 environmental education visits. The environmental education program provides education opportunities for both the surrounding community and non-residents. Environmental education opportunities for residents do not contribute to local economic impacts because the events typically do not bring visitors who are spending money toward travel-related goods and services. However, environmental education opportunities for non-residents (guided tours) do contribute toward local economic impacts.

Under Alternative 3, recreation visits are projected to increase by 33 percent compared to Alternative 1, by the end of 15 years. Ninety-five percent of recreational visitors would travel from outside the local area. As in Alternative 1, nearly all recreational visitors would participate in non-consumptive activities such as hiking, auto tours, and photography. Three percent of visits would be hunting and fishing.

Table 6-8. Alternative 3: Refuge Visitation

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	3,280	78,720	82,000
Other recreation	0	1,150	1,150
Environmental education	800	9,000	9,800
Hunting:			
Waterfowl	126	54	180
Other migratory birds	0	0	0
Upland game	500	500	1,000
Big game	0	0	0
Fishing:			
Freshwater	650	650	1,300
Saltwater	0	0	0
Total Visitation	**5,356**	**90,074**	**95,430**

Visitor recreation expenditures estimated for Alternative 3 are shown in Table 6-9. Total annual expenditures would be about $4.8 million, with non-residents accounting for $4.7 million or 99 percent of total expenditures. Expenditures associated with non-consumptive activities would account for 98 percent of all expenditures, followed by hunting and fishing at 2 percent.

Input-output models were used to determine the economic impact of expenditures on the Refuge's local economy. The estimated economic impacts are expected to occur in the local area of Harney County, Oregon. It is assumed that visitor expenditures occur primarily within this county. Table 6-10 summarizes the local economic effects associated with recreation visits. Under Alternative 3, final demand would total $4.7 million, with associated employment of 68 jobs, $1.4 million in employment income, and $692,700 in total tax revenue. The economic output is less than annual expenditures due to leakage outside the area economy, meaning, the area does not manufacture or support all the services and products that are purchased. Therefore, some of the expenditures "leak" to other areas.

Summary of Recreational Visitation Impacts: Tables 6-11 and 6-12 provide a summary of the potential economic impacts related to recreational visitation for each alternative. Table 6-11 summarizes the annual average for each alternative. Table 6-12 summarizes the annual change for recreation visitation for Alternatives 2 and 3, compared to Alternative 1.

Under Alternatives 2 and 3, there would be an increase in recreation visitation by 33 percent. As a result, economic output, jobs, job income, and tax revenue would increase by the same amount.

Table 6-9. Alternative 3: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Total wildlife observation	$47.6	$4,161.1	$4,208.7
Other recreation	$0.0	$60.8	$60.8
Environmental education	$0.0	$475.7	$475.7
Total non-consumptive	**$47.6**	**$4,697.6**	**$4,745.2**
Hunting:			
Waterfowl	$3.0	$4.5	$7.6
Other migratory birds	$0.0	$0.0	$0.0
Upland game	$8.8	$37.5	$46.3
Big game	–	–	–
Total hunting	**$11.9**	**$42.0**	**$53.9**
Fishing:			
Total fishing	$11.5	$18.6	$30.2
Total Annual Expenditures	**$70.9**	**$4,758.3**	**$4,829.2**

Table 6-10. Alternative 3: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Non-Residents	Total
Final demand	$69.9	$4,658.1	$4,727.9
Jobs	1	67	68
Job income	$20.3	$1,358.4	$1,378.7
Total tax revenue	$9.7	$683.0	$692.7

Table 6-11. Comparison of Annual Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Alternative 1	Alternative 2	Alternative 3
Recreation visits	71,675	95,880	95,430
Expenditures	$3,611.1	$4,839.7	$4,829.2
Economic output	$3,535.4	$4,738.2	$4,727.9
Jobs	51	68	68
Job income	$1,030.9	$1,381.6	$1,378.7
Total tax revenue	$518.0	$694.2	$692.7

Table 6-12. Change in Average Annual Recreation Visitors and Expenditures Compared to the Baseline (Alternative 1) (2010 dollars in thousands)

	Alternative 2	Alternative 3
Visitors	+24,205	+23,755
Economic output	+$1,228.5	+$1,218.1
Jobs	+17	+17
Job income	+$350.7	+$347.7
Total tax revenue	+$176.2	+$174.7

6.6.3 Refuge Expenditures Effects on Local Economic Indicators

In addition to impacts from recreational visitors, there are also economic effects related to Refuge expenditures that contribute to local and regional economies. As discussed in Appendix C, Refuge budget expenditures occur as one-time expenditures and annual operational expenditures. This analysis includes implementation costs under the assumption that all proposed projects would occur within the next 15 years. These tables do not account for the potential timing and likelihood of particular projects.

One-time costs are project costs that have a start-up cost associated with them, such as purchasing a new vehicle for wildlife and habitat monitoring, or designing and installing an interpretive sign. Table 6-13 shows that one-time expenditures would be $1.1 million for Alternative 1, $18.5 million

for Alternative 2, and $16.9 million for Alternative 3. For Alternative 1, about 63 percent of one-time expenditures are associated with implementation of wildlife and habitat programs. For Alternatives 2 and 3, about 75 to 81 percent of one-time expenditures are associated with implementation of wildlife and habitat programs.

Table 6-13. Malheur Refuge One-time Expenditures (2010 dollars in thousands)

Expenditure	Alternative 1	Alternative 2	Alternative 3
Salary	–	–	–
Visitor services programs	$61.5	$4,150.5	$2,534.5
Cultural resources programs	$330.0	$675.0	$675.0
Wildlife and habitat, sustainable practices programs	$658.6	$13,672.6	$13,672.6
Total	$1,050.1	$18,498.1	$16,882.1

Annual costs reflect Refuge spending of base funds allocated each year. These are also known as recurring costs and are usually associated with day-to-day operations and projects that last longer than three years. Table 6-14 shows that average annual expenditures would be about $3.2 million for Alternative 1, and about $5.0 million for Alternatives 2 and 3.

Table 6-14. Malheur Refuge Average Annual Expenditures (2010 dollars in thousands)

Expenditure	Alternative 1	Alternative 2	Alternative 3
Salary	$1,719.1	$3,084.9	$3,153.5
Visitor services programs	$22.5	$197.5	$193.0
Cultural resources programs	$14.5	$14.5	$14.5
Wildlife and habitat, sustainable practices programs	$1,411.9	$1,653.3	$1,653.3
Total	$3,168.0	$4,950.2	$5,014.3

Table 6-15 shows the economic impact of one-time expenditures. The economic impacts associated with one-time expenditures would be distributed throughout the 15-year time period depending on the timing and priority of the project. Under Alternative 1, the Refuge's one-time expenditures would generate approximately $995,300 in economic output, 10 jobs, $748,000 in job income, and $154,900 in tax revenue. One-time expenditures under Alternative 2 would generate economic output of $17.5 million, 180 jobs, $13.2 million in job income, and $2.7 million in tax revenue. Under Alternative 3, the Refuge's one-time expenditures would generate $16.0 million in economic output, 165 jobs, $12.0 million in job income, and $2.5 million in tax revenue. The economic output is less than expenditures due to leakage outside the area economy. Harney County does not manufacture or support all the services and products that are purchased, so some of the expenditures "leak" to other areas.

Table 6-15. Local Economic Effects Associated with One-time Expenditures (2010 dollars in thousands)

	Alternative 1	Alternative 2	Alternative 3
Economic output	$995.3	$17,533.2	$16,001.4
Jobs	10	180	165
Job income	$748.0	$13,176.4	$12,025.3
Total tax revenue	$154.9	$2,727.9	$2,489.6

Table 6-16 shows the economic impact of average annual (salary and non-salary) expenditures. Impacts associated with annual expenditures would continue to occur throughout the 15-year timeline of the CCP. Under Alternative 1, the Refuge's annual expenditures would generate approximately $2.7 million in economic output, 27 jobs, $1.4 million in job income, and $391,900 in tax revenue. Annual expenditures under Alternative 2 would generate economic output of $4.1 million, 41 jobs, $2.0 million in job income, and $589,300 in tax revenue. Under Alternative 3, the Refuge's annual expenditures would generate $4.2 million in economic output, 42 jobs, $2.0 million in job income, and $595,500 in tax revenue. The economic output is less than annual expenditures due to leakage outside the area economy. The area does not manufacture or support all the services and products that are purchased, so some of the expenditures "leak" to other areas.

Table 6-16. Local Annual Economic Effects Associated with Average Annual Refuge Budget Distributed over 15 Years (2010 dollars in thousands)

	Alternative 1	Alternative 2	Alternative 3
Economic output	$2,710.4	$4,125.2	$4,173.0
Jobs	27	41	42
Job income	$1,391.6	$1,962.6	$1,973.4
Total tax revenue	$391.9	$589.3	$595.5

Tables 6-17 and 6-18 show the change in economic impacts associated with the Refuge budget compared to the baseline (Alternative 1). One-time expenditures for Alternatives 2 and 3 would increase by $17.4 million and $15.8 million, respectively, compared to Alternative 1 (Table 6-17). Under Alternative 2, economic impacts associated with one-time expenditures would increase by $16.5 million in economic output, 170 jobs, and $12.4 million in job income. Under Alternative 3, economic impacts associated with one-time expenditures would increase by $15.0 million in economic output, 155 jobs, and $11.3 million in job income.

Table 6-17. Change in One-time Expenditures Compared to the Baseline (Alternative 1) Distributed over 15 Years (2010 dollars in thousands)

	Alternative 2	Alternative 3
One-time expenditures	+$17,448.0	+$15,832.0
Economic output	+$16,537.8	+$15,006.1
Jobs	+170	+155

	Alternative 2	Alternative 3
Job income	+$12,428.4	+$11,277.3
Total tax revenue	+$2,573.0	+$2,334.7

Annual expenditures for Alternatives 2 and 3 would each increase by about $1.8 million compared to Alternative 1 (Table 6-18). Under Alternative 2, economic impacts associated with annual expenditures would increase by $1.4 million in economic output, 14 jobs, and $571,000 in job income. For annual expenditures under Alternative 3, economic impacts would increase by $1.5 million in economic output, 15 jobs, and $581,800 in job income.

Table 6-18. Change in Average Annual Expenditures Compared to the Baseline (Alternative 1) (2010 dollars in thousands)

	Alternative 2	Alternative 3
Annual expenditures	+$1,760.8	+$1,846.4
Economic output	+$1,414.9	+$1,462.7
Jobs	+14	+15
Job income	+$571.0	+$581.8
Total tax revenue	+$197.4	+$203.7

6.6.4 Refuge Grazing and Haying

From 2002 to 2010, Malheur Refuge produced forage supporting an average of about 27,600 animal unit months[3] (AUMs) annually (Figure 6-5). Approximately 18,700 AUMs are from cattle grazing, while the remaining are attributed to the haying program.

[3] An animal unit month (AUM) is the amount of forage necessary to sustain a cow and its calf.

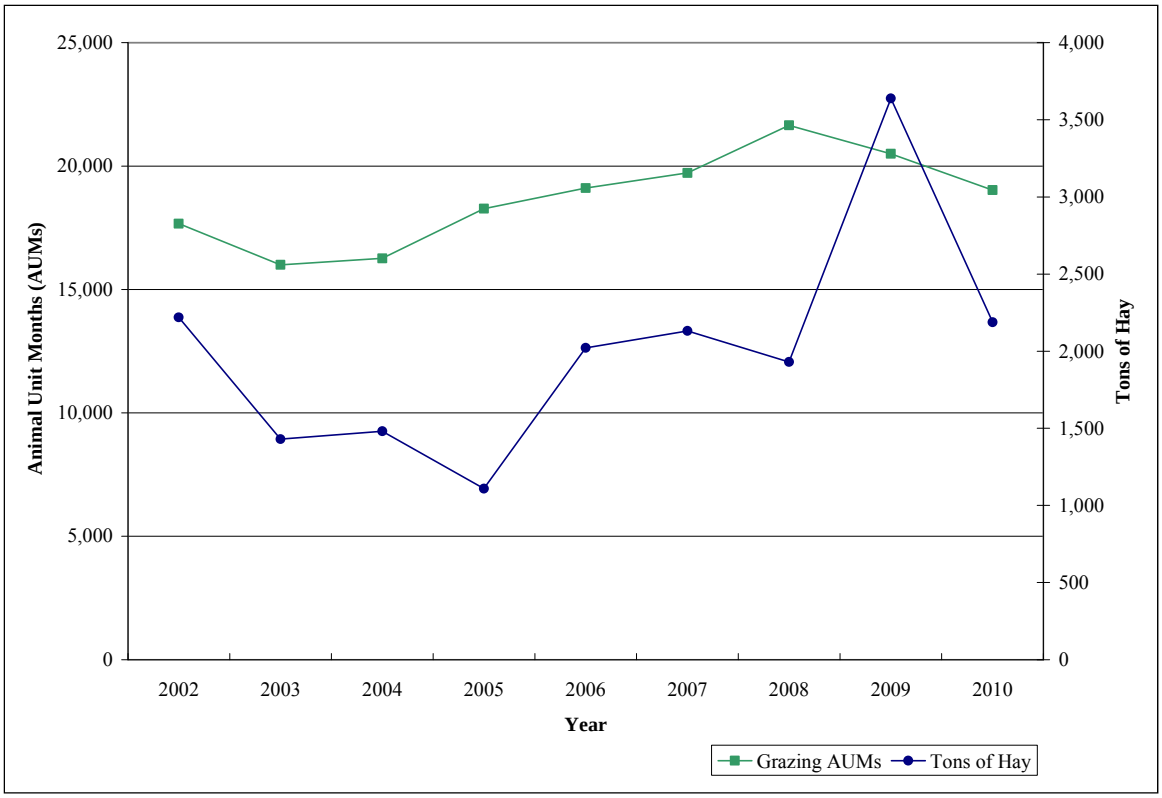


Figure 6-5. Malheur Refuge: grazing animal unit months and hay production, 2002-2010.

Table 6-19 shows the payments collected by the Refuge from 2002 to 2010. Over the last 9 years, total revenue from grazing and haying receipts has averaged about $180,000 annually.

Table 6-19. Malheur Refuge: AUMs and Revenue, 2002-2010 (2010 dollars in thousands)

Year	Total AUMs	Hay Revenue	Grazing Revenue	Total Revenue
2002	33,592	$47.1	$149.9	$197.0
2003	30,043	$29.7	$132.7	$162.4
2004	30,776	$29.9	$131.4	$161.3
2005	21,675	$21.7	$142.8	$164.5
2006	25,091	$38.3	$144.7	$183.0
2007	25,414	$39.2	$145.2	$184.4
2008	26,811	$34.2	$153.5	$187.7
2009	30,216	$64.7	$145.9	$210.6
2010	24,867	$38.3	$133.2	$171.5

Economic Impacts of Grazing: From 2006 to 2010, the grazing program averaged 20,003 AUMs annually. Grazing is permitted over a 5-month period from September through January. Thus, the

grazing program supports approximately 4,000 head of cattle annually. Most of the cattle grazing on the Refuge are cows that will produce calves sold the following year. Many of these calves are sold before the cows graze on the Refuge. This analysis assumes that grazing on the Refuge contributes to the economic impact of calves sold each year. It further assumes that each cow produces one calf that is sold annually. Thus, 4,000 calves are assumed to be sold annually. The estimated dollar value for cattle grazing on the Refuge is based upon the average price per head in Harney County in 2007. Thus, cattle grazing on the Refuge contributes about $3.0 million annually in cattle sales to the Harney County economy (Table 6-20). This represents 8 percent of cattle sales in Harney County.

Table 6-20. Annual Cattle Sales (2010 dollars in thousands)

	Oregon	Harney County	Malheur Refuge	Refuge Cattle as a Percentage of Harney County Cattle
Number of cattle and calves sold	1,020,380	55,987	4,000	7%
Total sales of cattle and calves	$841,692	$39,369	$2,958	8%

Source: Sales of cattle and calves (number and $) for Oregon and Harney County are from the 2007 U.S. Department of Agriculture (USDA) Census of Agriculture. The number of cattle and calves sold from Malheur Refuge are based upon a 5-year average from 2006 to 2010.

Although some highly prescriptive live-season grazing may occur under Alternatives 2 and 3, the overall forage value of grazing would not change under Alternatives 2 and 3 compared to the baseline. Economic impacts of cattle sales, as shown in Table 6-21, would be the same under each alternative. Cattle grazing on the Refuge generates approximately 44 jobs and $346,800 in job income. Overall, cattle sales would result in about $3.0 million in economic output. The economic output is only slightly higher than sales due to leakage outside the area economy. Harney County does not manufacture/support all the services and products that are purchased, so some of the expenditures “leak” to other areas.

Table 6-21. Economic Effects of Cattle Sales—All Alternatives (2010 dollars in thousands)

Economic output	$2,978.4
Jobs	44
Job income	$346.8
State and local tax revenue	$75.7
Federal tax revenue	$65.4

Economic Impacts of Hay Production: From 2006 to 2010, the haying program averaged 2,382 tons of hay annually. The estimated dollar value for hay on the Refuge is based upon the average price per ton in Harney County in 2007. Hay production on the Refuge contributes about $356,100 in hay sales to the Harney County economy annually (Table 6-22). This represents 1 percent of hay production in Harney County.

Table 6-22. Annual Hay Sales (2010 dollars in thousands)

	Oregon	Harney County	Malheur Refuge	Refuge Hay Production as a Percentage of Harney County Hay
Tons of hay sold	2,926,331	269,393	2,382	1%
Retail value of hay	$437,534.4	$40,278.7	$356.1	1%

Source: Sales of hay (tons and $) for Oregon and Harney County are from the 2007 USDA Census of Agriculture. Tons of hay sold by Malheur Refuge are based upon a 5-year average from 2006 to 2010.

Hay management would not change under Alternatives 2 and 3, compared to the baseline. Economic impacts of hay production, as shown in Table 6-23, would occur under each alternative. Hay sales generate approximately four jobs and $91,400 in job income. Overall, hay sales would result in about $364,300 in economic output. The economic output is only slightly higher than sales due to leakage outside the area economy. Harney County does not manufacture/support all the services and products that are purchased; therefore, some of the expenditures "leak" to other areas.

Table 6-23. Economic Effects of Hay Production—All Alternatives (2010 dollars in thousands)

Economic output	$364.3
Jobs	4
Job income	$91.4
State and local tax revenue	$17.8
Federal tax revenue	$16.3

6.6.5 Summary

This section summarizes the economic impacts generated by Refuge management activities for each alternative. Economic impacts for the Refuge budget include both one-time expenses and annual expenses. One-time expenses were distributed throughout the 15-year time period to average the impacts over 15 years. For each alternative, impacts would not change for haying or grazing.

Table 6-24 summarizes the economic impacts in Harney County for Alternative 1. Under Alternative 1, Refuge activities would generate an estimated $9.7 million in economic output, 126 jobs, $2.9 million in job income, and $1.1 million in tax revenue in the local economy. These economic impacts under Alternative 1 represent less than 1 percent of total income (0.4 percent) and total employment (0.7 percent) in the local area economy.

Table 6-24. Summary of Annual Economic Impacts for Alternative 1 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$3,535.4	51	$1,030.9	$518.0
Budget	$2,776.7	28	$1,441.5	$402.2
Haying	$364.3	4	$91.4	$34.1

Grazing	$2,978.4	44	$346.8	$141.1
Total	$9,654.8	126	$2,910.6	$1,095.3

Table 6-25 summarizes the economic impacts in Harney County for Alternative 2. Under Alternative 2, Refuge activities would generate an estimated $13.4 million in economic output, 169 jobs, $4.7 million in job income, and $1.6 million in tax revenue in the local economy. These economic impacts under Alternative 2 represent 0.6 percent of total income and 1.0 percent of total employment in the local area economy.

Table 6-25. Summary of Annual Economic Impacts for Alternative 2 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$4,738.2	68	$1,381.6	$694.2
Budget	$5,294.1	53	$2,841.0	$771.1
Haying	$364.3	4	$91.4	$34.1
Grazing	$2,978.4	44	$346.8	$141.1
Total	$13,375.0	169	$4,660.9	$1,640.5

Table 6-26 summarizes the economic impacts in Harney County for Alternative 3. Under Alternative 3, Refuge activities would generate an estimated $13.3 million in economic output, 169 jobs, $4.6 million in job income, and $1.6 million in tax revenue in the local economy. These economic impacts under Alternative 3 represent 0.6 percent of total income and 1.0 percent of total employment in the local area economy.

Table 6-26. Summary of Annual Economic Impacts for Alternative 3 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$4,727.9	68	$1,378.7	$692.7
Budget	$5,239.8	53	$2,775.1	$761.5
Haying	$364.3	4	$91.4	$34.1
Grazing	$2,978.4	44	$346.8	$141.1
Total	$13,310.4	169	$4,592.0	$1,629.4

6.7 Other Effects

6.7.1 Potential Impacts on Adjacent Lands and their Associated Natural Resources

No adverse effects are expected on adjacent lands from any of the alternatives.

6.7.2 Potential Impacts to Nearby Residents

No adverse effects are expected on adjacent residents from any of the alternatives.

6.8 Cumulative Effects

Council on Environmental Quality (CEQ) regulations (40 CFR § 1508.7), which implement the provisions of the National Environmental Policy Act (NEPA), define several different types of effects that should be evaluated in an EIS, including direct, indirect, and cumulative effects. Direct and indirect effects are addressed in the resource-specific sections of this chapter (Sections 6.1-6.6). This section addresses cumulative effects.

According to the CEQ, cumulative effects can result from the incremental effects of a project when added to other past, present, and reasonably foreseeable future projects in the area, regardless of the entity undertaking the action. Cumulative impacts can result from individually minor but cumulatively significant actions over a period of time. This analysis is intended to consider the interaction of activities at the Malheur Refuge with other actions occurring over a larger spatial and temporal frame of reference.

It should be noted that the cumulative effects analysis has essentially been completed by virtue of the comprehensive nature by which direct and indirect effects were analyzed in the previous sections. The analysis in this section primarily focuses on effects associated with reasonably foreseeable future events and/or actions regardless of what entity undertakes that action.

6.8.1 Effects from Reasonably Foreseeable Future Refuge Activities

The Army Corps of Engineers has completed construction of an island in the south-central portion of Malheur Lake for the purpose of attracting nesting Caspian terns. The intent is to attract part of the population that now nests in the Columbia River Estuary and preys upon juvenile salmonids at that location. Many of these salmonids are listed under the Endangered Species Act. Historical bird surveys revealed that Caspian terns have been observed nesting on small natural islands when water levels are adequate for nesting and raising young. Records of up to 25,000 ring-billed gulls, 1,300 pairs of Franklin’s gulls, and up to 350 pairs of Caspian terns have nested in Malheur Lake when water levels are ideal.

Effects of the project are analyzed in an environmental assessment (EA) (U.S. Army Corps of Engineers 2011). The project created temporary construction impacts. Longer-term, the presence of the island may assist in carp reduction efforts, although Caspian terns will only feed upon smaller age classes of carp. As discussed in the Corps EA, if depredation of the terns proves to be a problem by species such as gulls, the Refuge may engage in limited predator control on the new island.

The presence of the island is not expected to directly hinder attainment of any of the CCP goals; however, there may be some conflict between the need to provide a disturbance-free environment around the island during nesting season and the recreational and staff management activities that will occur in this same area. Disturbance from airboats and people near the colony can lead to the flushing of terns and the loss of their eggs and small chicks to gulls, which normally would not happen when the parents are near the nests. Therefore, such disturbance will be avoided.

The Refuge will retain the option of multiple strategies in its efforts to reduce carp populations in Malheur Lake. As explored in Objective 1a, this may include commercial fishing. Although details of any commercial fishing program have not yet been elaborated, it will be important to ensure that conflicts between carp reduction efforts (including commercial fishing) and the Caspian tern island are well thought out and implemented.

6.8.2 Potential Effects from Broader Environmental Trends

According to the Climate Impacts Group (CIG) at the University of Washington, "Even subtle changes in PNW precipitation and temperature have noticeable impacts on the region's mountain snowpack, river flows and flooding, the likelihood of summer droughts, forest productivity and forest fire risk, salmon abundance, and quality of coastal and near-shore habitat" (CIG 2011).

Warming, whether it results from anthropogenic or natural sources, is expected to affect a variety of natural processes and associated resources. However, the complexity of ecological systems means that there is a tremendous amount of uncertainty about the impact climate change will actually have. In particular, the localized effects of climate change are still a matter of much debate.

***Potential effects to other biota*:** If warming happens, it could have a range of potential effects to wildlife and other biota. Obviously, habitat shifts that result in changed dominance in any particular habitat type, loss of habitat, or change in key habitat components can influence habitat availability and quality for dependent species. However, rising temperatures may affect other ecological interactions, such as sex ratios in reptiles (Janzen 1994), spring flowering times, or emergence timing and patterns for insect and pollinator species. Lawler et al. (2009) consider amphibians to be some of the most susceptible animals to climate change, partly because the microhabitats they depend on may be among the most affected systems and partly because they have limited abilities to disperse across a fragmented landscape.

6.8.3 Other Reasonably Foreseeable Events and Activities from Others

Wind power development has been proposed in the area adjacent to the Refuge. Columbia Energy Partners, LLP is proposing a major industrial wind energy generation project on North Steens Mountain, approximately 12 miles east of the P Ranch Unit. Combined, the developments, if approved, would generate over 400 megawatts (MW) of electricity. The proposed transmission line conveying the electricity (Proposed Action, West Route-Alternative B) would cross approximately 19 miles of private land, 9 miles of BLM-administered public land, and 1.3 miles of land on the Malheur Refuge, including a span over the Blitzen Valley. Effects of the Echanis wind project (for 105 MW, a portion of the full wind development under consideration) are explored in the North Steen 230-kV Transmission Line Project Draft EIS (BLM 2010). According to the EIS, the Echanis project would result in an estimated fatality impact to birds of 24 to 690 birds annually, with 19 to 538 (about 78%) of these being passerine species. Estimates are based upon wind farm developments in the Pacific Northwest. The estimate of fatalities for other species include 0 to 22 raptors annually, 28 to 235 bats annually (mostly hoary and silver-haired bats), and minimal waterfowl and shorebirds.

The EIS also discloses that greater sage grouse would likely be displaced from their summer and winter habitats in the Echanis project area during maintenance activities, and likely would greatly reduce their time spent near the access roads and wind turbines.

The EIS projects some mortality to seven species of special status waterbirds that occur in the project area: western least bittern, white-faced ibis, black tern, trumpeter swan, snowy egret, Franklin's gull, and American white pelican. According to the EIS, "special measures" would be implemented to reduce the incidence of collision.

The transmission line also would be visible to travelers on the Blitzen Valley auto tour route and likely some of the Refuge trails and the High Desert Scenic Byway (Highway 205), where the right-of-way would cross those routes. According to the EIS, views of the transmission line are not expected to detract from the recreational experience because the views, if they occur at all, would be distant and intermittent along trails.

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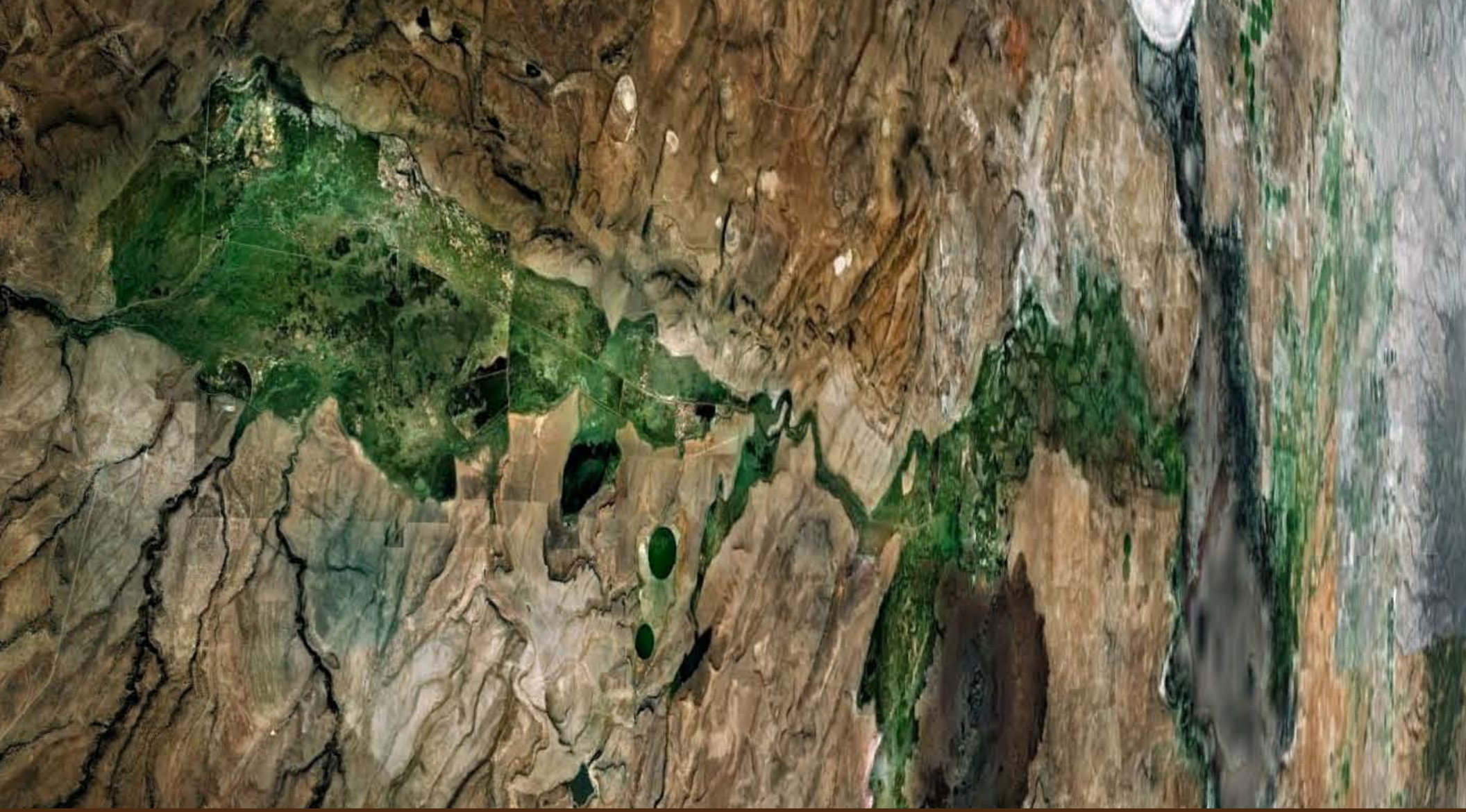
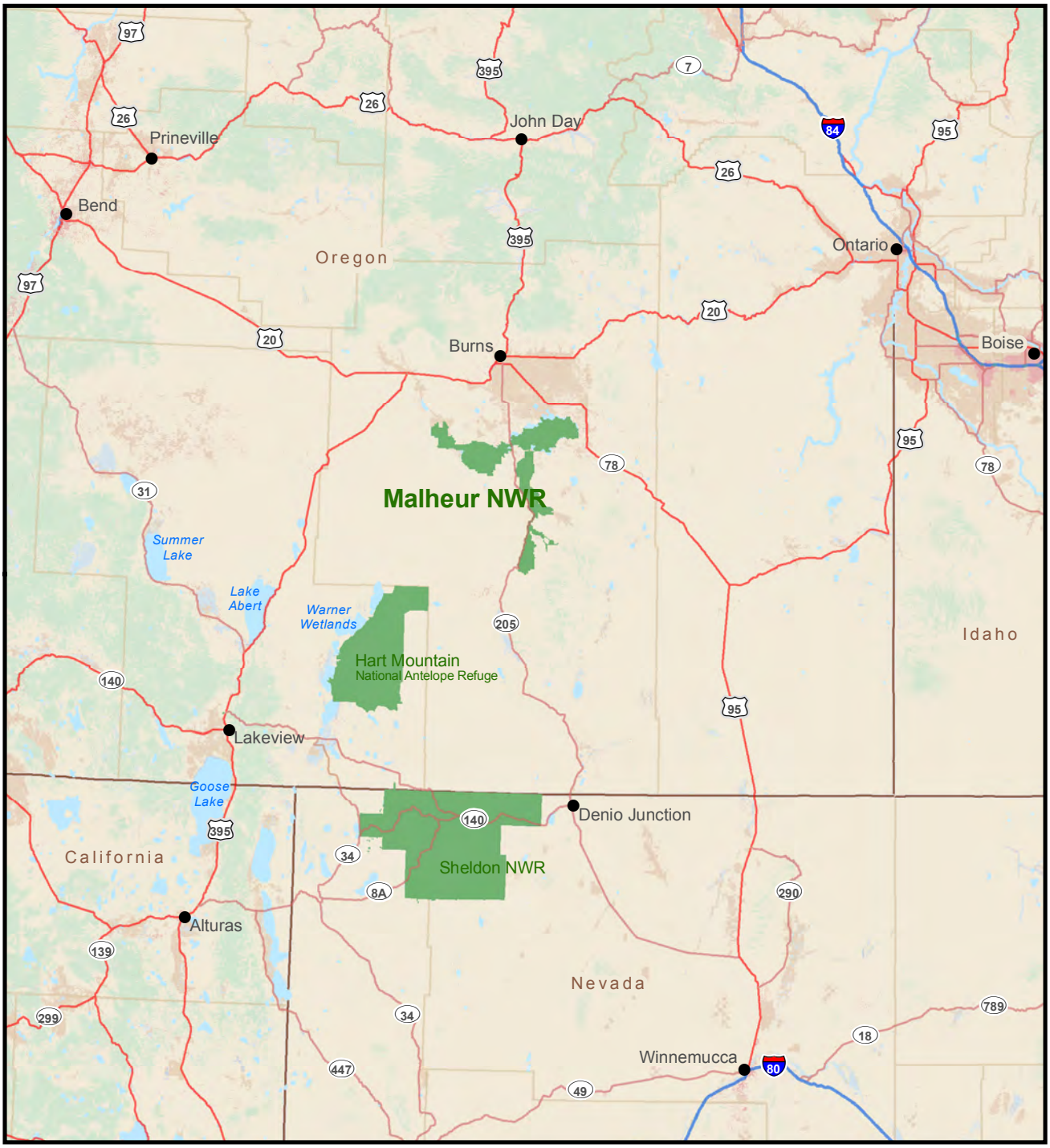


Maps

Map 1 ***Location of Refuge and Regional Land Cover***



National Wildlife Refuges
Forest
Shrub/Grassland/Barren
Cultivated Crops / Pasture

N

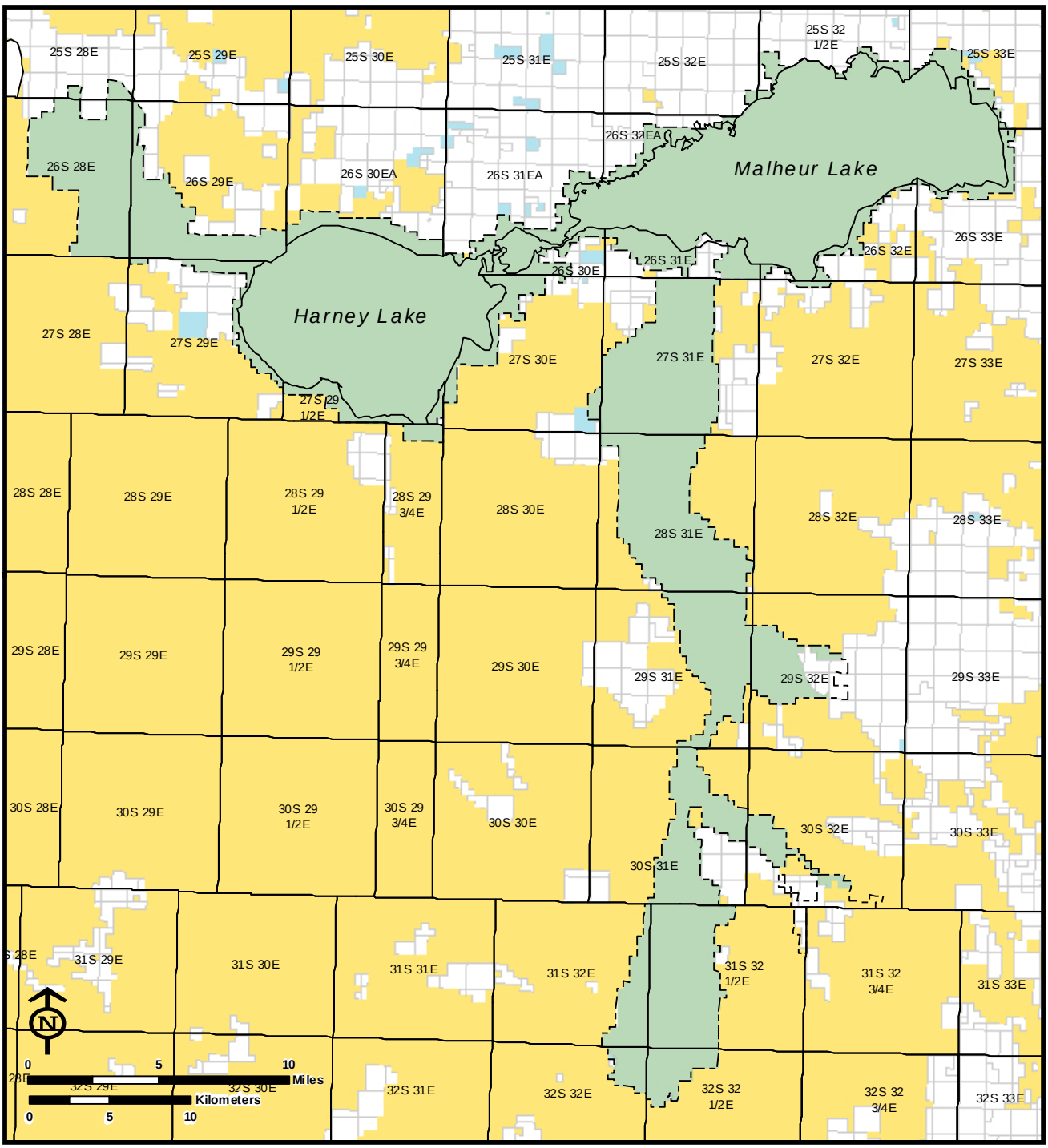
0 25 50 Miles

0 25 50 Kilometers

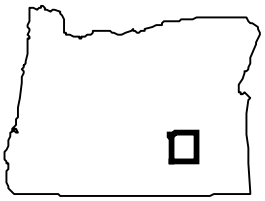
AREA ENLARGED

Map Date: 11/5/2012 File: 11-053-1.mxd
Data Source: ESRI StreetMap North America, USGS National Land Cover Dataset 2001

Map 2 ***Land Status***



PLSS Township Lines
USFWS Fee Ownership
USFWS Approved Acquisition Boundary
Private
Bureau of Land Management
State of Oregon



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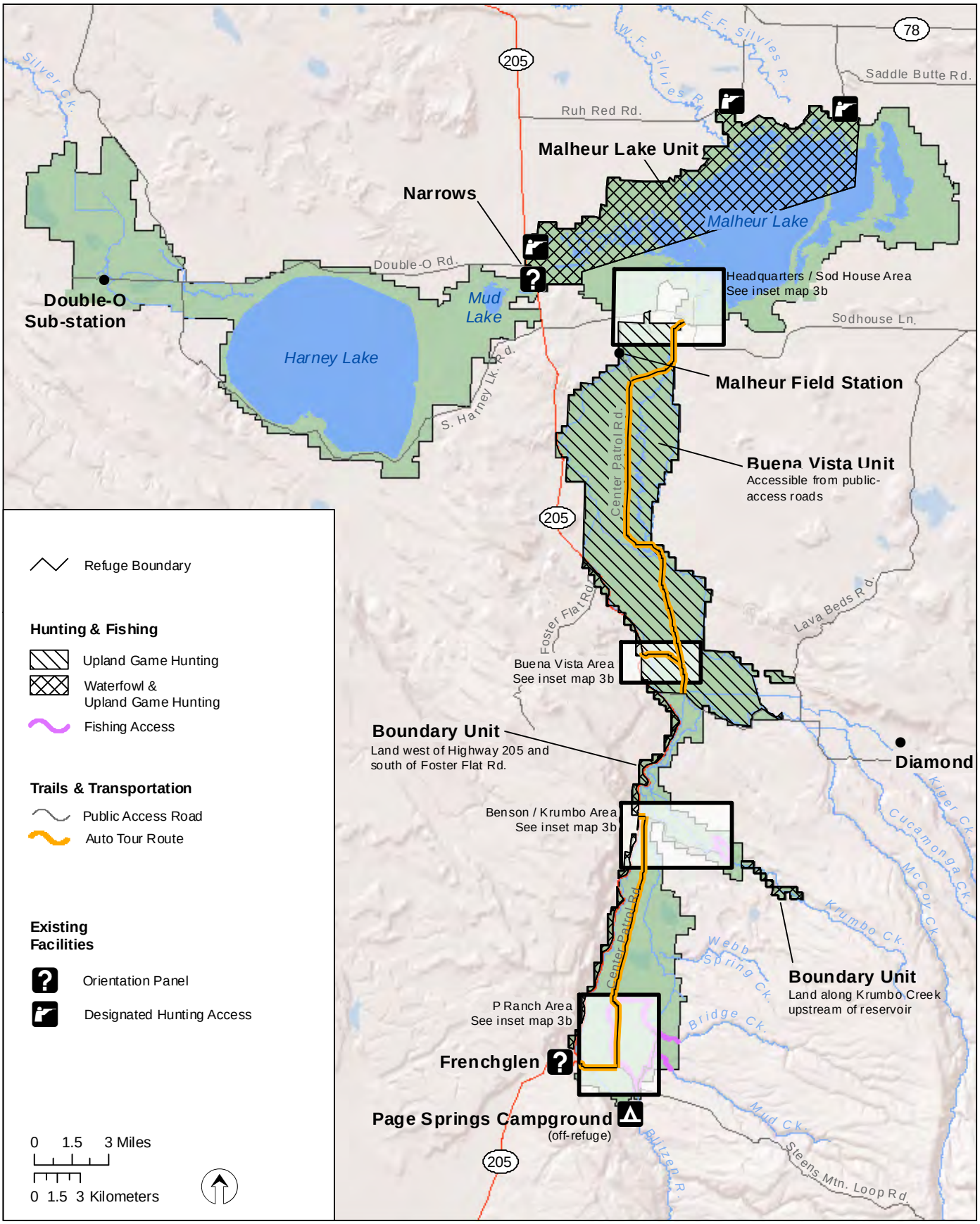
Data Source: Bureau of Land Management Ownership, PLSS

Map 3a — Public Use Facilities Alternative 1



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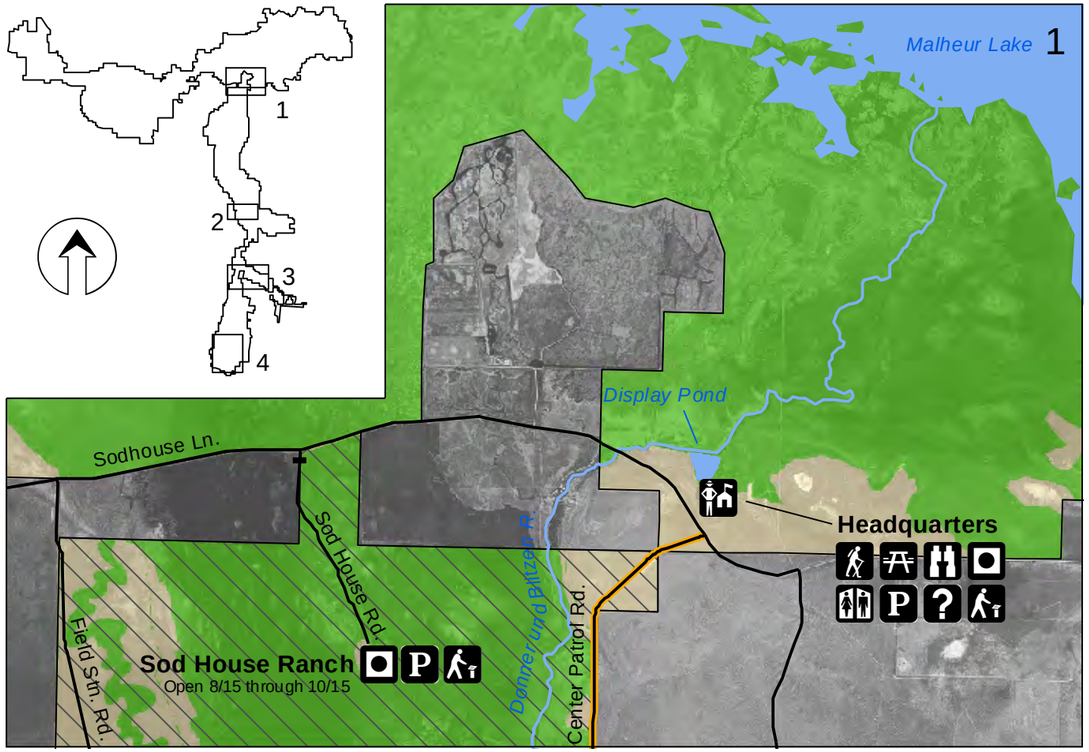
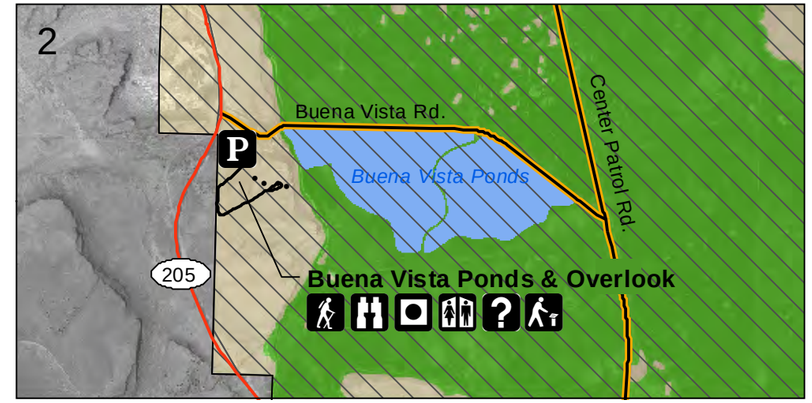
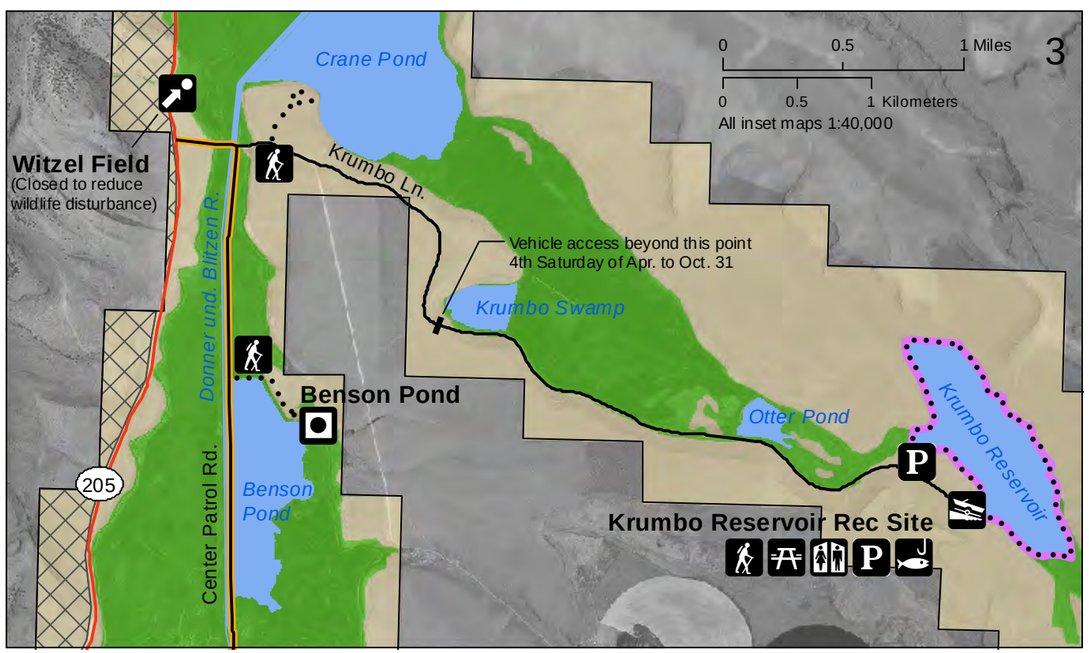
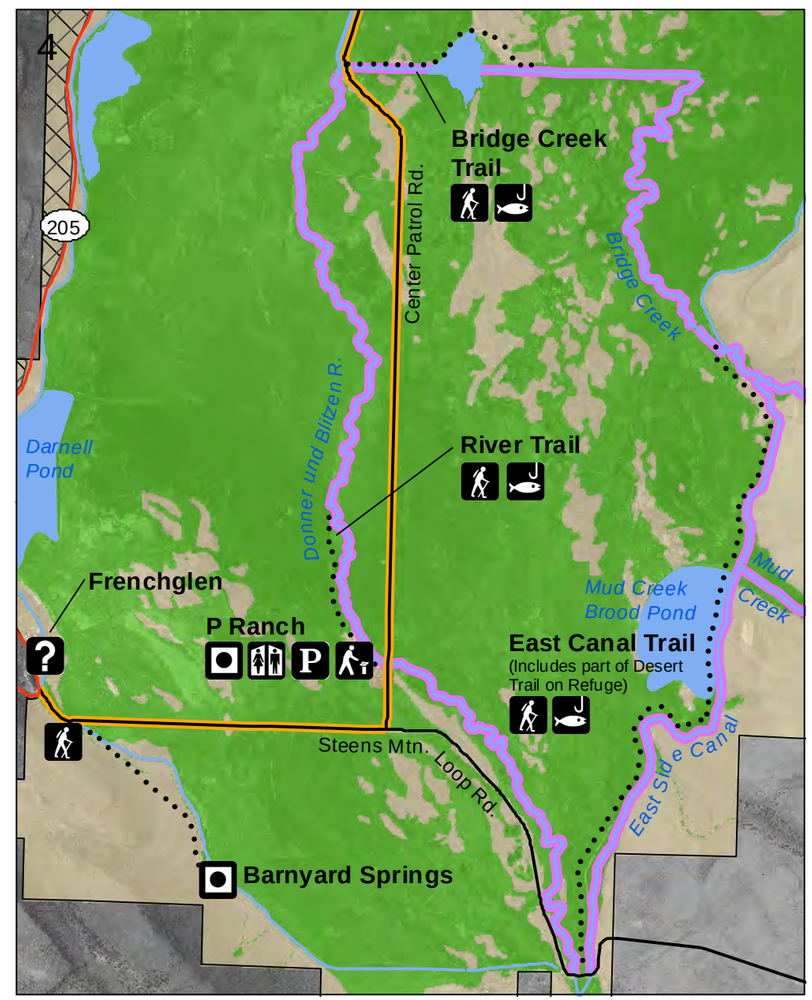








Map 3b
Public Use Facilities (Insets)
Alternative 1

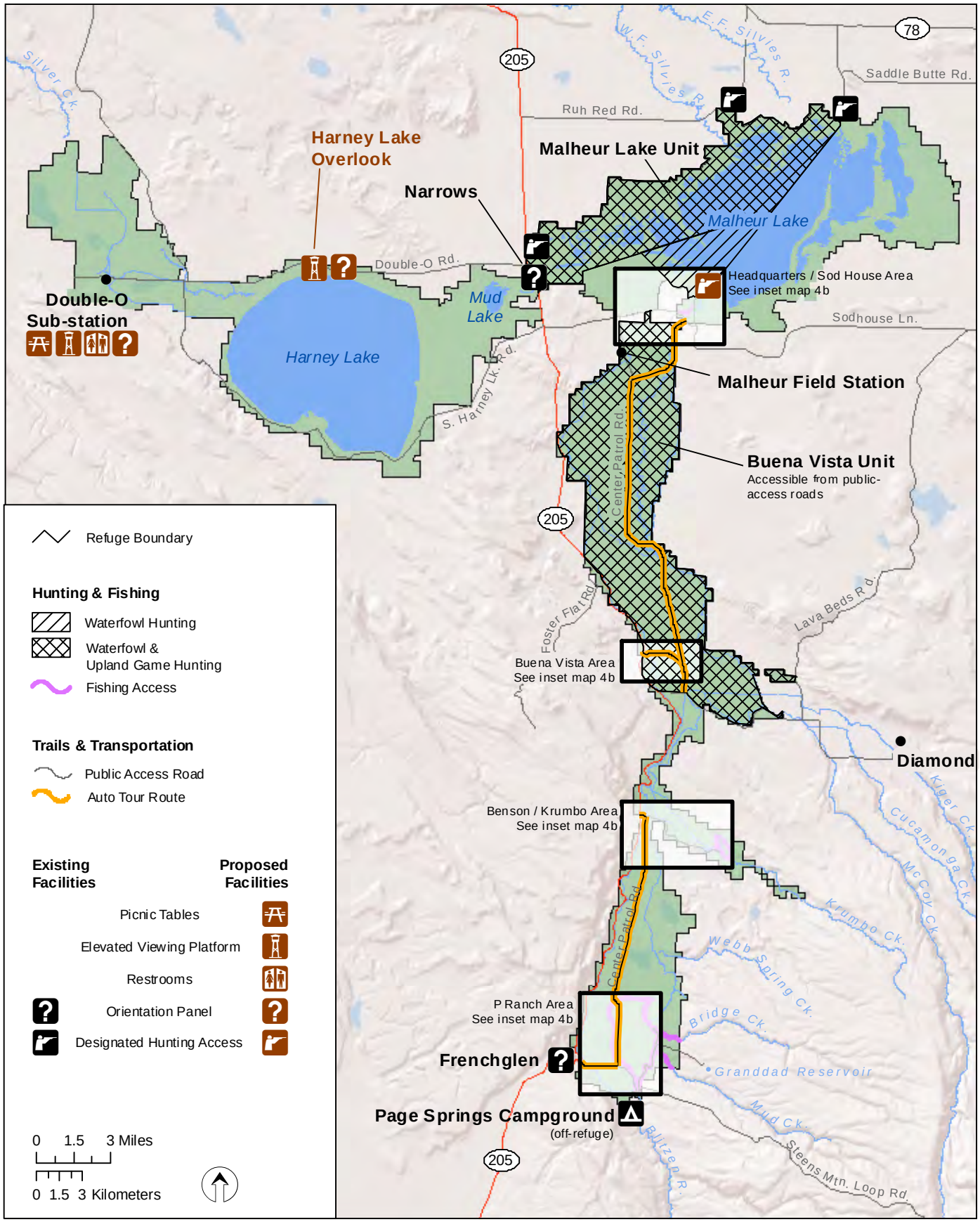
- Refuge Boundary
- Irrigated Habitat
- Upland Habitat
- Canal or Stream
- Select Ponds
- Gate - Seasonal Closure
- Upland Game Hunting
- Waterfowl & Upland Game Hunting

Existing Facilities

- Visitor Contact
- Trailhead
- Picnic Tables
- Viewing Overlook
- Historic Site
- Point of Interest
- Boat Ramp
- Restrooms
- Parking
- Orientation Information
- Interpretive Information
- Fishing
- Hiking Trail
- Fishing Access
- Public Access Road
- Auto Tour Route

Map Date: 9/6/2012 File: 11-053-3b.mxd
Data Source: USDA National Agriculture Imagery Program 2009

Map 4a — Public Use Facilities Alternative 2



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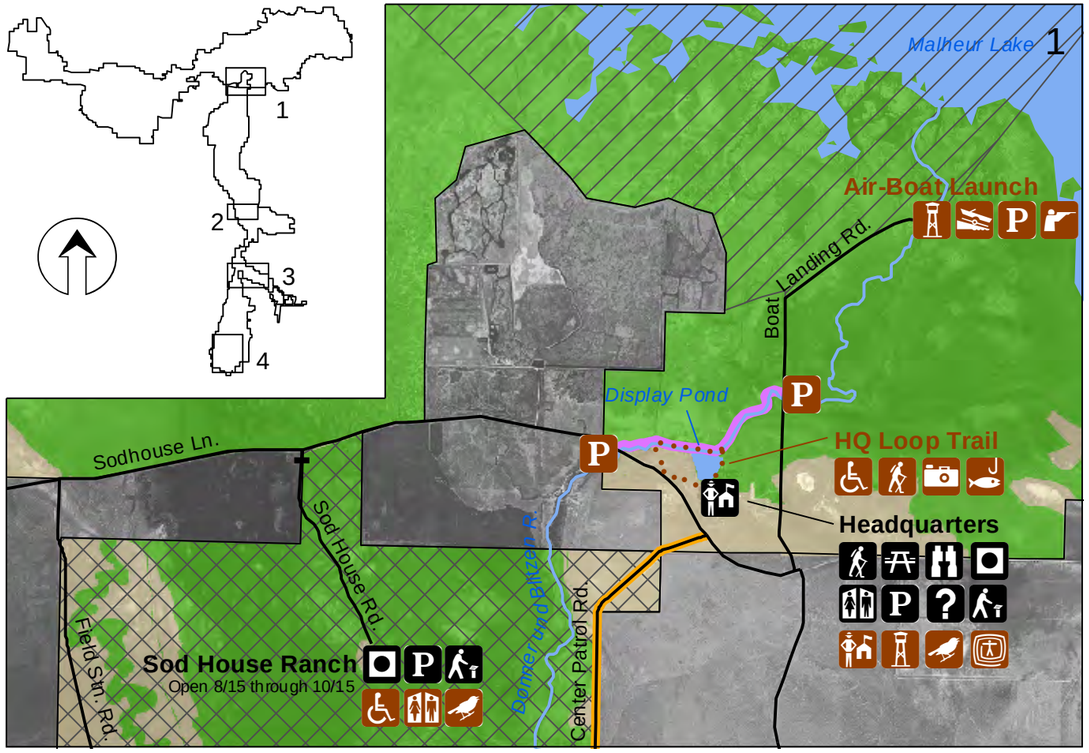
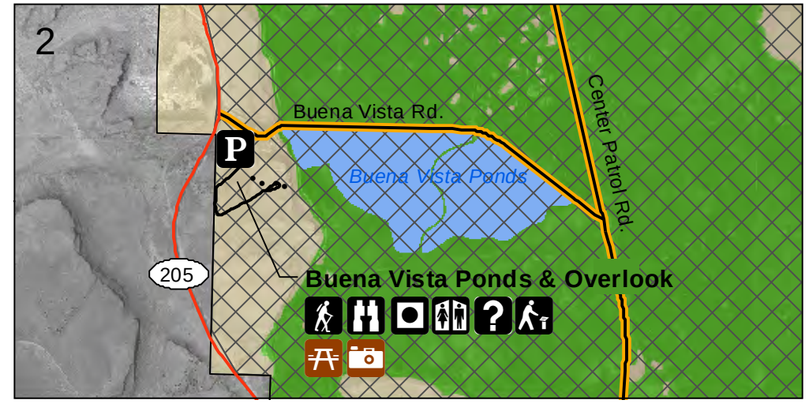
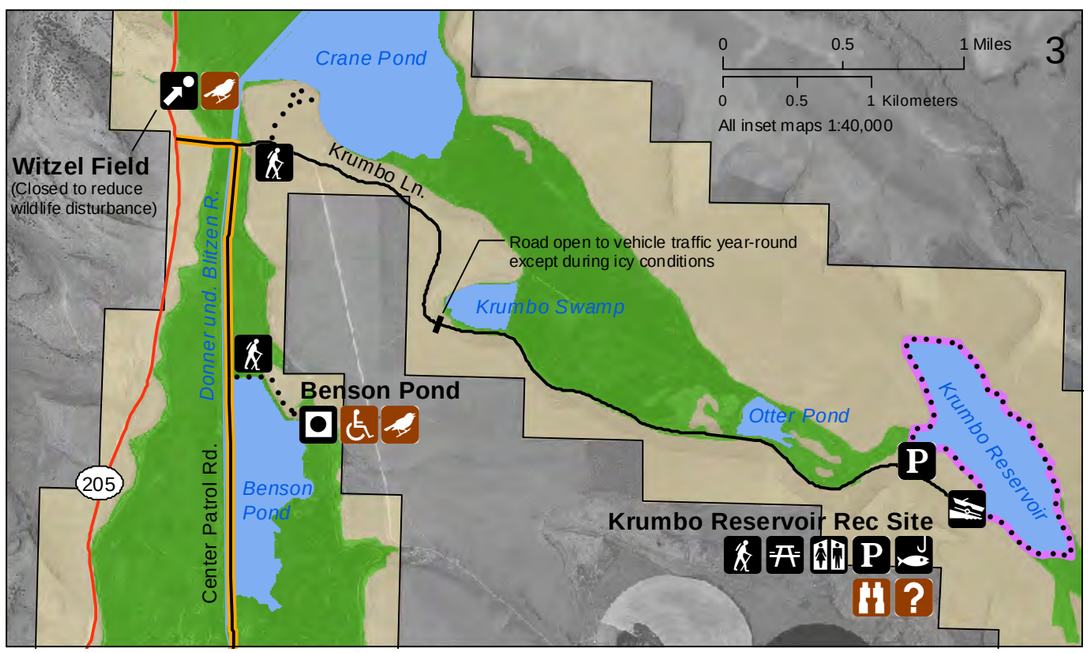
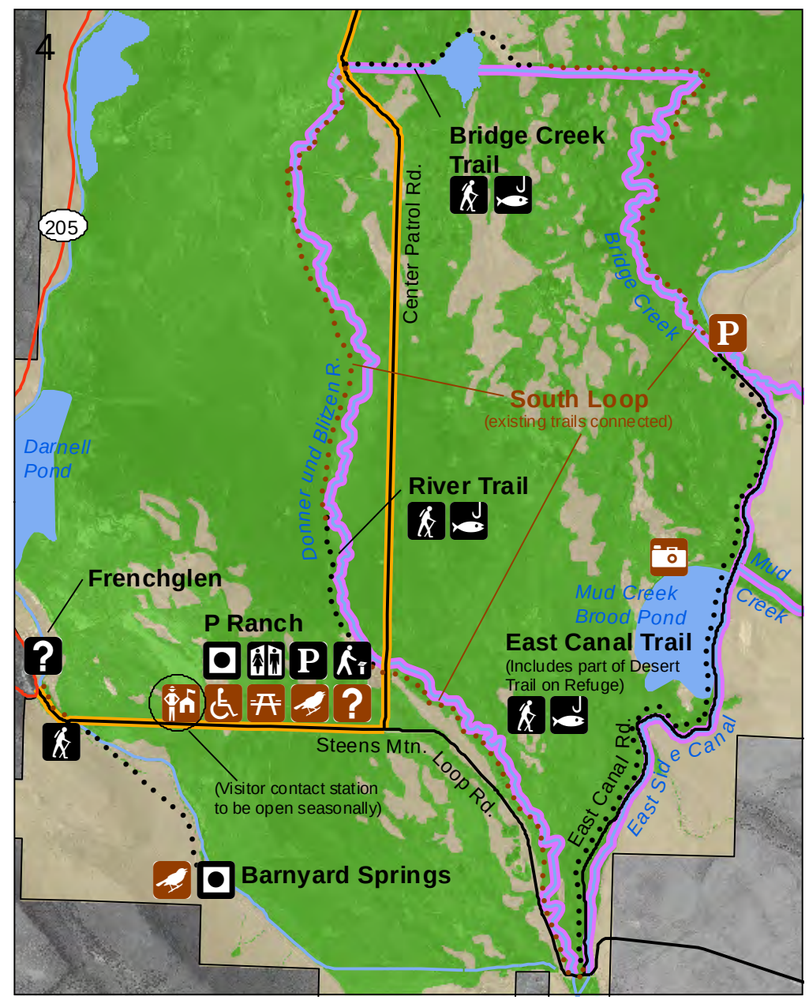
Data Source: USGS HUC, NHD, ESRI_ShadedRelief_World_2D









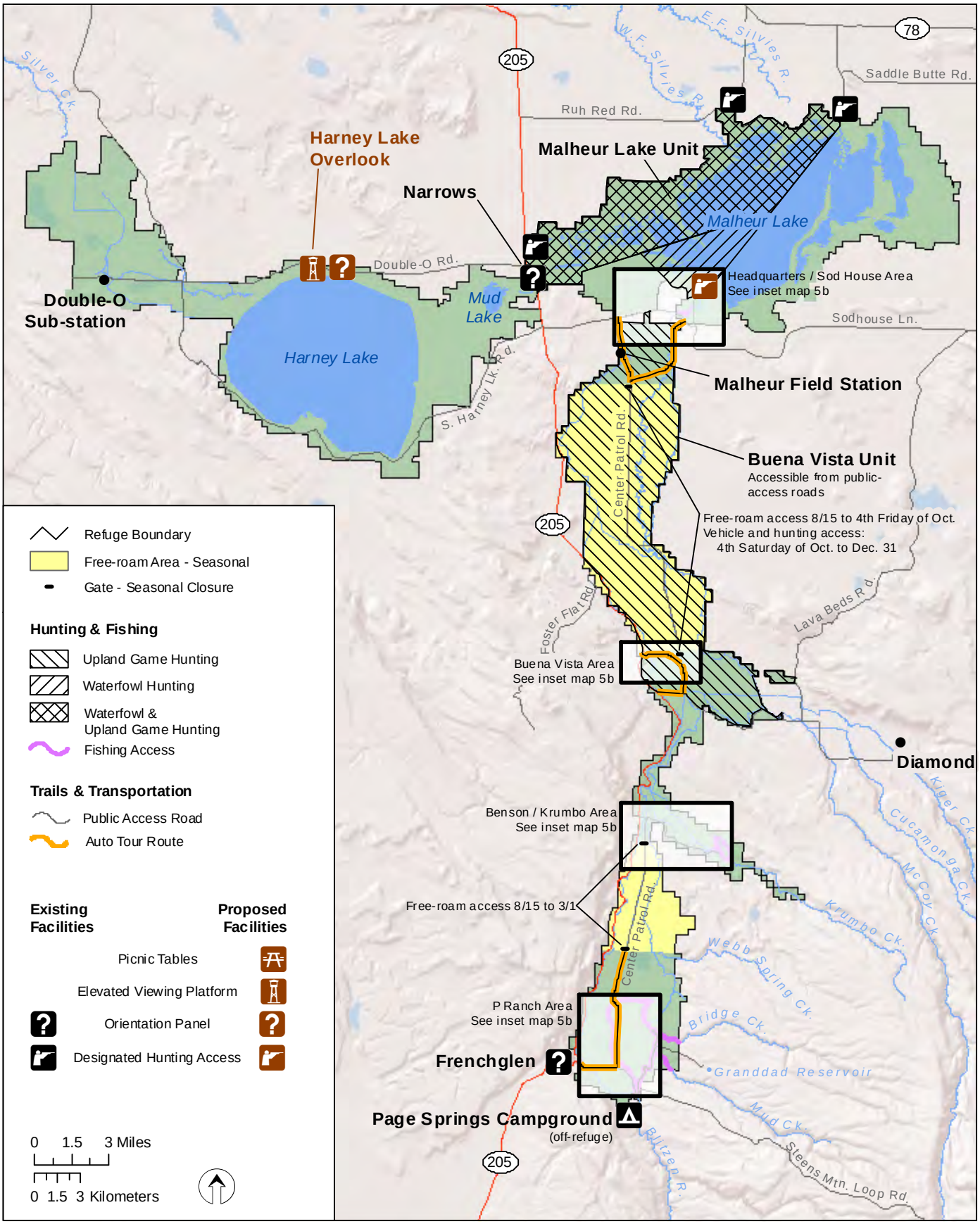
Map 4b
Public Use Facilities (Insets)
Alternative 2

- Refuge Boundary
- Irrigated Habitat
- Upland Habitat
- Canal or Stream
- Select Ponds
- Gate - Seasonal Closure
- Waterfowl Hunting
- Waterfowl & Upland Game Hunting

Existing Facilities		Proposed Facilities
	Visitor Contact	
	ADA Accessible	
	Trailhead	
	Picnic Tables	
	Viewing Overlook	
	Elevated Viewing Platform	
	Accessible Photo Blind	
	Passerine Management	
	Historic Site	
	Point of Interest	
	Boat Ramp	
	Restrooms	
	Parking	
	Education Shelter	
	Orientation Information	
	Interpretive Information	
	Fishing	
	Designated Hunting Access	
	Hiking Trail	
	Fishing Access	
	Public Access Road	
	Auto Tour Route	

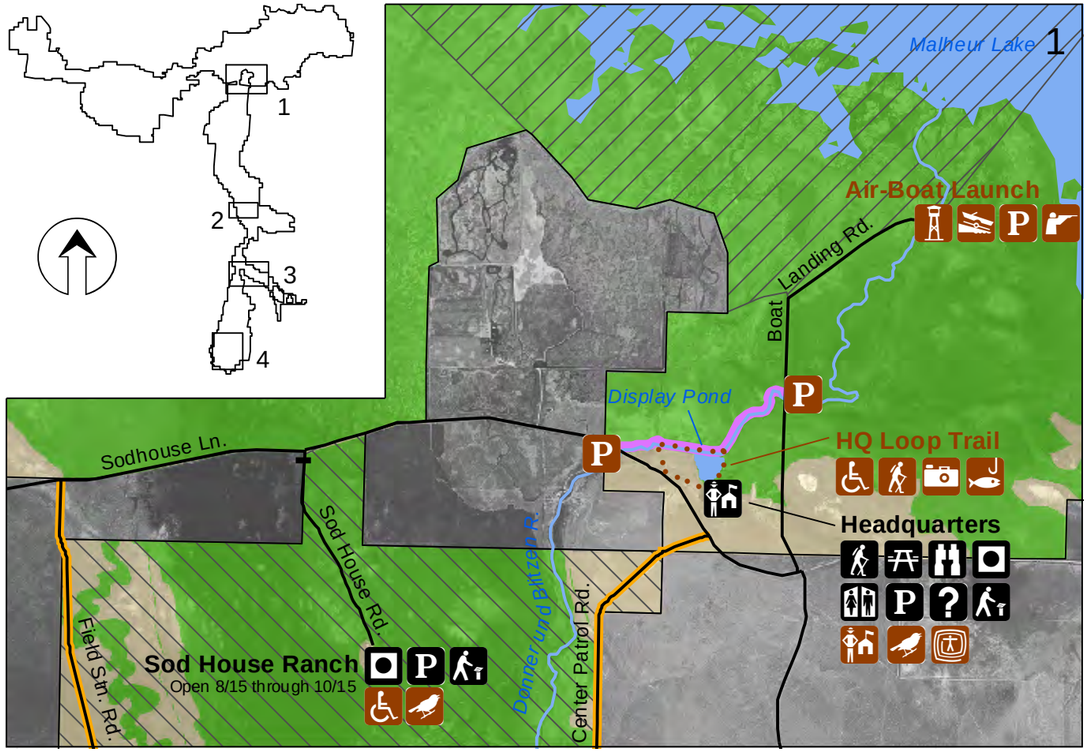
Map Date: 9/6/2012 File: 11-053-4b.mxd
Data Source: USDA National Agriculture Imagery Program 2009

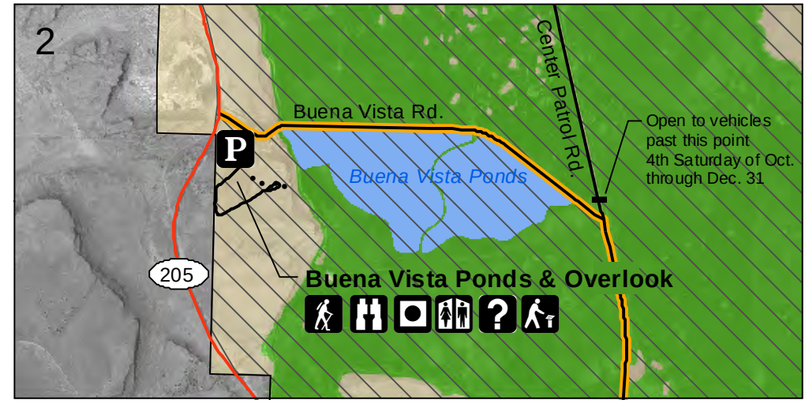
Map 5a — Public Use Facilities Alternative 3

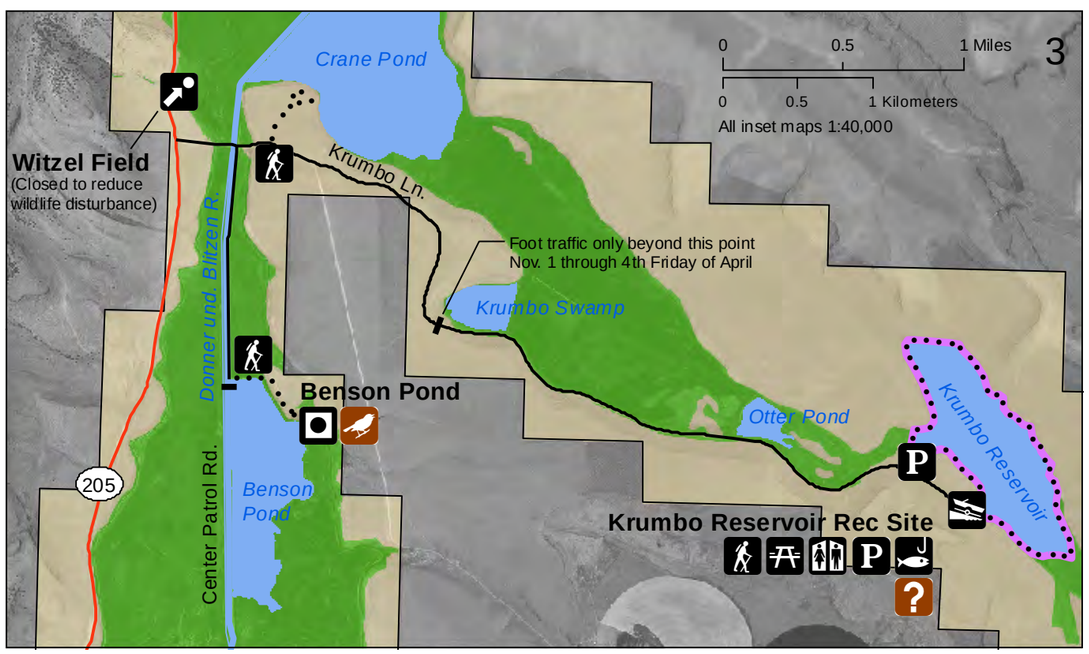


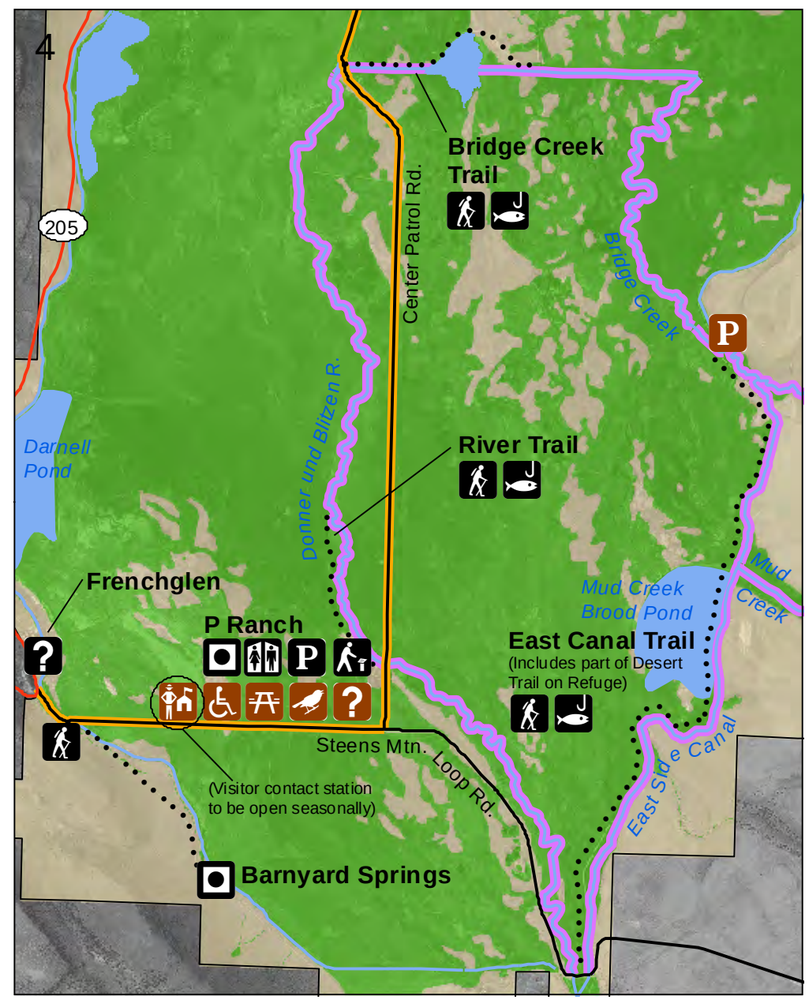
Map Date: 9/6/2012 File: Map5a_PublicUse_Alt3.mxd
Data Source: USGS HUC, NHD, ESRI_ShadedRelief_World_2D

Map 5b
Public Use Facilities (Insets)
Alternative 3







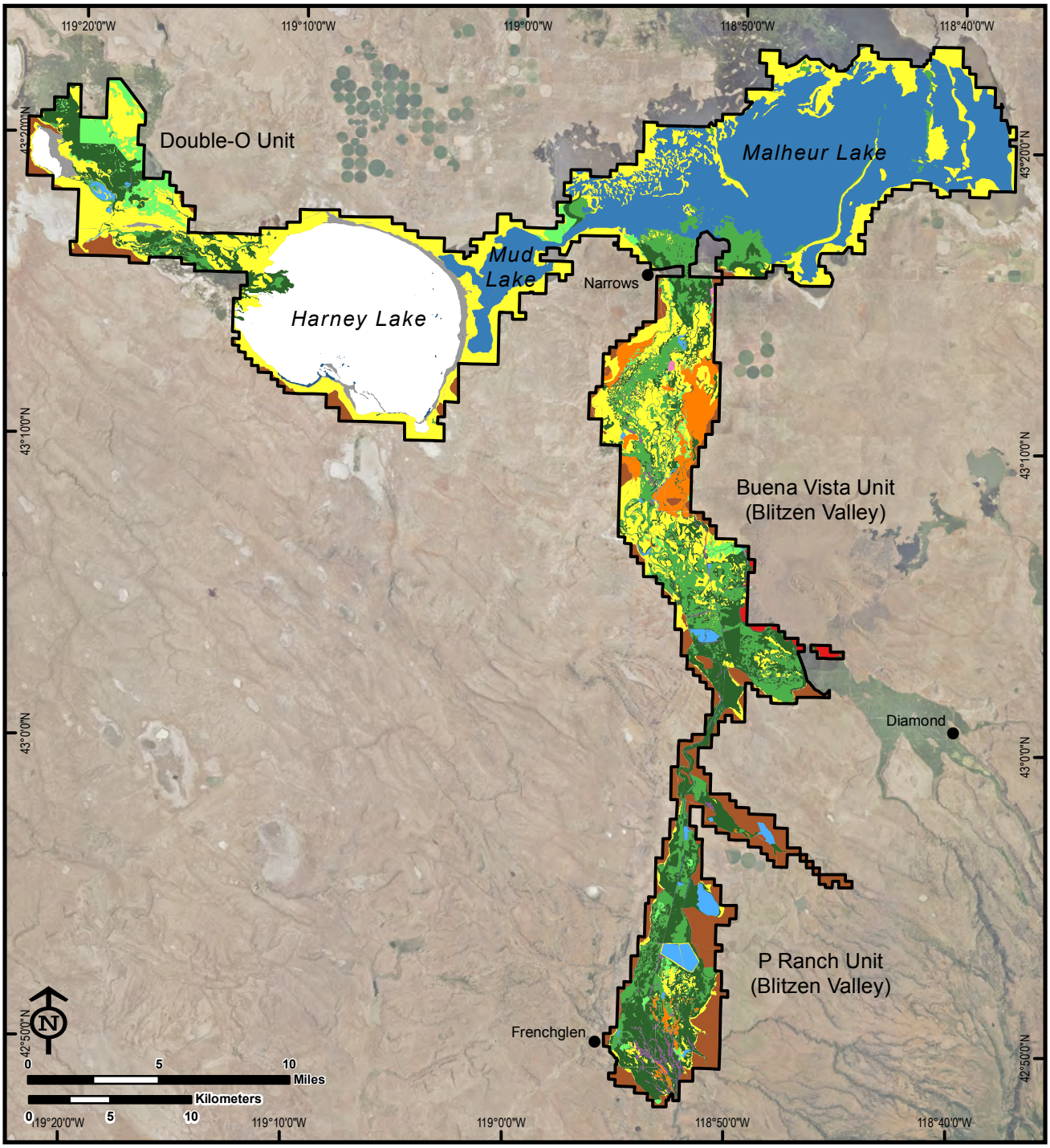


Refuge Boundary
Irrigated Habitat
Upland Habitat
Canal or Stream
Select Ponds
Gate - Seasonal Closure
Upland Game Hunting
Waterfowl Hunting

Existing Facilities		Proposed Facilities
	Visitor Contact	
	ADA Accessible	
	Trailhead	
	Picnic Tables	
	Viewing Overlook	
	Elevated Viewing Platform	
	Accessible Photo Blind	
	Passerine Management	
	Historic Site	
	Point of Interest	
	Boat Ramp	
	Restrooms	
	Parking	
	Education Shelter	
	Orientation Information	
	Interpretive Information	
	Fishing	
	Designated Hunting Access	
	Hiking Trail	
	Fishing Access	
	Public Access Road	
	Auto Tour Route	

Map Date: 9/6/2012 File: 11-053-5b.mxd
Data Source: USDA National Agriculture Imagery Program 2009

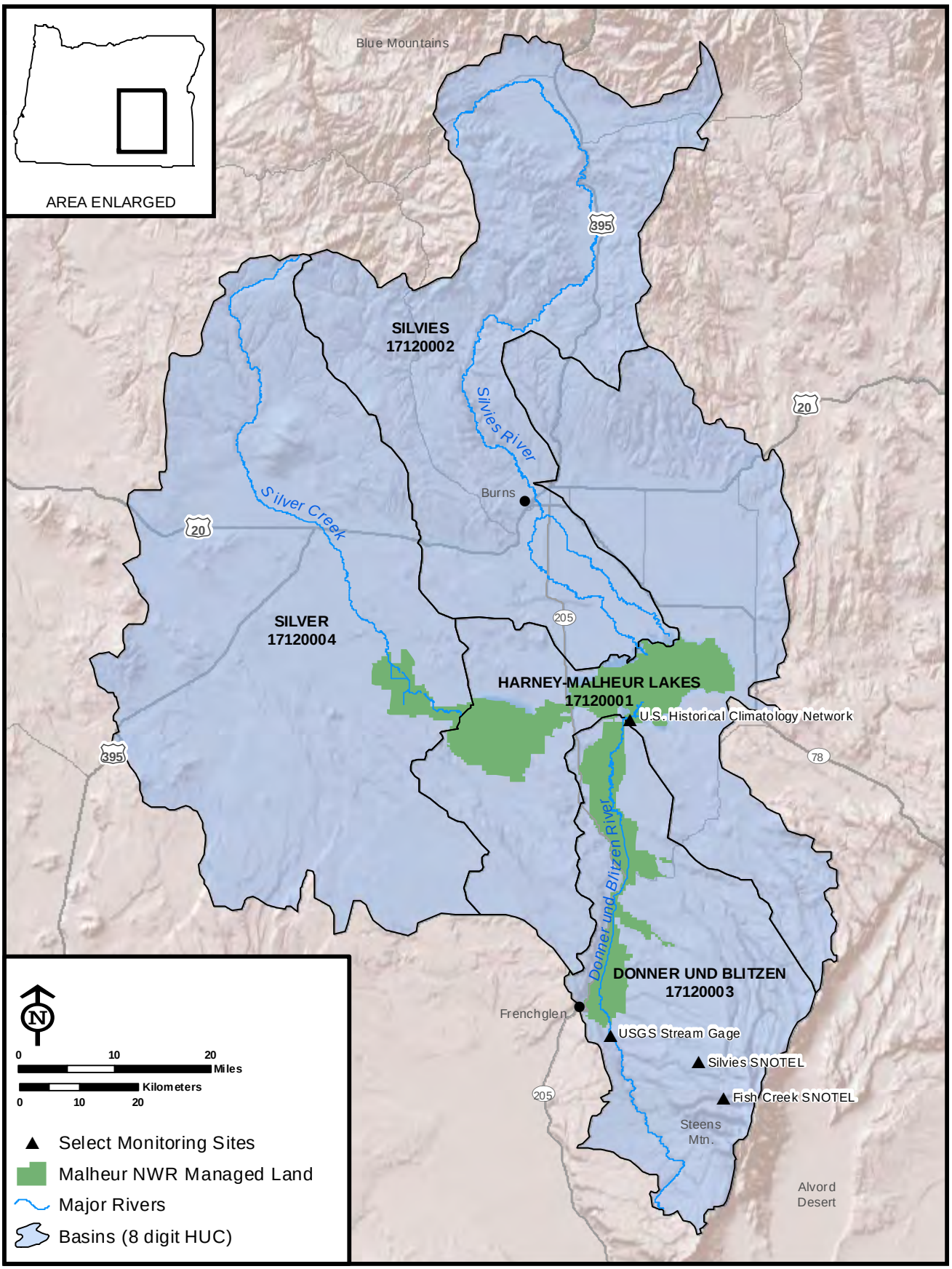
Map 6 ***Land Cover / Habitat***



Riverine	Dry Meadow	Sagebrush Steppe
Lacustrine (Lake)	Cropland	Dune
Palustrine Open Water/Emergent	Woody Riparian	Playa
Palustrine Emergent (Temporarily Flooded)	Salt Desert Scrub	Cliffs, Rimrock, and Outcropping
Palustrine Emergent (Seasonally Flooded)	Sagebrush Lowland	Cold and Hot Springs

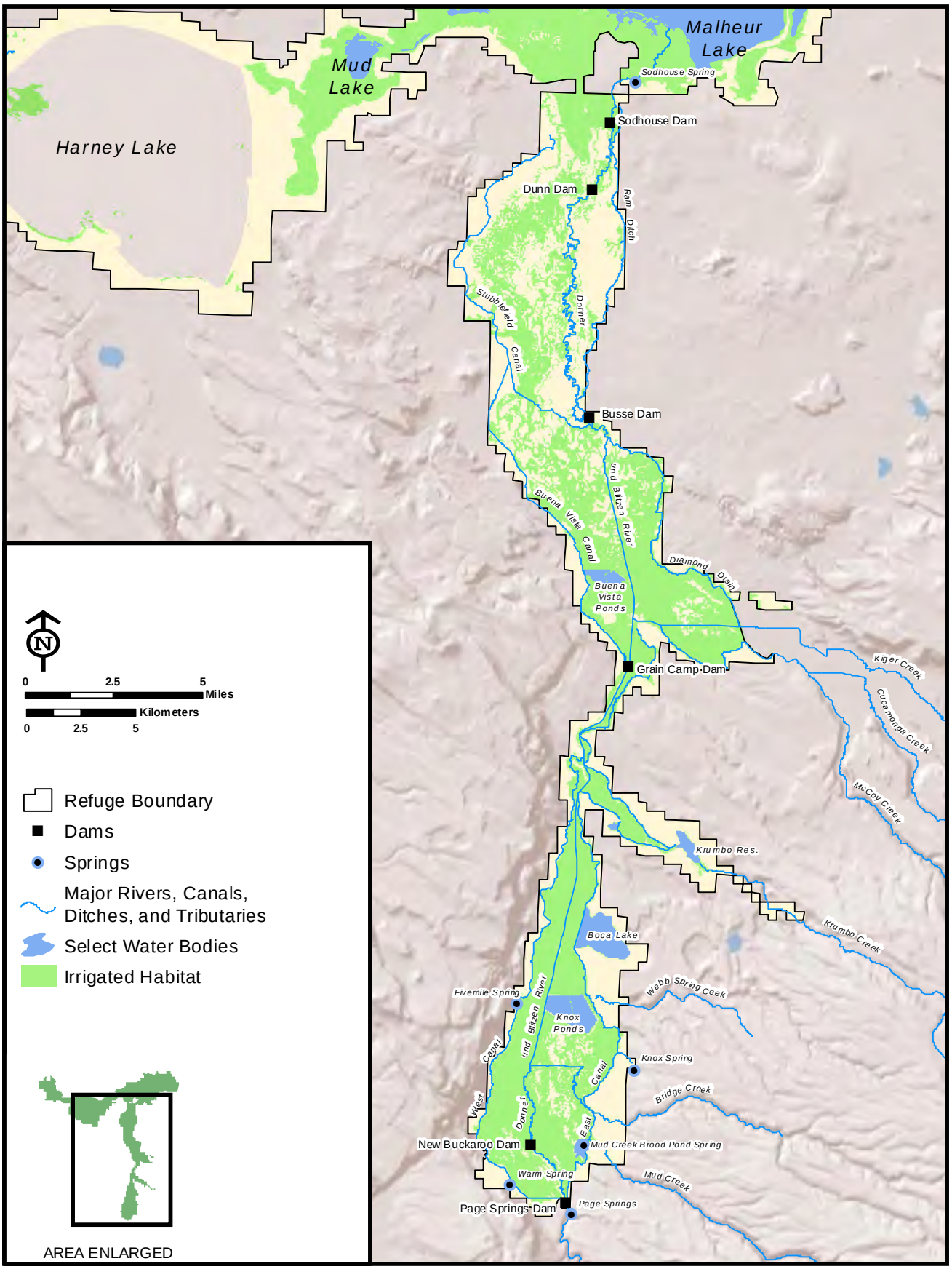
Map Date: 11/5/2012 File: 11-053-6.mxd
Data Source: USDA National Agriculture Imagery Program 2011

Map 7 *Watersheds*



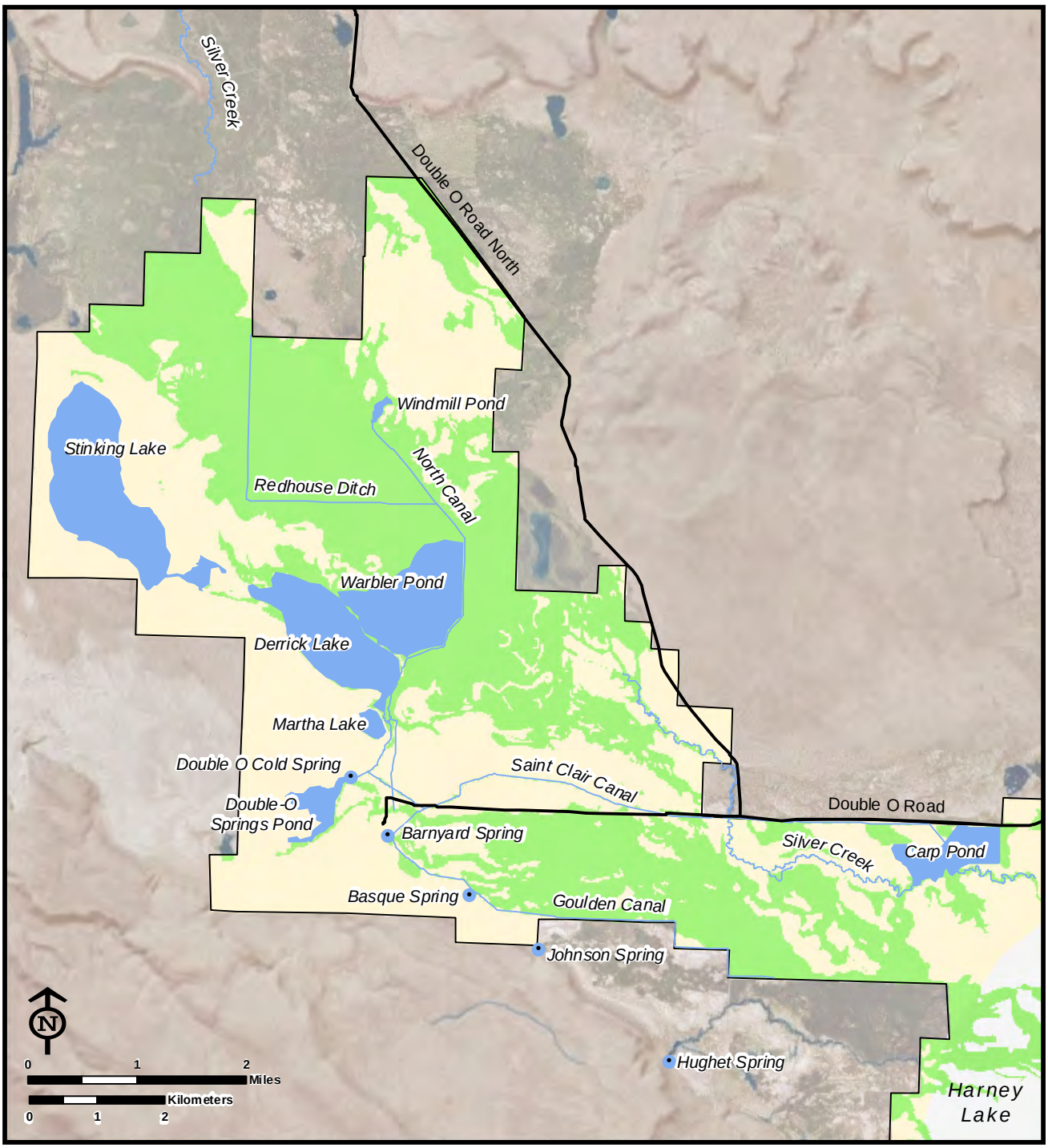
Map Date: 9/6/2012 File: 11-053-7.mxd
Data Source: USGS HUC, NHD, ESRI_ShadedRelief_World_2D

Map 8 ***Blitzen Valley Hydrologic System***

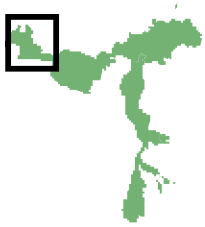


Map Date: 9/6/2012 File: 11-053-8.mxd
Data Source: USGS NHD, ESRI_ShadedRelief_World_2D

Map 9 ***Double-O Unit Hydrologic System***



Refuge Boundary
Springs
Major Rivers, Canals, Ditches, and Tributaries
Select Water Bodies
Irrigated Habitat



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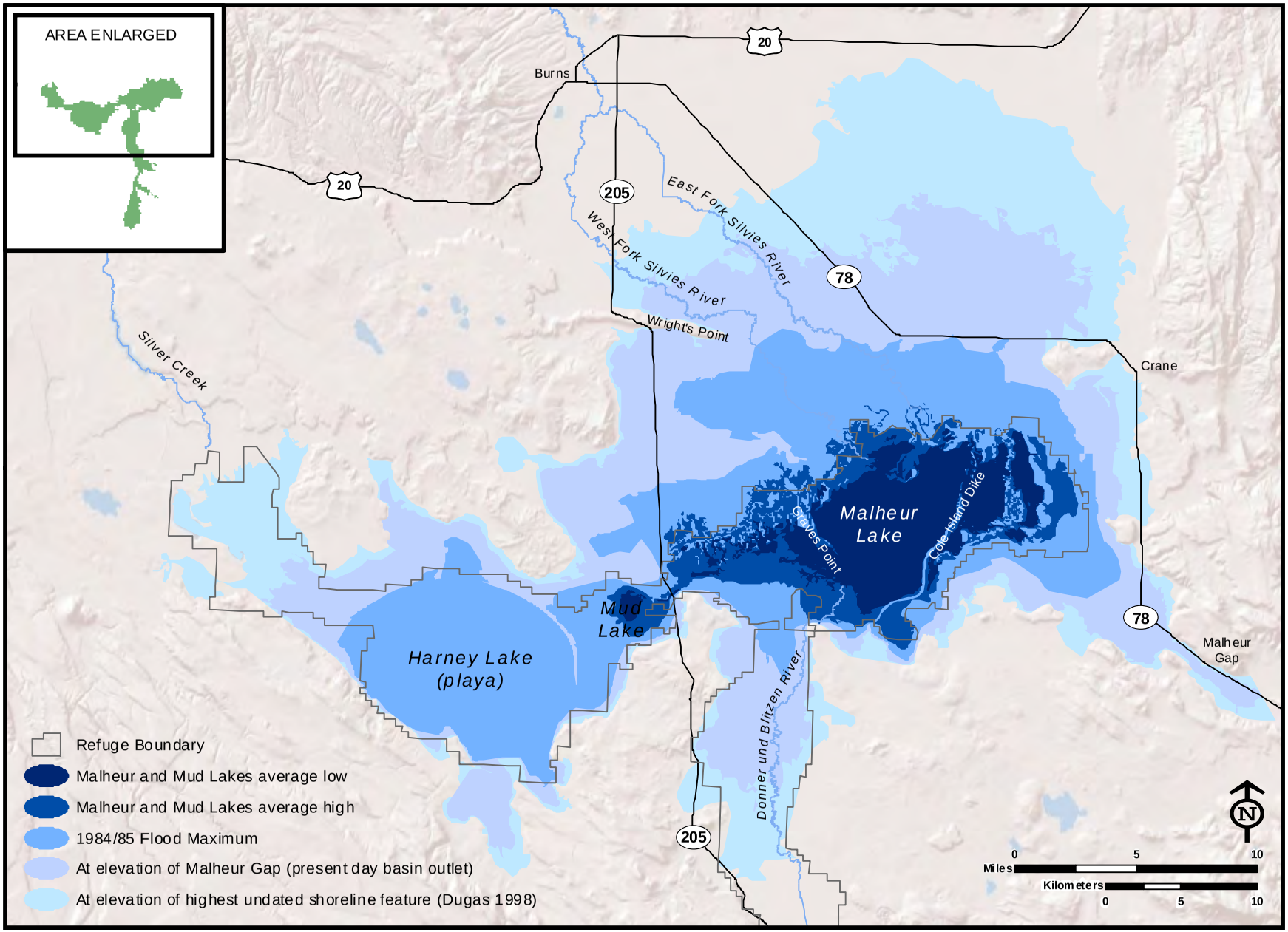
Map Date: 9/6/2012 File: 11-053-9.mxd
Data Source: USGS NHD, ESRI_ShadedRelief_World_2D, USDA National Agriculture Imagery Program 2011

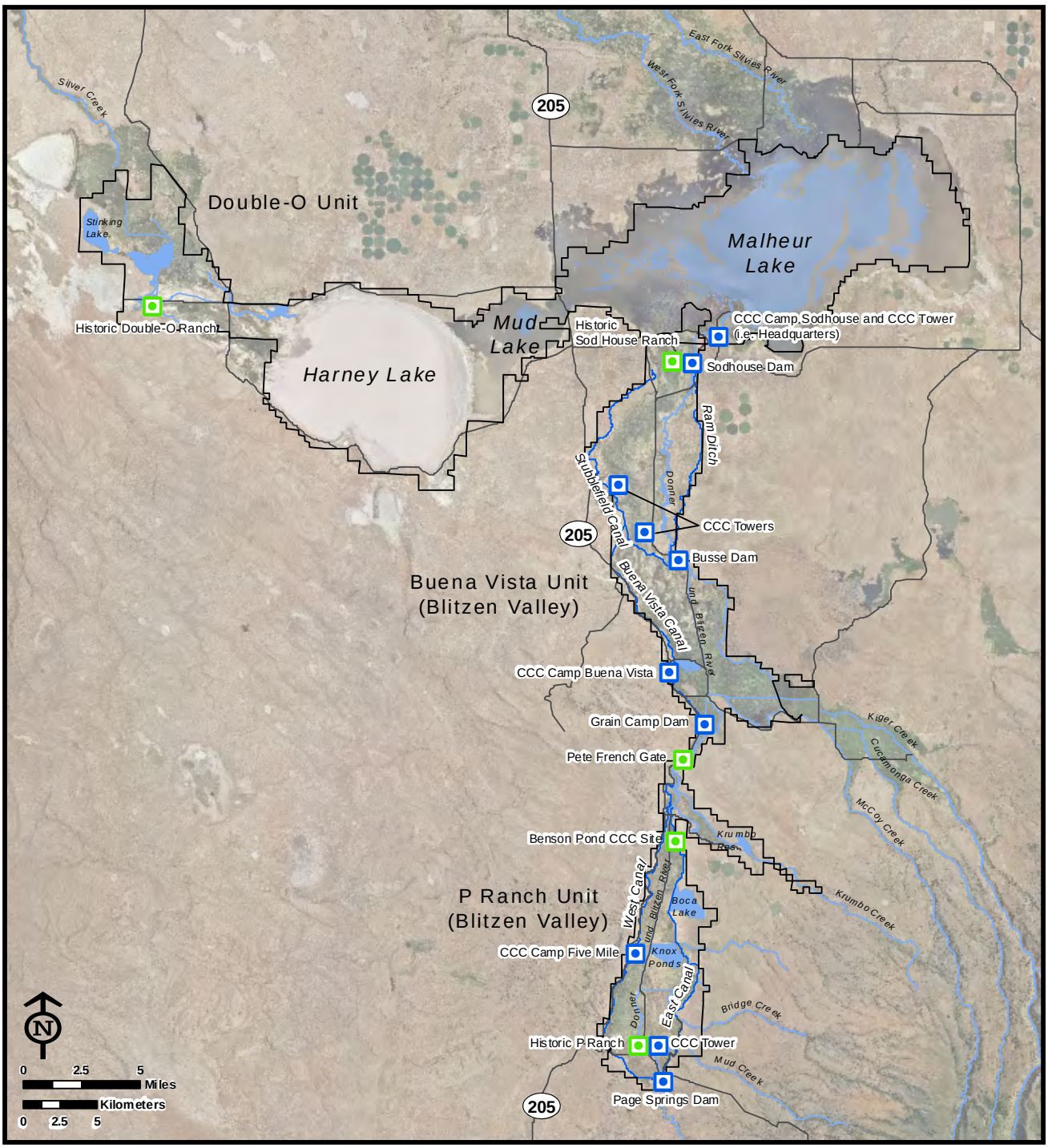
Map 10 — *Malheur, Mud, and Harney Lakes*



Map Date: 9/6/2012 File: 11-053-10.mxd
Data Source: ESRI_ShadedRelief_World_2D

Average low and high Malheur Lake elevations based on staffgage records 1938-2008, Malheur NWR. Contours (NGVD29 feet) derived from USGS National Elevation Dataset 30M DEM.
Source: Dugas, D.P. 1998. Late Quaternary Variations in the Level of Paleo-Lake Malheur, Eastern Oregon. Quaternary Research 50, 276-282.

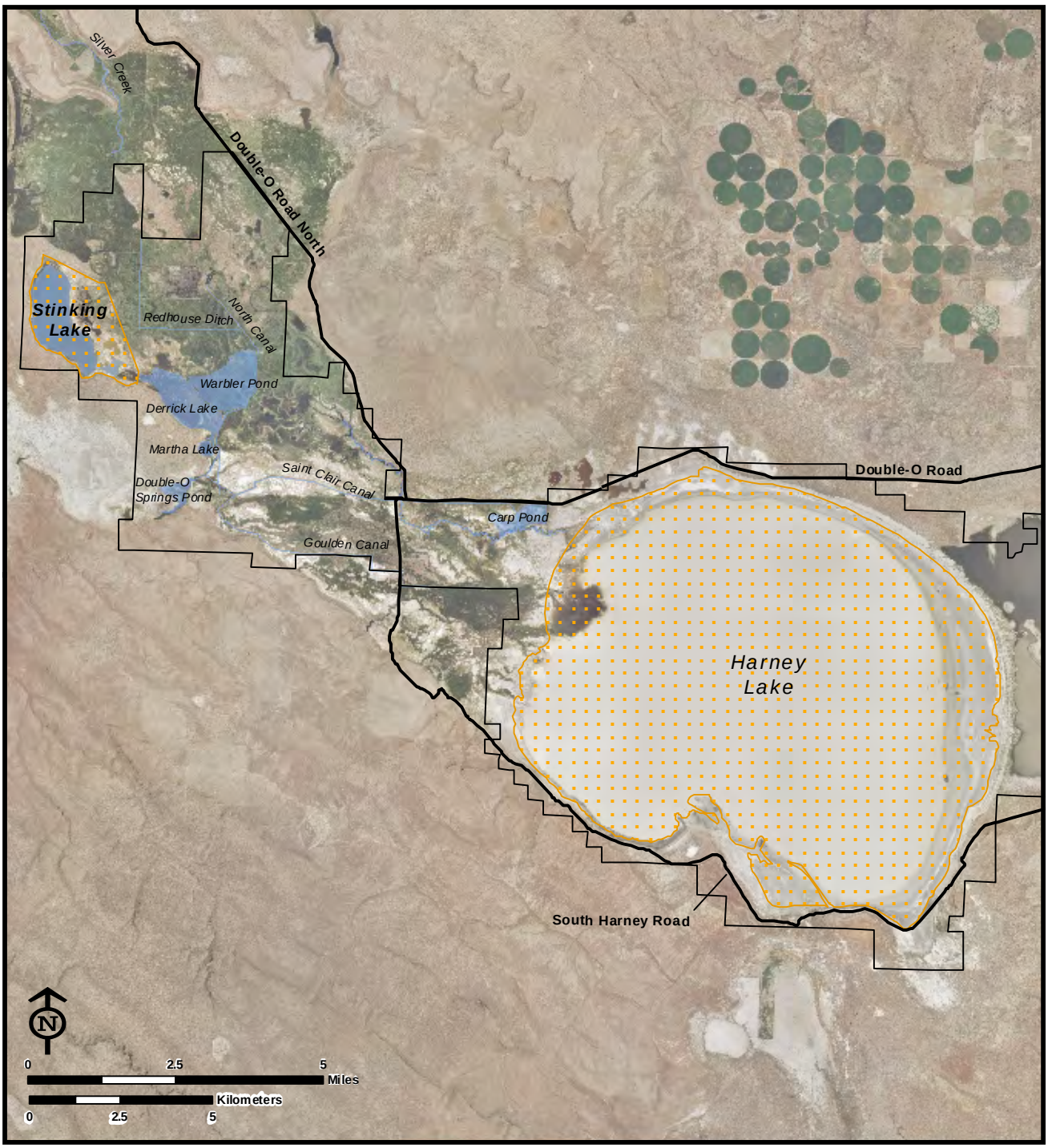
Map 11 *Historic Sites*



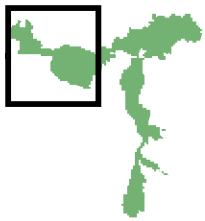
- Ranch-era Sites
- Civilian Conservation Corps (CCC) Sites
- CCC Constructed Canals and Ditches
- Refuge Boundary
- Select Hydrography
- Select Water Bodies

Map Date: 9/6/2012 File: 11-053-11.mxd
Data Source: USGS NHD, USDA National Agriculture Imagery Program 2011

Map 12 ***Research Natural Area Boundaries***



Refuge Boundary
Research Natural Area
Major Rivers, Canals, Ditches, and Tributaries
Select Water Bodies



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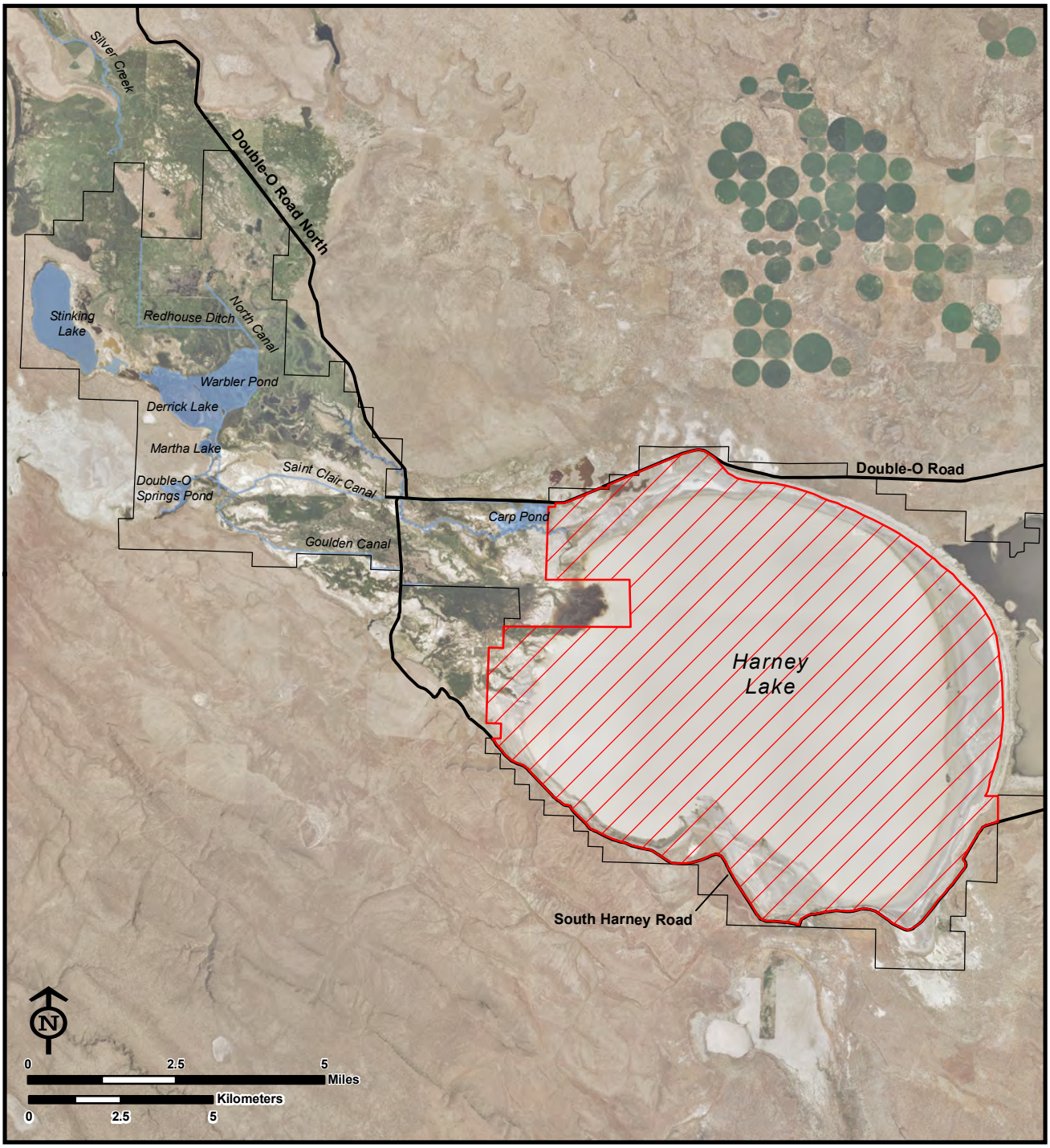
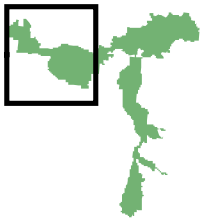
Map Date: 9/6/2012 File: 11-053-12.mxd
Data Source: USGS NHD, USDA National Agriculture Imagery Program 2011

Map 13 — *Wilderness Study Area Boundary*



Refuge Boundary
Wilderness Study Area
Major Rivers, Canals, Ditches, and Tributaries
Select Water Bodies



AREA ENLARGED

Map Date: 11/5/2012 File: 11-053-13.mxd
Data Source: USGS NHD, USDA National Agriculture Imagery Program 2011

U.S. Department of the Interior
U.S. Fish & Wildlife Service
Malheur National Wildlife Refuge
36391 Sodhouse Lane
Princeton, OR 97721

Phone: 541/493 2612
Fax: 541/493 2405

http://www.fws.gov

National Wildlife Refuge System Information
1 800/344 WILD

December 2012

The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

Cover Photo:
American coot and chicks.
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