United States
Department of
Agriculture

Forest Service

Intermountain
Region

Bridger-Teton
National
Forest

March 2019

Invasive Plant Management Draft Environmental Impact Statement for the Bridger-Teton National Forest

Bridger-Teton National Forest

Fremont, Lincoln, Park, Sublette and Teton Counties, Wyoming

Cheatgrass infestation on the Bridger-Teton National Forest

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees and applicants for employment on the bases of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, or all or part of an individual's income is derived from any public assistance program, or protected genetic information in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases will apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (PDF) within 45 days of the date of the alleged discriminatory act, event, or in the case of a personnel action. Additional information can be found online at www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form (PDF), found online at www.ascr.usda.gov/ complaint_filing_cust.html, or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter to us by mail at U.S. Department of Agriculture, Director, Office of Adjudication, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, by fax (202) 690-7442 or email at program.intake@usda.gov.

Persons with Disabilities

Individuals who are deaf, hard of hearing or have speech disabilities and you wish to file either an EEO or program complaint please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

Persons with disabilities, who wish to file a program complaint, please see information above on how to contact us by mail directly or by email. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.) please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Reviewers Comments

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review.

Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

Invasive Plant Management Draft Environmental Impact Statement

for the Bridger-Teton National Forest

Fremont, Lincoln, Park, Sublette and Teton Counties, Wyoming

Lead Agency: USDA Forest Service

Responsible Official: Tricia O'Connor, Forest Supervisor
P.O. Box 1880, 340 N. Cache
Jackson, WY 83001

For Information Contact: Chad Hayward, Natural resource Manager
Bridger-Teton National Forest
P.O. Box 218, 10418 S US Hwy 189
Big Piney, WY 83113

Abstract: This Draft Environmental Impact Statement presents the analysis concerning three alternatives for treating invasive plant species on the Bridger-Teton National Forest. Alternative 1 is a continuation of current invasive species management. Alternative 2, the preferred alternative, would treat thousands of acres annually using a combination of manual, mechanical, biological, aerial and ground herbicide applications. Alternative 3 is similar to Alternative 2 but does not utilize aerial herbicide application. The proposed treatments would occur over the next 10-15 years and would utilize adaptive and integrated invasive plant treatment.

Comments: The DEIS is available on the Bridger-Teton National Forest website. Use the link: https://www.fs.usda.gov/project/?project=52791 to download the document.

Information concerning the deadline for comments and methods to submit those comments will be published in the Federal Register and posted at the website address listed above.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review.

Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

Individuals and entities (non-governmental organizations, businesses, partnerships, state and local governments, Alaska Native Corporations and Indian Tribes) who submit timely, specific written comments regarding this project during this comment period or who have submitted timely, specific written comments during previous comment periods may subsequently file an objection when the draft record of decision is published. All timely, specific written comments that have been received during previous comment periods are filed in the project record, have been considered in the preparation of this document and will be considered again by the deciding officer before a decision is made. These previously submitted comments need not be resubmitted.

Submit comments to: comments-intermtn-bridger-teton@fs.fed.us

Table of Contents

Summary 1

Chapter 1. Purpose of and Need for Invasive Plant Management on the Bridger-Teton National Forest 5

Background 5

Purpose and Need for Invasive Plant Management on the Bridger-Teton National Forest 7

Proposed Action 10

Decision Framework 10

Public Involvement 11

Issues 12

Chapter 2. Alternatives, Including the Proposed Action 14

Introduction 14

Alternatives Considered in Detail 14

Alternative 1 – No Action 15

Alternative 2 – The Proposed Action 16

Alternative 3 – No Aerial Application of Herbicides 23

Alternatives Considered but Eliminated from Detailed Study 23

Comparison of Alternatives 24

Chapter 3. Affected Environment and Environmental Consequences 28

Introduction 28

Issue #1 Native Vegetation and Invasive Species 28

Issue #2: Threatened, Endangered, or Sensitive Species and Their Habitats (Plants and Wildlife) 44

Plants 44

Wildlife 56

Issue #3 Soil, Water and Aquatic Resources, Including Fisheries 70

Issue #4 Human Health and Safety 95

Wilderness, Wilderness Study Areas (WSA's), Inventoried Roadless Areas (IRA's), and Wild and Scenic Rivers (WSR's) 105

Special Interest Areas and Research Natural Areas 112

Recreation 113

Cultural Resources 116

Social and Economic Aspects 118

Climate Change 120

Other Resources in the Project Area 120

Short-term Uses and Long-term Productivity 121

Unavoidable Adverse Effects 121

Irreversible and Irretrievable Commitments of Resources 121

Other Required Disclosures ... 122

Chapter 4. Consultation and Coordination ... **123**

Preparers and Contributors ... 123

References ... **125**

Appendix A Resource Protection Measures ... **132**

Protection Measures for Federally Listed Wildlife Species ... 132

Protection measures for federally listed plant species ... 132

Protection measures by activity ... 133

Appendix B Herbicides, Product Name and Properties ... **140**

Appendix C Species-specific Ecology and Proposed Treatments, Including Herbicide Rates ... **142**

Species ... 143

List of Tables

Table 1. Invasive plant species proposed and priority of treatment on the Bridger-Teton should species occur 17
Table 2. Guidelines for selecting and prioritizing treatment 19
Table 3. Comparison of Alternatives........25
Table 4. Estimated treatment acres by method and Alternative – based on present funding levels 27
Table 5. Change in acres of invasive plant species present on the Bridger-Teton from 2007 to 2017 and invasive plant species likely to become established in the future. 29
Table 6. Plant communities and dominant vegetation on the Bridger-Teton 31
Table 7. Estimated acres of the major vegetation cover types on the Bridger-Teton. 32
Table 8. Summary of weed prevention measures currently available for use on the Bridger-Teton........35
Table 9. Summary of treatment methods currently approved for use on the Bridger-Teton 36
Table 10. USFWS listed terrestrial plant species and growth forms known or suspected to occur on the Bridger-Teton, considered for analysis and long-term benefits/ rationale for determination by alternative. 45
Table 11. Region 4 sensitive terrestrial plant species and growth forms known or suspected to occur on the Bridger-Teton, considered for analysis and long-term benefits/ rationale for determination by alternative. Shaded rows were excluded from further analysis. 47
Table 12. Past, present and reasonably foreseeable future actions considered in the cumulative effects analysis for T&E and sensitive plants........54
Table 13. TE&S plant species determination of effects for all alternatives........55
Table 14. USFWS listed terrestrial wildlife species and habitats known or suspected to occur on the Bridger-Teton, expected impacts for each alternative and consideration for detailed analysis........57
Table 15. Region 4 sensitive wildlife species known or suspected to occur on the Bridger-Teton, expected impacts for each alternative and consideration for detailed analysis 60
Table 16. Past, present and reasonably foreseeable future actions considered in the cumulative effects analysis for T&E and sensitive wildlife species 68
Table 17. TE&S species determination of effects for all alternatives and rationale for determination by alternative. 69
Table 18. Aquatic organisms and amphibians in the project area and their status 75
Table 20. Summary of determination of effects for federally listed and sensitive species, including rationale for determination. 93
Table 21. Herbicides available for use by alternative........97
Table 22. Comparison of risks to workers and the general public from herbicides available under all Alternatives. 100
Table 23. Wilderness areas and acres on the Bridger-Teton. 107
Table 24. Rivers included into the National Wild and Scenic River system. 120
Table 25. Project area resources that were not included in the DEIS. 120
Table 26. Forest Service interdisciplinary team (IDT) members participating in compilation of the draft environmental impact statement........123
Table 27. Local, state and federal agencies consulted. 124

List of Figures

Figure 1. Vicinity map of the Bridger-Teton National Forest.. 4
Figure 2. Decision tree to select treatment methods 22

Summary

The Forest Service proposes to treat invasive plant species on the Bridger-Teton National Forest (NF) using an adaptive and integrated invasive plant treatment strategy. The proposed action would occur over the next 10-15 years and would treat thousands of acres annually using a combination of manual, mechanical, biological, aerial and ground herbicide applications. Potential treatment areas include crucial big game winter ranges, greater sage-grouse habitat and other important habitats, fuels reduction projects, previously burned areas, roads and trails, power lines, rights-of-way, gravel and rock quarries, areas of timber harvest and beetle-killed forests where invasive plant species have already begun to proliferate. Implementing the proposed action would require compliance with herbicide label restrictions and comprehensive resource protection measures.

The proposed action would broaden the current management (noxious weed prevention, education and treatment of existing weed infestations) to do the following:

- Treat new infestations through adaptive management tools for assessing new treatments and new sites.
- Treat new invasive species in addition to those listed as noxious weeds by the State of Wyoming.
- Permit the use of newly developed, more species-specific, EPA-registered herbicides on National Forest System lands.
- Broaden control methods to include the use of aerial application of herbicides in limited or specific circumstances.
- Broaden protection measures for ground and aerial applications of herbicides.

The Bridger-Teton NF includes approximately 3.4 million acres of National Forest System (NFS) lands in five Wyoming counties: Fremont, Lincoln, Park, Sublette and Teton. New direction for invasive plant management on the NF is needed for the following reasons:

- To meet existing law, regulations and agency policy directing the Forest Service to treat non-native and invasive plants.
- To update existing management direction to include new invasive species and new treatments.
- To make cooperative treatment and control of invasive plant species more consistent and effective across land ownership boundaries.
- To help meet or maintain desired resource conditions on the NF. Invasive plants are threatening or dominating areas of both forests and the grassland with resulting impacts to native plant communities, soil, watershed function, wildlife habitats, forage areas for wildlife and livestock and recreational and scenic values.

The project was listed in the forestwide schedule of proposed actions (SOPA) for the Bridger-Teton NF in November 2017 titled *Invasive Plant Management EIS for the Bridger- Teton National Forest*.

The notice of intent (NOI) was published in the Federal Register on January 18, 2018 which started a 45-day comment period. The NOI asked for public comments on the proposal from January 18, 2018 through March 3, 2018.

As part of the public involvement process, the agency emailed scoping letters to individuals, businesses, organizations and tribes that expressed interest in the project development process. The scoping documents including the NOI and maps of the project areas were placed on the NF website for public viewing. Written comments were received from 15 respondents (members of the public and other local, state and federal agencies). The interdisciplinary team used the comments to develop a list of issues to be addressed.

The Forest Service identified the following significant issues during scoping:

- Issue #1: Effects on native vegetation, biological diversity, production and structure.
- Issue #2: Effects of herbicides on threatened, endangered or sensitive species and their habitats.
- Issue #3: Effects of herbicides on soils, water and aquatic resources.
- Issue #4: Effects of herbicides on human health.

In addition to the significant issues, the ID team identified the following potential concerns:

- Effects on wilderness, recommended wilderness, inventoried Roadless areas, wild and scenic rivers and research natural areas.
- Effects on recreation users.
- Effects on social and economic considerations, including effects on partnerships/ cooperators.

These issues led the agency to develop two alternatives to the proposed action.

Alternative 1: The current weed management program would continue. Herbicides would be applied using ground-based methods; aerial application would not be used. Ten herbicides identified in the 2004 NF Environmental Assessment (EA) for Management of Noxious Weeds would be available for routine weed control:

> 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, hexazinone, imazapyr, metsulfuron methyl, picloram and sulfometuron methyl.

An additional six herbicides have been approved and incorporated into weed management since the 2004 EA, these would also be would be available for routine weed control:

> aminocyclopyrachlor, aminopyralid, aquatic glyphosate, imazapic, indaziflam and rimsulfuron.

The following seven herbicides have been approved but have not been used in the past and would not be used under this alternative:

> atrazine, bromacil, diuron, mefluidide, simazine, tebuthiuron and triclopyr.

Adaptive management strategies would include the treatment of any newly introduced invasive plant species that are classified as noxious weeds by the State of Wyoming, treatment of weed infestations in new areas and use of new biological agents as they are approved by the USDA Animal and Plant Health Inspection Service (APHIS). More species-specific, EPA-registered herbicides that are developed in the future will *not* be available for use under this alternative.

Alternative 2: This alternative is the preferred alternative. The preferred alternative would expand current management to include:

- Treatment of any newly introduced invasive plant species that are classified as noxious weeds or Early Detection Rapid Response (EDRR) species by the five counties in the project area and the State of Wyoming.
- Use of new, more species-specific, EPA-registered herbicides. A Forest Service assessment team would evaluate new herbicides that become available after this analysis. The team would review the EPA's registration eligibility decision for new herbicides and determine if the herbicides are appropriate for use on the Bridger-Teton NF.
- Aerial herbicide application.
- Protection measures not included in the present weed management program (the no action alternative). This would include protection measures for ground-based and aerial herbicide application.

Thirteen herbicides would be available for use under Alternative 2: 2,4-D, aminocyclopyrachlor, aminopyralid, chlorsulfuron, clopyralid, glyphosate (aquatic and terrestrial), imazapic, imazapyr, indaziflam, metsulfuron methyl, picloram and rimsulfuron. The following nine herbicides would not be available for use under Alternative 2: atrazine, bromacil, dicamba, diuron, hexazinone, mefluidide, simazine, sulfometuron methyl, tebuthiuron and triclopyr. They were not included in the proposed action because they are not currently being used in the weed management program and the proposed herbicides are more effective with less risk.

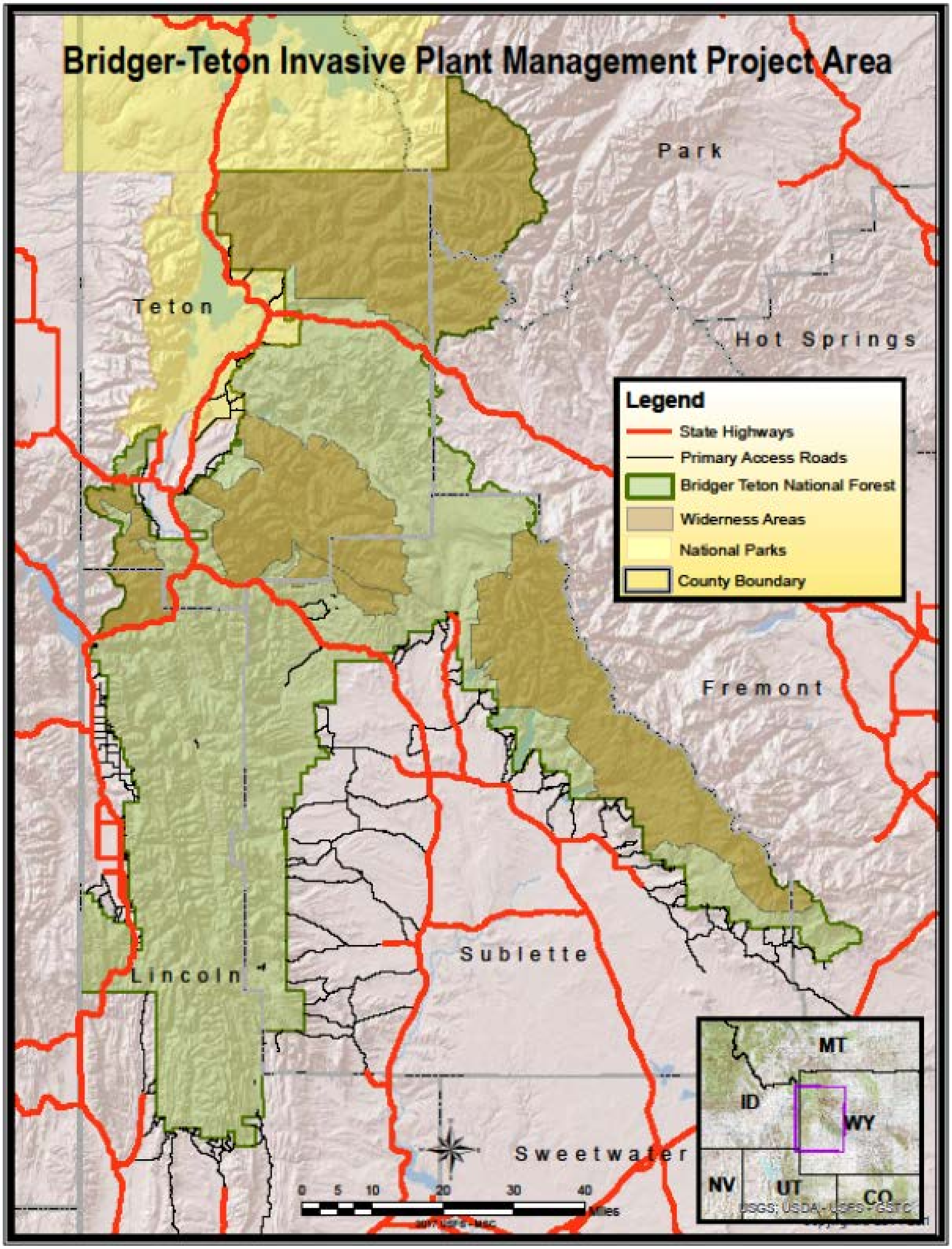
The preferred alternative would be implemented over the next 15 years and would treat approximately 5,000 and 15,000 acres annually. Of that, an estimated 5,000 to 10,000 acres could be treated using aerial application of herbicides.

Alternative 3: This alternative does not include aerial herbicide application. It allows treatment of about 3,000 – 5,000 acres per year on the NF using a combination of ground-based herbicide application plus manual, mechanical, biological and cultural control methods. Based upon the effects of the alternatives, the responsible official will make the following decisions:

- Whether to expand current efforts to control invasive plants.
- What control methods would be used.
- What herbicides would be used.
- What protection measures and monitoring measures would be required.

Whether to include an adaptive management approach to address future spread of invasive weeds.

Figure 1. Vicinity map of the Bridger-Teton National Forest



Chapter 1.
Purpose of and Need for Invasive Plant Management on the Bridger-Teton National Forest

The Forest Service has prepared this environmental impact statement (EIS) in compliance with regulations defined by the Council of Environmental Quality (CEQ) for implementing provisions of the National Environmental Policy Act of 1969 (NEPA) as amended, (40 CFR 1500-1508); U.S. Forest Service Environmental Policy and Procedures Handbook (FSH 1909.15); U.S. Forest Service Pesticide Use Management Handbook (FSH 2109.14); U.S. Forest Service Manual Invasive Species Management (FSM 2900), U.S. Forest Service Manual Environmental Management (FSM 2100) Chapter 2150 Pesticide-Use Management and Coordination (2013); Executive Order 13112 (1999) and other public land laws, rules and regulations. This EIS has been prepared to disclose the direct, indirect and cumulative environmental effects that would result from a proposal to expand the current Bridger-Teton National Forest (NF) non-native and invasive plant control program. The document is organized into four chapters, followed by appendices.

- *Chapter 1. Purpose and Need for Action:* The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.
- *Chapter 2. Alternatives, including the Proposed Action:* This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.
- *Chapter 3. Affected Environment and Environmental Consequences*: This chapter describes current environmental conditions on the Bridger-Teton NF and environmental effects of implementing the proposed action and alternatives.
- *Chapter 4. Consultation and Coordination:* This chapter provides a list of preparers and agencies consulted during the development of the DEIS.
- *Appendices:* The appendices provide more detailed information to support the analyses presented in the DEIS.

Additional documentation, including detailed analyses of the project, is maintained with the project record at the Forest Supervisor's office for the Bridger-Teton NF in Jackson, Wyoming.

Background

Nationally, non-native invasive plants are a growing environmental concern. The Forest Service recognizes that without efforts to control non-native invasive plants, their populations will expand, affecting the health and influencing the use of habitats across the forest. The ecological and economic effects of these species can be substantial and may include increasing environmental susceptibility to, and severity of, wildland fires.

Current management of noxious weeds on the Bridger-Teton NF is supported by a 2004 Environmental Assessment for Management of Noxious Weeds and subsequent NEPA decision. These documents provide for control or containment of noxious and other undesirable weeds using an integrated pest management strategy. However, the analysis did not study control of a comprehensive list of non-native invasive plant species already occurring on the NF or likely to arrive within the next 10 years, effects of new herbicides, or the aerial application of herbicides.

Integrated pest management strategies utilize various treatment options that identify the most economical and effective control of non-native and invasive plants. Anything that weakens the plant, prevents spreading, or prevents seed production can be an appropriate management tool. This analysis assesses the forest wide effects of new and existing treatment options and includes treatment of new non-native and invasive plant species. Proposed methods to control non-native and invasive plants include a combination of ground and aerial application of herbicides, mechanical, biological and cultural (e.g. seeding native plants, grazing, use of fertilizer) weed treatments.

The proposed integrated management strategies (which include weed prevention, weed treatment and resource protection measures) would be consistent with the NF Land and Resource Management Plan which directs land management activities on the forest.

To maintain consistency in this analysis, the following definitions are used to describe undesirable plants on the NF. The terms non-native invasive plants, invasive plants and invasive species will be used interchangeably.

- Non-native plants - In most cases, these are introduced species, plants that are not native to the region in which they occur.
- Noxious weeds - A plant species that is highly injurious or destructive and has the greatest potential for economic impact on forage and crop production. *Designated noxious weeds* are weeds that are designated state-wide. *Declared noxious weeds* are those that have been declared on a county-by-county basis.
- Invasive plants - All state- and county-listed noxious weeds are considered invasive plants. Also included in this designation are non-native plants that can successfully out-compete native plants and displace native plant communities but are not listed by state or counties as noxious weeds.

Purpose and Need for Invasive Plant Management on the Bridger-Teton National Forest

New direction for invasive plant management on the Bridger-Teton NF is needed for the following reasons. Each item is discussed in greater detail in the sections below.

- To meet existing law, regulation and agency policy directing the Forest Service to treat non-native and invasive plants.
- To update existing management direction to include new invasive species and new treatments.
- To make cooperative treatment and control of invasive plant species more consistent and effective across land ownership boundaries.
- To help meet or maintain desired resource conditions on the Bridger-Teton NF, including limiting the spread of invasive plants into areas with little or no infestation and to help reduce fuel loading and the resulting fire hazard and/or risk. Invasive plants are threatening or dominating areas of the forest with resulting impacts to native plant communities, soil, watershed function, wildlife habitats, foraging areas for domestic livestock and recreational and scenic values.

<u>Meeting existing law, regulation and agency policy for treating non-native and invasive plants</u>

The Forest Service is directed by law, regulation and agency policy to treat non-native and invasive plants. Several laws and regulations specifically provide for control of such species.

- *Carlson-Foley Act of 1968* (PL 90-583) authorizes and directs federal agencies to permit control of noxious weeds on federal lands by state and local governments on a reimbursement basis in connection with similar weed control programs carried out on adjacent nonfederal land.
- *Federal Noxious Weed Act of 1974* (PL 93-629) defines weeds and authorizes the Secretary of Agriculture to cooperate with other agencies, organizations or individuals to control and prevent noxious weeds.
- *The Federal Land Policy Management Act of 1976* (PL 94-579) authorizes control of weeds on rangeland.
- *The National Forest Management Act of 1976* (PL-94-588) authorizes removal of deleterious plant growth through forest plans.
- *The Wilderness Act of 1964, as amended (October, 1978).* The management goal for wilderness areas is to retain their primitive character and influence, without permanent improvements or human habitation, so as to preserve natural condition.
- *U.S. Forest Service Pesticide Use Management and Coordination Handbook* (FSH 2109.14). This directs proper use, containment and safety procedures for pesticide use by Forest Service personnel.
- *FSM 2100, Chapter 2150. Pesticide-Use Management and Coordination* directs the Forest Service to plan, evaluate and review pesticides and their use, as well as provide for safety in pesticide use, storage, transportation and disposal.
- *FSM 2900, Invasive Species Management* lists laws and regulations for the Forest Service to adhere to. Additionally, the manual states that the Forest Service invasive species policy and management objectives will be based on integrated pest management.
- *Code of Federal Regulations, 36 CFR 222.8* directs the Forest Service to cooperate with local weed control districts to analyze and develop noxious weed control programs where there are National Forests.

- *Forest Service Manual 2259.03* states, “Forest officers shall cooperate fully with State, County and Federal officials in implementing 36 CFR 222.8 and Sections 1 and 2 of Public Law 90-583. Within budgetary constraints, the Forest Service shall control to the extent practical, noxious farm weeds on all NFS lands.”
- *Wyoming Weed and Pest Control Act of 1973* (W.S. 11-5-101-11-5-119), the purpose of which is to control designated weeds and pests regardless of land ownership.
- *Wyoming Weed and Pest Special Management Program* (W.S. 11-5-301-11-5-303) authorizes development of county weed and pest control districts and an “integrated management system” for planning and implementation of a coordinated program utilizing all proven methods of control.
- *Existing Weed Control Plan - 2004 Bridger-Teton NF Environmental Assessment for Management of Noxious Weeds* is in place for the control of weeds on NFS lands by setting priorities, developing a prevention plan, continuing weed inventory and implementing a noxious weed control program.
- *Executive Order 13112 Invasive Species* (64 FR 6183; February 8, 1999) directs federal agencies “to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological and human health impacts that invasive species cause.”

Direction and support for non-native and invasive plant species management is also provided in the following:

- The 1998 *Forest Service Natural Resource Agenda* placed a strong emphasis on conserving and restoring degraded ecosystems as a management priority for the 21st Century, including actions to “attain desirable plant communities and prevent exotic organisms from entering or spreading in the United States.”
- The 1998 *Forest Service Strategy for Noxious and Non-native Invasive Plant Management* provided a “roadmap into the future for preventing and controlling the spread of noxious weeds and non-native invasive plants.”
- *The 2004 National Strategy and Implementation Plan for Invasive Species Management* identifies the Forest Service as one of the lead agencies in the effort to control non-native and invasive plants. It provides long-term direction to reduce, minimize or eliminate invasive species across all landscapes and ownerships by improving the management of invasive species using science-based technology, by emphasizing partnerships and by increasing performance and accountability, as well as communication and education.

<u>Updating existing management direction to include new invasive species and new treatments</u>

The 2004 management direction for noxious weeds on the Bridger-Teton NF did not anticipate the rate at which non-native and invasive plants have spread. There is a need to update that management direction to address new invasive plant species and new treatment options. This project provides the opportunity to update the 2004 Noxious Weed Implementation Plan by broadening the present adaptive and integrated management approach to include the following:

- Treatment of additional non-native and invasive species. The 2004 Plan allows treatment of new plant species that are classified as noxious weeds by Wyoming (i.e. cheatgrass is not classified as a noxious farm weed in Wyoming). There are other highly invasive species that should be treated whether or not they have been added to state lists of noxious weeds.
- Use of new herbicides that were developed and received EPA approval after 2004, or that may be developed in the future.
- Authorization to use aerial application of herbicides in prescribed situations.
- Additional specific protection measures to protect wildlife and aquatic resources.

The distribution, density and number of invasive species occurring on Bridger-Teton have increased, in part, due to:

- Large infestations occurring on lands adjacent to NFS lands.
- An increase in recreational activities, including use of off-highway vehicles, which have resulted in new infestations or accelerated rate of spread of current infestations.
- Lack of appropriate treatment options, such as the aerial application of herbicides to treat cheatgrass (*Bromus tectorum*) infestations. As a result, cheatgrass now occurs on more acres than all other invasive plants on the Bridger-Teton NF combined.
- Extended drought that has allowed cheatgrass to become established and spread rapidly, particularly in prescribed burn units, roadsides and areas burned by wildfire.
- A large-scale mountain pine beetle epidemic that has resulted in extensive areas of habitat now susceptible to non-native and invasive plant establishment.
- An increase in both recreational and commercial uses on the Bridger-Teton NF and surrounding lands have created environments suitable for the establishment of non-native and invasive species.

<u>Making cooperative treatment and control more consistent and effective</u>

Without an adequate plan for invasive plant species control on the Bridger-Teton NF, control efforts on adjacent and intermingled lands will be less effective. The public continues to demand increased invasive plant species control efforts on local, state and federal lands. The Forest Service has multiple cooperative weed management area agreements with counties and is pursuing additional coordinated efforts. Where private land owners and/or other federal, state and county landowners pool resources to treat invasive species, these treatments are less effective if weeds on adjacent or intermingled NFS lands are not treated because the Forest Service is not able to use some specific herbicides or cannot utilize aerial application. The seed source remains nearby to re-infest the treated sites and the Forest Service cannot take advantage of the reduced treatment costs that result from large scale treatment projects and leveraging of grant monies.

Recreation and other vehicle traffic, wildlife, livestock, wind and contaminated gravel, straw and hay readily move invasive plants between the Bridger-Teton NF and other lands. Many adjacent landowners control noxious weeds on their property. Consequently, a partnership approach among adjoining federal, state agencies, local governments and owners of adjacent and intermingled private land is vital to a successful treatment and control program.

<u>Meeting or maintaining desired resource conditions</u>

The proposed action responds to the goals and objectives outlined in the forest plan and helps move the Bridger-Teton NF toward the desired conditions described in the plan by doing the following:

- Protecting the natural condition and biodiversity of the Bridger-Teton NF by preventing or limiting the spread of non-native and invasive plant species.
- Promptly eliminating newly identified populations of invasive species not previously reported on NFS lands before they become firmly established.
- Preventing or limiting the spread of established invasive plants into areas containing little or no infestation. This could also reduce fire hazard and/or risk.
- Protecting sensitive and unique habitats including critical big game winter ranges, sage- grouse core areas and other important habitats.
- Reducing known and potential invasive plant seed sources along roads and trails, within powerline corridors, rights-of-ways, gravel and rock quarries, fuels reduction projects,

previously-burned areas and forests impacted by the mountain pine beetle.

Invasive plants are threatening or dominating areas of the Bridger-Teton NF with resulting impacts to native plant communities, soil, watershed function and wildlife habitats, forage areas for wildlife and livestock and recreational and scenic values. Non-native and invasive plants currently infest more than 75,000 acres (2%) of the Bridger-Teton NF. Density of infestations varies from a few plants per acre to nearly solid monocultures of non-native and invasive species.

Non-native plants on the Bridger-Teton NF have invaded important big game transition and winter ranges, reducing forage available for migrating and over-wintering mule deer, elk, moose and bighorn sheep. Cheatgrass invasion into big sagebrush (*Artemisia tridentata*) stands have degraded habitat for sagebrush-dependent species such as the greater sage-grouse (*Centrocercus urophasianus*). Once cheatgrass dominates the spaces between sagebrush plants, the likelihood of wildfire and the severity of wildfire, is increased. Wildfires supported by fine fuels such as cheatgrass may kill big sagebrush, thereby reducing or degrading sage-grouse habitat.

Proposed Action

The Forest Service proposes to treat invasive plant species on the Bridger-Teton NF using an adaptive and integrated invasive plant treatment strategy. The proposed action would occur over the next 10-15 years and would treat thousands of acres annually using a combination of manual, mechanical, biological, aerial and ground herbicide applications. Potential treatment areas include crucial big game transition and winter ranges, migration corridors, greater sage-grouse core areas and other important habitats, fuels reduction projects, previously-burned areas, roads and trails, power lines, rights-of-ways, gravel and rock quarries, areas of timber harvest and beetle-killed forests where invasive plant species have already begun to proliferate. Implementing the proposed action would require compliance with herbicide label restrictions and comprehensive resource protection measures. The proposed action is described in more detail in Chapter 2.

Current management of invasive plant species is based on the 2004 Bridger-Teton NF *Environmental Assessment for Management of Noxious Weeds* and includes prevention, education and treatment of existing noxious weed infestations. The proposed action would broaden the current management to:

- Treat new infestations through adaptive management tools for assessing new treatments and new sites.
- Treat new and existing invasive species in addition to those listed as noxious weeds by the State of Wyoming.
- Permit the use of newly developed, more species-specific, EPA-registered herbicides. A Forest Service assessment team will be established to review the EPA issued registration eligibility decision and determine the new herbicide's appropriateness for use on public lands.
- Broaden control methods to include the use of aerial application of herbicides in limited or specific circumstance.
- Broaden protection measures for ground and aerial applications of herbicides.

Decision Framework

The deciding official reviews the purpose and need, the proposed action, the other alternatives and the environmental effects in order to make the following decisions:

- Whether or not to expand current efforts to control invasive plants and noxious weeds.
- What control methods would be used.
- What herbicides would be used.
- What protection measures and monitoring measures would be required.

- Whether or not to include an adaptive management approach to address future spread of invasive plants and weeds.

The DEIS is a project level analysis. The scope of the project is confined to issues and potential environmental consequences relevant to the decision. This analysis does not attempt to re-evaluate or alter decisions made at higher levels. The decision is subject to, and would implement, direction from higher levels.

National and regional policies and forest plan direction require consideration of effects of all projects on weed spread and prescribe protection measures, where practical, to limit those effects.

Reconsidering other project level decisions or prescribing protection measures or standards for future forest management activities (such as travel management, timber harvest and grazing management) is beyond the scope of this document. Chapter 3 contains cumulative effects analyses which evaluate the effects of the proposed action in combination with effects of other forest activities.

The following decisions will **not** be made based on analyses done for this project:

- Changes in land use and forest management objectives.
- Changes in the level of wildland fire suppression, strategies and tactics and decisions on whether or not to control wildfire.
- Re-evaluation of road analyses or road management decisions, including changes in travel, road use and access.
- Existing prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions will not be repeated in this analysis.

Public Involvement

The project was listed in the forest wide schedule of proposed actions (SOPA) in November 2017 issue titled *Invasive Plant Management EIS for the Bridger- Teton National Forest*.

The notice of intent (NOI) was published in the Federal Register on January 18, 2018 which started a 45-day comment period. The NOI asked for public comments on the proposal from January 18, 2018 through March 3, 2018.

As part of the public involvement process, the agency emailed scoping letters to individuals, businesses, organizations and tribes that expressed interest in the project development process. The scoping documents including the NOI and maps of the project areas were placed on the Bridger-Teton NF web site for public viewing. Written comments were received from 15 respondents (members of the public and other local, state and federal agencies). The interdisciplinary team used the comments to develop a list of issues to be addressed.

Issues

The Forest Service separated the issues into two groups: significant and non-significant issues. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those 1) outside the scope of the proposed action, 2) already decided by law, regulation, Forest Plan, or other higher level decision, 3) irrelevant to the decision to be made, or 4) conjectural and not supported by scientific or factual evidence.

The Council on Environmental Quality (CEQ) NEPA regulations explain this delineation in Sec. 1501.7,

"…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…"

A list of non-significant issues and reasons for their categorization are in the project record located at the Forest Supervisor's office in Jackson, Wyoming. The Forest Service identified the following significant issues during scoping:

Issue #1: Effects on native vegetation, biological diversity, production and structure

There is a concern with potential impacts on native vegetation, biological diversity, production and structure if weeds and invasive plants are not treated through an integrated pest management strategy.

Issue Indicators:

- Potential for spread or reduction of weeds in acres.

Issue #2: Effects of herbicides on threatened, endangered, or sensitive species and their habitats

Some respondents expressed concern about the effects of herbicides used for invasive plant control on threatened, endangered, or sensitive (TE&S) plant and animal species and their habitats. Other respondents expressed concern about the effects on TE&S species and their habitats if invasive plant species are not controlled.

Issue Indicators:

- Impacts that exceed regulatory compliance thresholds.
- Potential impact of herbicides to non-target resources.

Issue #3: Effects of herbicides on soils, water and aquatic resources

Respondents expressed concern about effects of herbicides used for invasive plant and noxious weed control on aquatic organisms (fisheries, insects and amphibians) and water quality. Some respondents expressed concern about herbicide drifting from treatment areas into riparian areas, streams and other lands with unintended consequences. One respondent expressed concerns about potential contamination of public drinking water supply.

Issue Indicators:

- Impacts that exceed regulatory compliance thresholds.
- Potential impact of herbicides to non-target resources.

Issue #4: Effects of herbicides on human health

There is a concern with potential impacts on human health from the use of herbicides to control weed infestation. Respondents also wanted to know how people who are sensitive to herbicides would be protected. Some were concerned about drift from either ground or aerial applications.

Issue Indicators:

- Potential for exposure, including exposure from spray drift.
- Potential for oral doses or concentrations in air likely to be associated with adverse effects over

lifetime exposure.

Other Related Potential Concerns

In addition to the significant issues, the ID team identified the potential concerns listed below.

- Effects on wilderness, recommended wilderness, inventoried Roadless areas, wild and scenic rivers and research natural areas.
- Effects on recreation users.
- Effects on social and economic considerations, including effects on partnerships/cooperators.

Chapter 2.
Alternatives, Including the Proposed Action

Introduction

This chapter provides a more detailed description of the agency's proposed action for invasive plant management on the Bridger-Teton NF and two alternative management scenarios. The alternatives were created using scoping comments submitted by the public and internal Forest Service input. This chapter includes discussion on integrated and adaptive management and a summary table comparing the proposed action and alternatives.

Alternatives Considered in Detail

The Forest Service developed three alternatives that are considered in detail in this draft EIS. They are described in greater detail below, including discussions of adaptive and integrated pest management strategies, methods and activities that could be implemented.

- Alternative 1, No action – no change from current management.
- Alternative 2, Proposed action. Aerial and ground-based herbicide applications plus manual and mechanical, biological, cultural control and combinations of treatments.
- Alternative 3, No aerial herbicide application. Ground-based herbicide application plus manual and mechanical, biological, cultural control and combinations of treatments.

<u>Features Common to All Alternatives</u>

Integrated and adaptive weed management

Integrated and adaptive weed management strategies would be used under all alternatives, but the specific tools available for weed treatment and the amount of adaptability vary by alternative.

Integrated management uses a variety of weed prevention and weed treatment methods to maximize effectiveness while minimizing negative effects to other resources.

In adaptive management, the management strategy changes over time as weed treatment challenges and opportunities change. Two examples of adaptive management are use of a newly approved herbicide that is more selective or treatment of a new invasive plant species which has not been encountered before. The integrated and adaptive management strategies for the proposed action and alternatives are discussed in the following sections.

<u>Resource protection measures</u>

Protection measures for the proposed action and alternatives are described in Appendix A. The proposed action and alternatives have some protection measures in common, but some protection measures only apply to particular alternatives. For example, protection measures for aerial application of herbicides only apply to the proposed action (Alternative 2).

Resource protection measures are actions designed into the proposed action and alternatives to reduce impacts of proposed activities. They include requirements that must be complied with by law, regulation, or policy, best management practices (BMPs), forest plan standards and guidelines, and standard operating procedures.

Cooperation and coordination

To increase the effectiveness of invasive plant treatments, the Forest Service would continue cooperative, multi-ownership control efforts and would expand those efforts where possible. Cooperative efforts may include any of the following:

- Sharing databases and information on the presence of weeds.
- Sharing resources such as personnel, equipment and herbicides. This would include working with counties to prioritize roads for weed treatments and developing funding agreements for weed control work along priority roads crossing Bridger-Teton NF and county lands.
- Using input from the counties and local land owners to help set treatment priorities.
- Applying for and sharing grants and aid as a block of cooperators instead of single agencies or organizations.
- Using cooperative agreements to pay for weed control work that crosses ownership boundaries.

Monitoring and record keeping

Under the proposed action and all alternatives, invasive plant species treatments would be recorded, monitored and reported annually. Detailed, accurate record keeping and monitoring are fundamental components of a successful adaptive management program. Record keeping provides a historical record of activities and helps map out future treatment activities. Monitoring and surveying are necessary to determine whether treatments are effective and meeting management objectives. Annual reporting is important and required for program accountability and includes inventorying invasive plant species treated and documenting specifics of each treatment. Global Positioning System devices (GPS units) or other methods are used to map the treated area and record specific site data.

Those data may include the following:

- Name of invasive plant targeted for treatment.
- Treatment method.
- Date and time of treatment.
- Name, location and estimated area of treatment site.
- Biocontrol – species and number of biological control agents released.
- Herbicide – brand name and EPA registration number, formulation, mix rate, amount applied, applicator’s name and general weather conditions, including wind speed.

Alternative 1 – No Action

Under the no action alternative, the current weed management program would continue. Herbicides would only be applied using ground-based methods. Aerial application would not be used.

Ten herbicides identified in the 2004 Environmental Assessment for Noxious Weed Management would be available for routine weed control: 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, hexazinone, imazapyr, metsulfuron methyl, picloram and sulfometuron methyl. An additional six herbicides which have been incorporated into the weed management program since the 2004 analysis would also be authorized. These include: aminocyclopyrachlor, aminopyralid, aquatic glyphosate, imazapic, indaziflam and rimsulfuron. No additional herbicides that are developed in the future to achieve more species-specific treatments will be used under this alternative.

Integrated pest management – mechanical, cultural, biological and herbicide treatments – would continue. Present weed management techniques are described in Chapter 3 in the Native Vegetation and Invasive Species section.

Past funding has allowed treatment of approximately 3,000-5,000 acres annually. Many of these acres are re-treatment acres since some infestations require repeated treatment for 5 to 8 years to ensure effective control or provide containment.

Appendix A lists protection measures for the no action alternative.

Alternative 2 – The Proposed Action

The preferred alternative would expand current management to include:

- Treatment of any newly introduced invasive plant species that are classified as noxious weeds or Early Detection Rapid Response (EDRR) species by the five counties in the project area and the State of Wyoming.
- Use of new, more species-specific, EPA-registered herbicides. A Forest Service assessment team would evaluate new herbicides that become available after this analysis. The team would review the EPA's registration eligibility decision for new herbicides and determine if the herbicides are appropriate for use on the Bridger-Teton NF.
- Aerial herbicide application.
- Protection measures not included in the present weed management program (the no action alternative). This would include protection measures for ground-based and aerial herbicide application.

Thirteen herbicides would be available for use under Alternative 2: 2,4-D, aminocyclopyrachlor, aminopyralid, chlorsulfuron, clopyralid, glyphosate (aquatic and terrestrial), imazapic, imazapyr, indaziflam, metsulfuron methyl, picloram and rimsulfuron. All are EPA-registered and have Syracuse Environmental Research Associates (SERA) or BLM risk assessments or herbicide fact sheets, collectively referred to as Environmental Risk Assessments. Aminocyclopyrachlor, aminopyralid, aquatic glyphosate, imazapic, indaziflam and rimsulfuron were not included in the previous weed analysis because they had not been fully tested and approved when the 2004 analysis was done. See Appendix B and the risk assessments in the project record for more information on these herbicides.

The following nine herbicides would not be available for use under Alternative 2: atrazine, bromacil, dicamba, diuron, hexazinone, mefluidide, simazine, sulfometuron methyl, tebuthiuron and triclopyr. They were not included in the proposed action because they are not currently being used in the weed management program and the proposed herbicides are more effective with less risk.

The preferred alternative would be implemented over the next 15 years and would treat approximately 5,000 and 15,000 acres annually. Of that, an estimated 5,000 to 10,000 acres could be treated using aerial application of herbicides. Aerial treatment would primarily target cheatgrass and the herbicides initially proposed for use are imazapic and rimsulfuron. These herbicides are selective herbicides that are effective on annual grasses.

The following table lists invasive plants known to occur on the Bridger-Teton NF and those considered likely to occur on the Bridger-Teton NF in the future.

Priority 1 indicates non-native and invasive species of highest priority for treatment and eradication if possible, on NFS lands. In areas where known infestations of these non-native and invasive species occur on adjacent non-NFS lands, prevention and monitoring activities will be given highest priority. Efforts will be prioritized to coordinate control efforts across jurisdictions and to cooperate with adjacent landowners to treat these infestations.

Priority 2 indicates non-native and invasive species which are increasing on NFS lands. Efforts here will be to prevent new infestations and to contain or reduce existing infestations. Efforts here will be to spot infestations as soon as possible and to work toward eradication if infestations occur.

Priority 3 indicates non-native and invasive species which are so common and widespread that forestwide eradication is not presently reasonable. Efforts here will be directed toward prevention of new infestations and control of localized infestations in priority habitats.

Priority 4 indicates non-native and invasive species which are not currently known to occur on NFS lands. Prevention and early detection, rapid response will be the focus for these species.

Table 1. Invasive plant species proposed and priority of treatment on the Bridger-Teton NF should species occur

Common Name	Scientific name	Priority
Diffuse knapweed	*Centaurea diffusa*	1
Dyers woad	*Isatis tinctoria*	1
Leafy spurge	*Euphorbia esula*	1
Perennial pepperweed	*Lepidium latifolium*	1
Purple loosestrife	*Lythrum salicaria*	1
Rush skeletonweed	*Chondrilla juncea*	1
Russian knapweed	*Acroptilon repens*	1
Saltcedar	*Tamarix complex*	1
Scotch thistle	*Onopordum acanthium*	1
Cheatgrass	*Bromus tectorum*	2
Field scabious	*Knautia arvensis*	2
Hoary cress	*Cardaria draba*	2
Houndstongue	*Cynoglossum officinale*	2
Plumeless thistle	*Carduus acanthoides*	2
Russian olive	*Elaeagnus angustifolia*	2
Scentless chamomile	*Tripleurospermum perforatum*	2
Spotted knapweed	*Centaurea stoebe ssp micranthos*	2
St. Johnswort	*Hypericum perforatum*	2
Yellow toadflax	*Linaria vulgaris*	2
Canada thistle	*Cirsium arvense*	3
Common burdock	*Arctium minus*	3
Common tansy	*Tanacetum vulgare*	3
Dalmatian toadflax	*Linaria dalmatica*	3
Field bindweed	*Convolvulus arvensis*	3
Hoary alyssum	*Berteroa incana*	3
Ox-eye daisy	*Leucanthemum vulgare*	3
Sulfur cinquefoil	*Potentilla recta*	3
Black henbane	*Hyoscyamus niger*	3
Bull thistle	*Cirsium vulgare*	3
Common mullein	*Verbascum thapsus*	3
Musk thistle	*Carduus nutans*	3
Perennial sowthistle	*Sonchus arvense*	3
North Africa grass	*Ventenata dubia*	4
Medusahead	*Taeniatherum caput-medusae*	4
Squarrose knapweed	*Centaurea virgata ssp squarrosa*	4
Meadow knapweed	*Centaurea pratensis*	4
Austrian fieldcress	*Rorippa austriaca*	4
Yellow starthislte	*Centaurea solstitialis*	4
Common teasel	*Dipsacus fullonum*	4

Appendix A lists the protection measures for the preferred alternative.

Integrated Pest Management

Integrated pest management (IPM) is a key part of the proposed action. The proposed action would utilize a variety of tools, singularly or in combination, to implement integrated pest management.

- Mechanical treatment, such as hand-pulling, grubbing, mowing or cutting.
- Revegetation, where competitive vegetation is seeded to reduce invasive species, possibly after other treatments.
- Grazing with livestock.
- Biological control using most effective application method.
- Herbicide control using ground-based application methods.
- Herbicide control using aerial application methods.
- Prescribed fire in conjunction with other treatment methods.
- Education to inform people of the effects of invasive plant infestations, methods of spread and preventative management opportunities and practices.
- Prevention practices that reduce invasive plant spread, including a weed-free forage program and washing vehicles to remove seeds.

Except for aerial application of herbicides, all of these IPM treatment and prevention methods are part of the current weed management program (the no action alternative).

Selection of control methods is not a choice of one tool over another, but rather selection of a combination of tools that would be most effective on target species for a particular location. Reliance on one method or restricting use of one or more tools may prove less effective. Effectiveness and applicability of each tool varies and depends on invasive plant biology and ecology, location and size of the infestation, environmental factors, management objectives and management costs. Appendix C identifies example treatment(s) for each target invasive plant species, using the treatment methods listed above.

The Forest Service proposes to use the strategy outlined in the table below to help select the most appropriate and effective control method. However, based on site-specific conditions and circumstances, strategies may change. Following EPA labels and APHIS direction (for biological control agents) and implementing resource protection measures will ensure that treatment methods are properly used.

Table 2. Guidelines for selecting and prioritizing treatment

BIOLOGICAL CONTROLS WILL BE EMPHASIZED ON / IN
• Large infestations of weeds for which there is an effective biocontrol available that are in stream, riparian and wetland areas, • Rough terrain and/or areas where herbicide use is restricted or problematic (highly permeable soils, high water tables) • Non-native biological control will not be utilized near or within designated Wilderness, Wilderness Study Areas, or Research Natural Areas.
GROUND HERBICIDE APPLICATION WILL BE EMPHASIZED ON
• Weeds for which no accepted and effective biological controls are known • New infestations • Small infestations • Easily accessed infestation sites • Edges of large infestations • Ownership boundaries • Oil well sites (producing and rehabilitated) • Sites where biological controls are not effective
AERIAL HERBICIDE APPLICATION WILL BE EMPHASIZED ON
• Large infestations of weeds that do not have effective biological controls available, especially those in inaccessible or remote areas. • Infestations in areas of critical habitat where ground application is less effective or hazardous.
MECHANICAL TREATMENTS WILL BE EMPHASIZED ON
• Infestations where other treatments are not effective • Small infestations where it is effective and practical
GRAZING WILL BE EMPHASIZED FOR USE
• On infestation areas where other methods are not effective or allowed • Where herbicide application is not practical • Where biological control methods are ineffective
REVEGETATION WILL BE EMPHASIZED FOR USE
• In combination with other treatments to revegetate bare ground or where native species are not present
FIRE WILL BE EMPHASIZED FOR USE
• To enhance the effectiveness of other treatments (biological, herbicides and in revegetation efforts)
PREVENTION AND EDUCATION
• Prevention and education are ongoing programs.
PRIORITY FOR TREATMENT
• Threatened, endangered, candidate, or sensitive species habitats • New infestations of new species • New infestations of existing species (outside currently infested areas) • Fast spreading species • Areas with high probability of success • Perimeters of existing infested sites • Sensitive plant habitat and rare plant communities • Ownership boundaries • Areas likely to accelerate weed spread (for example trails, trailheads, roads) • Areas where adjacent landowners are actively working to control infestations • Wilderness, Wilderness Study Areas, Wild and Scenic River corridors, and Research Natural Areas, where natural integrity and ecological processes are at high risk from invasive plant species.

Adaptive Management Strategy

The proposed action includes the concept of adaptive management to deal with infestations that are constantly changing. Adaptive management offers a way to describe and evaluate the consequences of changing or new infestations and new treatment options while still addressing other resource concerns.

Adaptive management strategies would include the treatment of any newly introduced invasive plant species that are classified as noxious weeds by the five counties in the project area or the state of Wyoming or EDRR species.

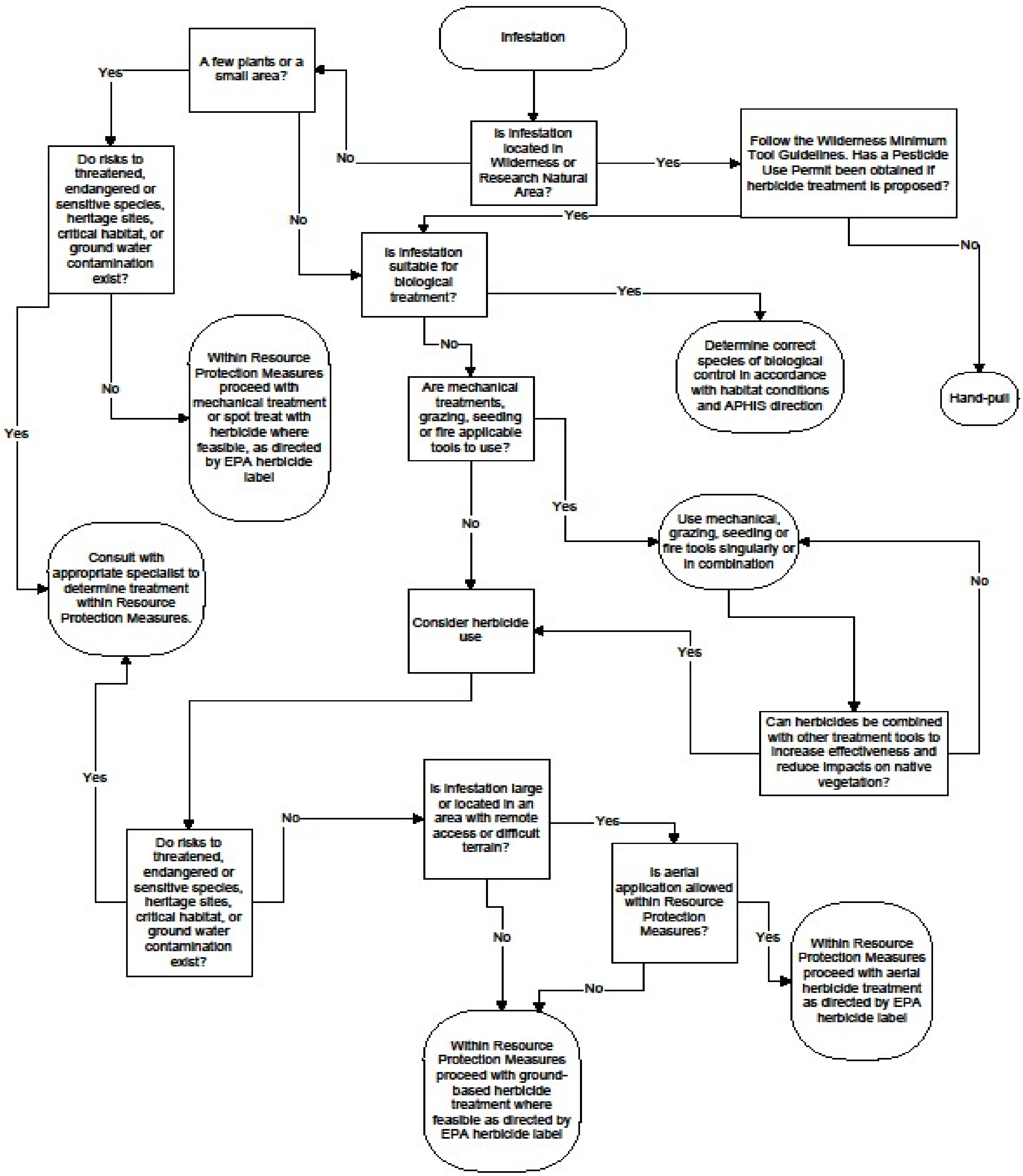
The adaptive management strategy consists of two principle components:

1. Use of a decision tree (see Figure 2 below) to select methods to quickly and effectively treat new infestations. The decision tree is based on infestation size, location, site characteristics and consultation with specialists.
2. Evaluation of new technology, application methods, biological controls, or herbicides to improve treatment effectiveness and reduce impacts.

New technology, biological controls, herbicide formulations and supplemental labels are likely to be developed within the life of this project. New treatments would be considered if they are more species-specific than methods currently used, less toxic to non-target vegetation, less toxic to people, less persistent and less mobile in the soil, or more effective. An adaptive management strategy would allow use of new treatment methods if they meet the following criteria:

- The new or existing herbicide must have an EPA-approved herbicide label. Application must adhere to label specifications.
- A Forest Service assessment team would evaluate new herbicides that become available after this analysis. The team would review the EPA's registration eligibility decision for new herbicides and determine if the herbicides are appropriate for use on the forests and rangeland.
- New biological agents must be detrimental to the target plants and virtually harmless to native or desirable non-native plants.
- New biological agents must be approved by USDA Animal, Plant Health Inspection Service (APHIS) and the State of Wyoming prior to their introduction.
- A FSH 1909.15, 18.4 (Section 18) review will be conducted to determine if the effects of the new or existing herbicide are consistent with those identified in this project.
- Mechanical methods of treatments must be cost effective. These methods would be reviewed before use to determine if other resource quality standards can be maintained.

Figure 2. Decision tree to select treatment methods



Alternative 3 – No Aerial Application of Herbicides

Alternative 3 differs from the proposed action in that it does not include aerial herbicide application. Alternative 3 allows treatment of approximately 3,000 – 5,000 acres per year on the Bridger-Teton NF using a combination of ground-based herbicide application plus manual, mechanical, biological and cultural control methods. The integrated and adaptive management strategies for the proposed action would be available under Alternative 3.

Appendix A lists protection measures for Alternative 3.

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by NEPA to explore and evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). During scoping, the public suggested alternative methods for achieving the purpose and need. Several alternatives for the proposed project were considered but eliminated from detailed analysis. Reasons for their dismissal include not meeting project purpose and need, not meeting CEQ (NEPA) guidelines of being reasonable, feasible and viable, not differing substantially from other alternatives being analyzed in detail, being beyond the scope of the EIS, and/or not complying with current laws, regulations, policies and forest plan direction. The alternatives and the rationale for dismissing them are summarized below.

Prohibit all activities that spread invasive plants.

The intent of this alternative is to address and take action on human activities that promote the spread of weeds. The alternative proposed closing roads, modifying authorized livestock grazing permits, and altering or eliminating existing timber, mining and recreational OHV activities.

These human uses and activities are authorized in the records of decision for the land and resource management plan. The plan meets the requirements of several public land laws and regulations authorizing multiple uses on NFS lands. Taking action on activities previously authorized under existing laws, regulations, permits and the land and resource management plan is beyond the scope of this EIS.

No use of herbicides

An alternative that discontinues the use of herbicides was considered but eliminated from detailed analysis because it does not meet the purpose and need of the project and does not comply with the Forest Plan Noxious Weed Control Standard which states, “Effective management of noxious weeds will be accomplished by cooperating with the Wyoming Department of Agriculture and County weed control districts, using Integrated Pest Management techniques, following the procedures outlined in the Bridger-Teton NF Environmental Assessment for noxious weed control and appropriate technical guides. No toxic herbicides will be applied in a manner that will adversely affect non-target species.”

No invasive plant management treatments.

An alternative that discontinues the current weed management program was considered but eliminated from detailed analysis because it does not meet any of the project purposes. It does not comply with the Bridger-Teton NF’s integrated pest management program, is inconsistent with Forest Service policy that noxious weeds and their adverse effects be managed on NFS lands and it violates federal and state laws and executive orders.

Use herbicides only after other treatment methods have failed.

Other alternatives also eliminated from detailed analysis included mechanical, vegetative, biological and combinations of treatments followed by herbicide application if these treatments are unsuccessful. This alternative was eliminated because of the concern that if the non- herbicidal treatments fails and some time passes before this failure is determined, the weed infestation may expand well beyond the original acreage and further impact forest resources. The resulting need for follow-up treatments would then have greater potential impacts than the original action. Such an occurrence would not meet the project purpose and need.

Climate change and global warming effects on resource conditions

This alternative was eliminated from further consideration because current science is insufficient to determine a cause and effect relationship between climate change and invasive plant management treatments. The preponderance of current literature suggests that "most of the important elements of global change are likely to increase the prevalence of biological invaders" (Dukes and Mooney 1999). The Bridger-Teton NF landscape is expected to become more vulnerable to the establishment of invasive plant infestations, actual acreage affected by invasive plants are expected to increase and control strategies are expected to become more difficult. Recommended management responses to these predictions are early detection (resulting from regularly scheduled monitoring) followed by a rapid response to eradicate initial infestations (Hellmann et al. 2008, Joyce et al. 2008, Tausch 2008). Early detection and rapid response are included in the proposed action and the alternatives.

Comparison of Alternatives

This section summarizes the effects of implementing the proposed action and alternatives. The comparison focuses on activities with effects or outputs that can be distinguished quantitatively or qualitatively between alternatives. The alternatives are compared by their design, their components, or by the environmental, social and economic effects of implementing them.

Table 3. Comparison of Alternatives

Item to Compare	Alternative 1 - No Action	Alternative 2 - Proposed Action	Alternative 3 - No Aerial Application
Issue #1 Effects of invasive species on native vegetation, biological diversity, structure and production.	Reduces or prevents spread of infestations of the listed invasive plant species. Does not reduce negative effects of cheatgrass or other invasive plants not listed as noxious weeds by the State of Wyoming. Some weed species will continue to increase, with negative consequences to native plant communities and wildlife.	More adaptive and integrated management options to treat invasive plant species. Allows treatment of all new invasive plant species of concern. Offers the best opportunity to reduce large infestations of cheatgrass and other non-native annuals. Minimizes negative impacts by employing the widest array of control measures compatible with other resource values	Similar effectiveness as Alternative 2 with the exception of cheatgrass. Without aerial application, very few acres of cheatgrass or other non-native annuals would be treatable on an annual basis; infestations are likely to remain large and increase in size, spreading into Wilderness.
Issue #2 Effects of herbicides on threatened, endangered or sensitive species and their habitats.	Low risk to TES species and their habitat due to protection measures in place. Some weed species and most large weed infestations of cheatgrass would not be treated, so habitat quality would be degraded for some plant and animal species. Greater sage-grouse and Rocky Mountain bighorn sheep are two sensitive species most likely to be negatively affected by the lack of effective cheatgrass treatment.	Low risk to TES species and their habitat due to protection measures in place. All invasive species of concern could be treated, including large infestations of cheatgrass and non-native annuals in important habitats for TES species.	Low risk to TES species and their habitat due to protection measures in place. Most cheatgrass infestations would not be treated, so habitat quality would be degraded for some plant and animal species. Greater sage-grouse and Rocky Mountain bighorn sheep are two sensitive species most likely to be negatively affected by the lack of effective cheatgrass treatment.
Issue #3 Effects of herbicides on soils, water and aquatic resources	Low risk of negative effects from herbicide treatment due to protection measures in place. Lack of effective treatment of many weed species and infestation sites could result in increased sedimentation and possible impacts to water quality and some aquatic organisms.	Low risk of negative effects from herbicide treatment due to protection measures in place, including those for aerial application.	Low risk of negative effects from herbicide treatment due to protection measures in place. Lack of effective treatment of many weed species and infestation sites could result in increased sedimentation and possible impacts to water quality and some aquatic organisms.

Item to Compare	Alternative 1 - No Action	Alternative 2 - Proposed Action	Alternative 3 - No Aerial Application
Issue #4 Effects of herbicides on human health	Risk of exposure, including drift There is potential for exposure from ground-based herbicide application. There is less risk to the public from exposure to drift because there is no aerial spraying. Risk of worker exposure could be higher because ground-based treatment is less effective than aerial so more treatments may be required. Potential exposure would be reduced by following the herbicide label instructions and implementing the protection measures in Appendix A. Risk of doses exceeding EPA's reference dose (RfD) For four herbicides, there is little risk to workers or the public because the maximum exposure would be less than EPA's RfD. Based on SERA's risk assessments, seven herbicides exceed the RfDs for chronic or acute exposure for the public or workers or both. Implementing the protection measures in Appendix A would reduce the risk of exposure to both groups All herbicides would be applied according to label instructions to minimize exposure and adverse health effects.	Risk of exposure, including drift There is potential for exposure from ground-based herbicide application. Aerial spraying could increase the public's risk of exposure; however, this potential exposure would be reduced by following the herbicide label instructions and implementing the protection measures in Appendix A. Aerial spraying reduces worker exposure to the herbicide. The person who mixes and loads the herbicide has less contact time and the pilot who applies it is protected by the enclosed cockpit of the helicopter/fixed-wing aircraft. Risk of doses exceeding EPA's reference dose (RfD) For five herbicides, there is little risk to workers or the public because the maximum exposure would be less than EPA's RfD. Based on SERA's risk assessments, nine herbicides exceed the RfDs for chronic or acute exposure for the public or workers or both. Implementing the protection measures in Appendix A would reduce the risk of exposure to both groups. All herbicides would be applied according to label instructions to minimize exposure and adverse health effects.	Risk of exposure, including drift There is potential for exposure from ground-based herbicide application. There is less risk to the public from exposure to drift because there is no aerial spraying. Risk of worker exposure could be higher because ground-based treatment is less effective than aerial so more treatments may be required. Potential exposure would be reduced by following the herbicide label instructions and implementing the protection measures in Appendix A. Risk of doses exceeding EPA's reference dose (RfD) For five herbicides, there is little risk to workers or the public because the maximum exposure would be less than EPA's RfD. Based on SERA's risk assessments, nine herbicides exceed the RfDs for chronic or acute exposure for the public or workers or both. Implementing the protection measures in Appendix A would reduce the risk of exposure to both groups. All herbicides would be applied according to label instructions to minimize exposure and adverse health effects.

Table 4. Estimated treatment acres by method and Alternative – based on present funding levels

Treatment Option	Alternative 1	Alternative 2	Alternative 3
Biological control	100 - 300	100 - 300	100 - 300
Biological control - grazing and browsing	0 - 250	0 – 250	0 - 250
Mechanical[1] low ground disturbance	100 - 200	100 - 200	100 - 200
Mechanical[2] moderate to high ground disturbance	0-50	0-50	0-50
Ground application of herbicide	2,700 – 4,000	2,700 – 4,000	2,700 – 4,000
Aerial application of herbicide	0	5,000 – 15,000	0
Prescribed fire	100 - 200	100 - 200	100 - 200

[1] Includes hand-pulling or grubbing, mowing, cutting

[2] Revegetation –disking, drilling, reseeding

Chapter 3.
Affected Environment and Environmental Consequences

Introduction

This chapter summarizes the physical and biological environments of the project area and the effects of implementing each alternative on that environment. Direct, indirect and cumulative effects are addressed. It also presents the scientific and analytical basis for the comparison of alternatives presented in Chapter 2.

Cumulative effects are addressed by resource. Council of Environmental Quality (CEQ) guidance on considering past actions in cumulative effects analysis (June 24, 2005), states agencies should

1) use scoping to focus on the extent to which information is relevant to reasonably foreseeable significant adverse impacts,
2) is essential to a reasoned choice among alternatives, and
3) can be obtained without exorbitant cost. Generally, agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions (CEQ, 2005).

Past actions generally include livestock grazing practices and associated developments, past noxious weed treatments by both the agency and adjoining landowners, timber sales, oil and gas development on the Bridger-Teton NF including road and pad construction, other road and trail construction and maintenance, recreational activities and the spread of invasive species (other than noxious weeds). Current and reasonably foreseeable activities that could contribute to the degree of impacts include travel planning, including potential reconstruction and decommissioning of routes, livestock grazing practices, continued herbicide and/or other chemical application for both noxious weeds and agricultural purposes by adjoining landowners, anticipated increases in recreation use and developments such as campgrounds and trails and oil and gas activities.

Events such as wildfire, drought, landslides, blowdowns and bark beetle epidemics will continue to create disturbances that help invasive species establish and spread. All have potential to introduce new weed species, introduce weeds to new locations, or facilitate spread of existing infestations. Climate change is another factor likely to stress native plant communities and perhaps create an ecological advantage for invasive species. Most invasive species flourish because they can cope with challenging growing conditions. The effects of these natural disturbances are described in the affected environment sections.

Issue #1 Native Vegetation and Invasive Species

Affected Area

The analysis area for native vegetation and invasive species includes all vegetation communities near proposed treatment areas or those habitats where weeds have potential to invade. These plant communities have the potential to be directly or indirectly affected by weeds and proposed treatment methods.

Analysis Method

Information used came from data on file at the Bridger-Teton NF district offices, literature review and personal communication with resource specialists who have knowledge of vegetation, weed control and herbicide effects. Acreage estimates of vegetation cover types were derived using GIS. Much of the information was assembled for the forest planning effort.

Affected Environment – Vegetation

Components of the affected vegetation are the weed species themselves and the native plants communities adjacent to weed infestations or within which weeds are found. The vegetation information is presented in the following sub-sections: Weed Species, Weed Ecology, Native Plant Communities, Vulnerability to Infestations, Human Activities and Invasive Species and Present Weed Management Practices.

Weed Species

The term noxious weeds, as used here, refers to those non-native plant species that have been officially listed as noxious by the State of Wyoming and/or its counties as harmful and therefore targeted for control and prevention efforts including EDRR species. The number of non-native species and noxious weed species present on the Bridger-Teton NF has likely increased since these surveys were completed, particularly for areas surveyed over 5 years ago, as invasive plant species continue to arrive on the Bridger-Teton NF in a variety of ways. Weeds proposed for treatment on the Bridger-Teton NF are listed in Tables 1 and 5. Table 1 lists the potential weed species and treatment priority for the Bridger-Teton NF.

Table 5. Change in acres of invasive plant species present on the Bridger-Teton NF from 2007 to 2017 and invasive plant species likely to become established in the future.

Common Name	Scientific name	2007 Inventoried Infested Acres	2017 Inventoried Infested Acres
Species currently present			
Dalmatian toadflax	*Linaria dalmatica*	31	210
diffuse knapweed	*Centaurea diffusa*	0	1
dyers woad	*Isatis tinctoria*	110	1462
leafy spurge	*Euphorbia esula*	31	1534
perennial pepperweed	*Lepidium latifolium*	0	65
Russian knapweed	*Acroptilon repens*	5	1
spotted knapweed	*Centaurea stoebe ssp micranthos*	356	203
Scotch thistle	*Onopordum acanthium*	0	4
yellow toadflax	*Linaria vulgaris*	16	8,499
black henbane	*Hyoscyamus niger*	207	700
bull thistle	*Cirsium vulgare*	30	552
cheatgrass*	*Bromus tectorum*	Not Inventoried	2819
common tansy	*Tanacetum vulgare*	27	182
hoary cress	*Cardaria draba*	146	15
musk thistle	*Carduus nutans*	3,480	12,668
scentless chamomile	*Tripleurospermum perforatum*	0	62
St. Johnswort	*Hypericum perforatum*	4	58
sulfur cinquefoil	*Potentilla recta*	22	38
Canada thistle	*Cirsium arvense*	2,540	9,926
common mullein	*Verbascum thapsus*	0	767
field bindweed	*Convolvulus arvensis*	2	12
houndstongue	*Cynoglossum officinale*	127	1378
ox-eye-daisy	*Leucanthemum vulgare*	11	63
perennial sowthistle	*Sonchus arvense*	0	10
Species currently managed as EDRR			
medusahead	*Taeniatherum caput-medusae*	0	0
North Africa grass	*Ventenata dubia*	0	0
plumeless thistle	*Carduus acanthoides*	0	0
common burdock	*Arctium minus*	0	0
squarrose knapweed	*Centaurea virgata ssp squarrosa*	0	0
curveseed butterwort	*Ceratocephala testiculata*	0	0
saltcedar	*Tamarix complex*	0	0
Russian olive	*Elaeagnus angustifolia*	0	0
purple loosestrife	*Lythrum salicaria*	0	0

*Inventoried Cheatgrass acres represent past treatments. Aerial detection flights have mapped over 25,000 acres.

Of the 24 species documented on the Bridger-Teton NF, 21 have either increased or first appeared within the past 10 years. Those that have increased the most are cheatgrass, Dyers woad, yellow toadflax, houndstongue, leafy spurge, Canada thistle and musk thistle. New infestations are found with increasing frequency and acreage estimates do not represent a complete weed inventory. Acres of cheatgrass infestation were not documented until 1996, as the species was not considered a significant threat at that time. With the beginning of the severe drought that started in 1999, land managers on the Bridger-Teton NF saw rapid increases in cheatgrass infestations that continue today. Cheatgrass now occupies over half as much acreage as all the other 28 documented invasive species combined, at over 25,000 acres.

Populations of a few species (Russian knapweed, hoary cress and spotted knapweed) appear to have decreased since 2007. If the Bridger-Teton NF has achieved some measure of success with Russian knapweed, spotted knapweed and hoary cress, it is because all three are high priority for treatment and effective herbicides exist for treatment.

Due to their dynamic nature, it is not possible to list all invasive species that may be considered a threat to NFS lands. The many uses and activities that occur on Bridger-Teton NF lands create numerous opportunities for new invasive plant species to be introduced. Management of species that may be a threat in the future is addressed in the adaptive management strategy described in Chapter 2.

Weed Ecology

The invasive plant species listed in this document are not native to North America. They were largely introduced as contaminants in agricultural products or as ornamental plants. They gained a competitive advantage by leaving their natural enemies and disease behind on their continents of origin and all have characteristics that allow them to compete aggressively with native vegetation in a variety of habitat types, as described below:

- Ability to quickly invade disturbed areas. (i.e. roadsides, trails, campgrounds)
- Germination and growth late fall and very early in the spring, allowing them to utilize available soil moisture before native plants come out of dormancy (cheatgrass, medusahead, curveseed butterwort).
- Extensive creeping root stocks that rapidly increase population size without the need for successful seed production (Canada thistle, leafy spurge, the toadflaxes, hoary cress and perennial pepperweed).
- The ability to secrete chemicals that inhibit growth of adjacent native plants (knapweeds, dyers woad). This characteristic is known as allelopathy.
- Toxic chemicals in leaves, stems and flowers that make them poisonous or unpalatable to many herbivorous animals, hence protecting them from being grazed (leafy spurge, scentless chamomile, knapweeds, black henbane, curveseed butterwort, houndstongue, St. Johnswort).
- Spines on leaves and stems or awns on seeds that discourage consumption by herbivorous animals (the thistles, cheatgrass, medusahead).
- Prolific seed production.
- Seeds that remain viable for a long time.
- Excellent seed dispersal via wind, water, animals, people and vehicles.

Invasive plant species are well equipped to establish themselves wherever native plant communities have been altered by physical disturbance to soils as well as in areas where native plants have been stressed by either natural or man-caused changes including drought, fire (natural or prescribed), overgrazing, insect and disease outbreaks, chemical alteration (i.e. fertilization, salinization, herbicide application) or climate change. In recent years, two large scale natural disturbances, a severe drought and a regional mountain pine beetle epidemic, have significantly stressed and altered many native plant communities on the Bridger-Teton NF. The effects are further discussed below in the *Vulnerability to Infestations* section.

Native Plant Communities

The nearly 3.4 million acres of the Bridger-Teton NF support a diverse mixture of plant communities. The elevation ranges from around 6,000 feet to over 12,000 feet creates four different life zones, each with its characteristic plant communities. Big sagebrush communities occupy large areas of moderately deep and well-drained soils in the foothills, ridges, slopes and valleys of western Montana and Wyoming, northwestern Colorado, northern Utah and Nevada, southern and central Idaho, eastern Oregon, central Washington and southern interior British Columbia (Tisdale in Shiflet 1994, Wyoming Interagency Vegetation Committee 2002). On the Bridger-Teton NF this is the most extensive non-forested community at 11.7% of total NFS acres (2007 Vegetation Map).

The big sagebrush community's canopy structure and diverse understory species provide ideal seasonal habitat and spring and summer forage for deer, elk, antelope, as well as other mammals; blue grouse, sage-grouse and Brewer's sparrow among other birds; and reptiles and amphibians (Winward 2004, Wyoming Interagency Vegetation Committee 2002). Big sagebrush/grass plant communities make up the dominant non forested cover type.

Table 6. Plant communities and dominant vegetation on the Bridger-Teton NF

Bridger-Teton Forest	Dominant Vegetation
Foothill zone	Idaho fescue, Sandberg bluegrass, needle and thread grass, Letterman needlegrass, mountain brome, bluebunch wheatgrass, western wheatgrass, prairie junegrass
	mountain big sagebrush, Wyoming big sagebrush, silver sagebrush, bitterbrush, serviceberry, chokecherry, true mountain- mahogany, snowberry
	Rocky Mountain juniper
Montane zone	lodgepole pine, aspen, Douglas-fir, limber pine, tall forb
Subalpine zone	Engelmann spruce, subalpine fir, Whitebark Pine
Alpine zone	sheep sedge, black alpine sedge, alpine bluegrass, arctic bluegrass, alpine avens, creeping sibbaldia, alpine clover, eightpetal mountain-avens, arctic willow
Riparian and wetland communities	grass/sedge meadows, forb-lands, willow shrublands and narrowleaf cottonwood communities

The following table lists primary cover types on the Bridger-Teton NF and approximate acres of each, rounded to the nearest hundred acres.

Table 7. Estimated acres of the major vegetation cover types on the Bridger-Teton NF.

Cover Type	Bridger-Teton NF Acres
Tall Forbs	72,100
Grassland/Forbland	251,100
Sagebrush*	433,100
Alpine Communities	184,500
Riparian Communities**	174,400
Aspen forest	174,300
Lodgepole pine forest	770,000
Douglas-fir forest	249,200
Spruce/fir forest	496,100
TOTAL	2,804,800

*Primarily mountain big sagebrush (*Artemisia tridentata*) and spiked big sagebrush (*Artemisia tridentata*) but also silver sage (*Artemisia cana*) and low sagebrush (*Artemisia arbuscula*).

** Riparian Communities are riparian shrublands, cottonwood communities and riparian meadows combined.

Vulnerability to Infestation

Alpine Vegetation Communities

None of the weed species listed in this analysis are alpine specialists and alpine vegetation communities are not generally at risk of invasion because site conditions are incompatible for the growth and establishment of most invasive species. However, infestations of yellow toadflax have been identified in alpine communities on the neighboring forests. Climate change may increase susceptibility of these sites to invasion by non-natives in the future, depending upon the magnitude of temperature and moisture regime changes and the stresses those changes place on the native alpine plant communities.

Sagebrush, Grassland/Forbland and Tall Forb cover types

Plant communities in these cover types are at greatest risk from non-native species invasion because environmental conditions where they are found are very similar to the conditions where many invader species originated. They are non-forested, only seasonally moist and have patchy plant distribution that provides bare soil areas where introduced seed can easily germinate. Natural and man-caused disturbances regularly occur in these plant communities, including grazing/browsing by wild and domestic animals, wind erosion, mineral and energy exploration and development, unauthorized off-road vehicle use, wildfire and prescribed fire. The majority of weed infestations being treated on the Bridger-Teton NF are in these cover types. Collectively they occupy about 27% of the total acres on the Bridger-Teton NF.

Cheatgrass is a particular concern where disturbance, including, wild and prescribed fire, has created conditions favorable to invasive species by weakening or altering native plant communities. From 1999- 2005, a severe drought impacted the upland grass and upland shrub-grass cover types. A notable effect of the drought was the establishment and spread of dense cheatgrass stands in locations where it had not been seen before or where only scattered plants had previously been observed. Cheatgrass can rapidly alter site conditions by changing soil structure and organic matter content (Norton et. al. 2004, Sperry et. al. 2006), crowding out most native grasses and forbs and changing the natural fire return interval from 30 or more years to more frequent intervals, potentially as short as every 3-4 years.

On the Bridger-Teton NF, the largest cheatgrass infestations are on steep southward-facing (south, southeast and southwest) sagebrush slopes that provide important winter feeding areas for mule deer, bighorn sheep and elk. In most cases, cheatgrass became dominant after wildfire or prescribed fire altered the native plant communities and soil nutrients.

Cheatgrass is the most abundant invasive species of concern on the Bridger-Teton NF, but few acres have been treated due to the lack of effective and affordable treatment methods. Failure to treat all but a few small infestations of cheatgrass has contributed to its present abundance.

<u>Riparian Plant Communities</u>

Many riparian areas and wetlands are relatively resistant to invasion by non-native species because the abundant moisture provides for vigorous and tightly packed native species with few bare areas for invading seeds to reach bare soil.

However, some invasive species are well equipped to exploit even very limited opportunities and can still become established and spread in these types of plant communities. Canada thistle, saltcedar and purple loosestrife are examples of invasive species that are able to gain a foothold in riparian areas and wetlands. Although leafy spurge and spotted knapweed are not considered a moisture-loving plant, it can flourish in well-drained river cobbles and gravel bars along stream courses.

<u>Aspen Forest Plant Communities</u>

The aspen plant communities on the Bridger-Teton NF do not appear to be at high risk from invasion by the invasive, non-native plants unless they undergo an extreme disturbance such as fire or die-off from insects and/or disease.

The combination of shade from the tree canopy; deep, moist soils; and the presence of rhizomatous and otherwise competitive native understory species limits opportunities for non- native species to become established.

In many stands, new aspen sprouts are being produced from the roots (a process called suckering) as the mature trees decline and these stands are likely to remain at least somewhat shaded and moist as they regenerate and therefore relatively resistant to weed invasion. Aspen stands that exhibit weak or no suckering will be more susceptible to invasive plants as they lose canopy cover and become more sunny and dry.

<u>Coniferous Forest Plant Communities</u>

Vulnerability goes up sharply when wildfire or ground-disturbing activities such as timber harvest and hazard tree removal occur in the beetle and disease infested dead and dying stands. Over time, as dead trees start falling, ecological severity of wildfires will increase greatly due to heavy fuels on the ground surface. Most invasive species are well adapted to colonizing sites where organic components of the soil have been removed by intense wildfire and/or subsequent erosion.

As new trees regenerate and grow in these areas, we are likely to see a decrease in weeds as ground shading increases.

Human Activities and Invasive Species

Natural events can create conditions (bare soil, or more sunlight, or reduced competition from native plants) where exotic weeds will flourish if introduced. Once a weed species is established, it can be naturally spread by wind, water, or wildlife but that may take many decades. Humans have the ability to accelerate the spread of invasive plants across the landscape. All of the following human activities can create sites conducive to weed establishment: road and trail construction and maintenance, timber harvest, recreation uses and activities, off-road vehicle use, irrigation ditch maintenance, livestock trailing and trampling, overgrazing, prescribed burning, wildfire suppression, dispersed camping, mining, energy development (oil and gas exploration and development) and pipeline/power line construction and maintenance.

Human access to many parts of the Bridger-Teton NF has improved markedly due to the increasing popularity of off-highway vehicles (OHVs). OHVs get more people further into remote areas than ever before and they offer numerous cracks and crannies in which weed seeds can be transported. Spotted knapweed and cheatgrass, in particular, appear to be very well suited to spread by motorized vehicles; they often appear in isolated locations along motorized routes far from any known seed sources.

Recreational vehicles are not the only vectors for introducing and spreading weeds on the Bridger-Teton NF. Vehicles and heavy equipment are routinely used to maintain and repair roads, trails, campgrounds and administrative sites; harvest timber; maintain irrigation ditches and powerlines; fight fires; conduct prescribed burns; build and repair fences; haul livestock; and to monitor and administer these activities. The Forest Service uses or requires equipment cleaning provisions for some activities (timber harvest, road construction and firefighting) to help prevent the introduction or spread of invasive plants, but these provisions are not required for all activities.

Weed seeds can also be introduced by hikers, pack and saddle horses, mules, llamas, pets and domestic livestock, as well as wildlife species including big game animals. Invasive species with seeds that cling to fur, feathers and clothing are especially easily spread in this manner.

Cheatgrass, medusahead, houndstongue, curveseed butterwort and common burdock are examples of such species. Some livestock operators who graze permitted livestock on the Bridger-Teton NF bring their livestock from remote wintering areas, some as far as California, so the opportunity exists to introduce weed seed from a long distance away via this practice. Another route for weed seeds to arrive is in hay or straw brought in for animal feed or mulch. The Forest Service requires any hay, straw or other plant-based animal feed brought onto the Bridger-Teton NF to be certified free of noxious weed seed, but this cannot always be enforced with limited law enforcement presence spread over a large area. In addition, certification only covers weeds listed by the particular state in which the feed was certified. It can therefore contain seed from a variety of unlisted invasive species, including cheatgrass.

Present Weed Management Practices

The current weed treatment program on the Bridger-Teton NF is described in the 2005 *Decision Notice and Finding of No Significant Impact for Management of Noxious Weeds*. It is an integrated management approach using a variety of prevention measures and treatment methods as shown in the following two tables. The goal of integrated pest management is to manage undesirable plants so resource goals and objectives are met while minimizing adverse effects.

Table 8. Summary of weed prevention measures currently available for use on the Bridger-Teton NF

Prevention Measures	Discussion/Considerations
Seeding exposed soil	Most often used to reduce the likelihood of weed establishment on sites where native vegetation has been removed by a natural event (such as an intense wildfire or landslide) or management activities (such as gravel pit development or road construction). Locally derived, native plants are the first choice for seeding.
Cleaning of heavy equipment	Routinely used for forest projects before arrival of equipment on the Bridger-Teton NF or when moving from infested sites to non- infested sites. Required in timber harvest/road construction contracts; can also be implemented in fire-fighting situations.
Certified noxious weed free hay, straw and other unprocessed livestock forage products requirement	Required by regulation on the Bridger-Teton NF. Certification means the forage does not contain any of the listed noxious weeds for the state in which they were grown. Despite this limitation, the regulation has likely been helpful in reducing new noxious weed infestations at dispersed campsites and trailheads.
Mulching	Occasionally used in conjunction with seeding to help establish desirable plant species and hold topsoil in place until revegetation is accomplished. Used at administrative sites (where there is landscaping) and on small areas where soils have been disturbed and the potential for erosion is high.

Table 9. Summary of treatment methods currently approved for use on the Bridger-Teton NF

Prevention Strategy	Discussion/Considerations
Cultural Control	
Competitive seeding	Occasionally used but only after weed populations have already been reduced by other control methods. Most effective on sites where seed drills can be used.
Prevention Strategy	Discussion/Considerations
Manual / Mechanical Control	
Hand-pulling/grubbing	This is the primary mechanical treatment method used on the Bridger-Teton NF. It is labor intensive and only practical on small infestations of non-rhizomatous weed species. Used in sensitive areas such as habitat for threatened, endangered, or sensitive species or near water or where an infestation consists of only a few plants.
Mulching	Uses plastic, geotextiles or other materials to smother established weeds. On the Bridger-Teton NF, this method has only been used to control weeds around buildings at some administrative sites.
Biological Control	
Parasites, predators and pathogens	Insects are the only biological control currently in use on the Bridger-Teton NF. They have been released since the 1990s. They have had varied success, but most have not reduced existing weed infestations or prevented their spread.
Herbicides	
Ground application only	Application methods used on the Bridger-Teton NF include backpack sprayers, packhorse-mounted spray equipment and spray equipment mounted on OHVs or trucks. For woody species (Russian olive and saltcedar), herbicides are wiped on cut surfaces or injected. The following herbicides are currently used: 2,4-D, aminocyclopyrachlor, aminopyralid, aquatic glyphosate, chlorsulfuron, clopyralid, glyphosate, hexazinone, imazapic, imazapyr, indaziflam, metsulfuron methyl, picloram, rimsulfuron, and sulfometuron methyl. Herbicides are applied according to label specifications which include user safety recommendations; first aid; environmental hazards; directions for use, storage and disposal; mixing and application rates; approved uses; and inherent risks of use. Herbicide application is performed by, or directly supervised by, a state-licensed applicator following all current legal application procedures administered by the Wyoming department of agriculture.

Environmental Effects

This section analyzes the effects of weed control activities on invasive plants and native vegetation. Effectiveness of various weed control techniques on the invasive weed species of concern are presented in Appendix C.

Direct and Indirect Effects Common to All Alternatives

Under all alternatives, the Bridger-Teton NF would continue to integrate mechanical, biological and cultural treatments to slow the spread of invasive plants and eradicate some infestations. None of the alternatives analyzed in this document will result in the treatment of all known infestations of weeds on the Bridger-Teton NF if funding and manpower levels continue at present levels or at levels allocated over the past decade. When implemented properly, mechanical, cultural and biological weed treatment methods can reduce or prevent the spread of weed populations.

Potential effects are listed below by treatment method. The estimated acres that would be treated using these methods vary by alternative and are summarized in the *Comparison of Alternatives* section in Chapter 2.

Hand-pulling /Grubbing– Neither hand-pulling nor grubbing are very effective on plants that can reproduce vegetatively from pieces of root or underground stems. Half of the invasive species listed in this document fall into this category. For non-rhizomatous, shallow-rooted invasive species, hand control is only effective if the plant has not yet produced seed or if repeated trips are made to remove young seedlings until the weed seed bank in the soil is exhausted. For some species, this can take seven or more years and often requires several visits per year.

Hand-pulling has very little negative impact to native plants and does not increase susceptibility to re-infestation or establishment of new invasive species if done on a small scale. If done on a large scale (with a large group of volunteers, for example, working on a large infestation), it could increase the amount of bare ground and result in trampling damage to native species interspersed with the target weeds. Test plots established on Blue Mountain (Lolo NF) and the Lee Metcalf National Wildlife Refuge near Stevensville, Montana, measured effects of hand pulling on spotted knapweed. On the two sites, spotted knapweed covered 76 percent and 53 percent, respectively. Hand pulling provided 100 percent flower control and 56 percent plant control at Blue Mountain but increased bare ground from 2.7 percent to 13.7 percent during the first year after treatment (USDA Forest Service 2005).

Grubbing, as used here, refers to digging out weeds that cannot simply be hand pulled because they would break off at the surface, leaving the roots intact. It involves use of a shovel, mattock, hoe, or similar device to remove the root crown and larger roots. Like hand-pulling, it is very effective on some weed species and low impact to native plant communities if done on a small scale. On a large scale, it is cost prohibitive and has high impact to native vegetation due to the amount of soil disturbance.

Mowing – Very few acres are likely to be treated in this manner because it has limited effectiveness on many weed species and can only be effectively implemented on relatively flat terrain that does not have a very rough surface, large rocks, woody shrubs, trees or mowing- intolerant native plants. Because many invasive weeds flower throughout the summer, it is difficult to time mechanical treatments to prevent flowering and seed production. Repeated mechanical treatment too early in the growing season can result in a low weed growth form that is still capable of producing flowers and seed (DiTimaso 2001; Goodwin and Sheley 2001).

Mowing would mainly decrease the amount of seed production by weeds and weaken root and rhizome systems of creeping perennial weeds. Early forbs would be minimally affected if mowing occurs from midsummer through early fall, as they have produced seed and withered by that time. This would include many of the forbs in sagebrush, mixed mountain shrub and dry grassland plant communities. In some instances, where grasses have accumulated a lot of dead plant material, mowing can improve plant health, stimulating vigorous new growth.

Plant communities dominated by plants that cannot tolerate mowing would usually not be considered for such a treatment, as it would be counterproductive to the maintenance of healthy native plant communities.

Tilling – Tilling would injure or destroy above-ground plant biomass and the upper 4-12 inches of the underground root systems of most or all vegetation within the treatment area, thus it is not at all selective in its negative effects on native vegetation. For that reason, it has limited application and would have to be combined with an aggressive seeding treatment. The extent and location of tilling activities would be limited by terrain and soil characteristics, the need to minimize impacts on native plant species and the nature of the weeds to be treated. Since very few acres would be treated using this method, it would have little impact on native vegetation on a district or forest scale.

Tilling is an ineffective method of control for weeds that reproduce vegetatively and can actually increase size and density of infestations (Goodwin and Sheley 2001). As mentioned above under the discussion of effects of hand-pulling and grubbing, half of the invasive species on the Bridger-Teton NF reproduce by this method.

For invasive species that reproduce from seed, tilling can reduce seed production for the treated season; however, invasive weed seeds may remain viable in the soil for years (Stannard 1993; Messersmith et al. 1985). Field bindweed seed can reportedly remain viable for up to 50 years (Whitson 1996). Re-infestation from residual seed will often occur without continued follow-up treatment. In most cases, native species do not appear capable of out-competing invasive weeds when seeds of both are present on a tilled site.

Seeding – Seeding can be done by broadcast methods, in which the seed is scattered on the ground surface or with a seed drill. The overall effect on native vegetation is moderate to light, depending on the species composition of the plant community.

A seed drill is the preferred method where high rates of germination and seedling establishment are critical. On many sites on the Bridger-Teton NF, a seed drill cannot be used due to the ruggedness of the terrain or because the plant community is mostly forested or shrub covered.

Broadcast seeding must be used on most sites and it is sometimes very ineffective. Seeds may not land in locations conducive to germination or may be consumed by insects, birds or small mammals. Competitive seeding is not likely to be effective on most highly invasive weeds unless the existing weed population is also treated by hand-pulling, mowing, tilling or herbicide application.

The greatest potential impacts to native plant communities from seeding can come from the seed that is used. When purchased seed is used for revegetation, there is a risk of introducing non-native and/or invasive species. Use of certified weed-free seed is required on the Bridger-Teton NF and reduces this risk but does not eliminate it. Because cheatgrass is not a state listed invasive species in Wyoming, cheatgrass seed can be readily found in certified weed free seed mixes. Cheatgrass free seed mixes can be acquired upon request and should be used.

If native plant seed is used to revegetate a site, but it is derived from a population that is not of local origin, there is a risk of negatively affecting the gene pool of the local population; similar elevation zones are an important consideration. The plants that develop from non-local seed can interbreed with the local plants of the same species and introduce genetic traits that make the plants less fit for their environment. Protection measures listed in Appendix A minimize this risk to native plant communities, but until commercially available, locally derived native seed supplies are developed, there will be some use of non-local native plant materials on the Bridger-Teton NF.

Felling/Cutting (Russian olive, saltcedar) – This technique selects only the target species and is used for woody invasive species. Use of this technique without accompanying herbicide application is largely ineffective on Russian olive and saltcedar because both can resprout from the stump.

There is potential for some native plants to be negatively affected by this treatment method if slash is piled on them; however, this would be a short-term effect. Slash could help some native plants at a treatment site by protecting them from livestock or wildlife browsing and thereby improving their ability to fill in where the invasive plants were removed. Due to its minor occurrence slash from Russian olive and saltcedar cutting has so far not been heavy enough to suppress native plant growth or require piling and/or burning.

Shade-adapted plants that were growing under the canopy of the targeted woody invasives may find their habitat too dry and sunny for long-term survival, however, they will naturally be replaced by other native plants adapted to a sunnier site. As native woody plants establish themselves on the site (or are planted), native shade-adapted understory plants will regain dominance in most cases.

Grazing – Grazing has mixed effectiveness on the target weed species and mixed impacts on native plant communities depending upon how the grazing treatment is applied, the nature of the weed infestation and the intermingled native plants. Heavy grazing and trampling can produce temporary negative effects to native plants. Where native woody plants are present, negative effects can be more long-term, particularly when goats are used for weed control. Browsing by goats may remove several years' worth of accumulated annual twig growth. Timing, stocking rate and duration of the grazing treatment are critical to achieve weed control without long- lasting negative effects to native vegetation.

Appropriate grazing by animals preferring weeds can shift the plant community toward desired plant species (Stannard 1993). Conversely, grazing can selectively reduce competitiveness of native plants, shifting the community in favor of weeds (Vallentine and Stevens 1994; Kimball and Schiffman 2003). Most weedy species are well adapted to invade heavily grazed areas and some weed species have chemical or physical defenses (spines) that prevent them from being utilized by livestock. Grazing animals can be used to assist in weed control efforts but in most cases, will not eradicate mature infestations when used alone.

Due to the need to closely confine livestock used in weed control, to protect them from predation (in the case of sheep and goats) and to apply grazing two or more times per growing season, grazing treatments are likely to be used on small areas for most weed species. Treatment of dense, large scale cheatgrass infestations would be an exception. Livestock can be penned on large cheatgrass infestations for a brief period in early spring when the grass is palatable and nutritious, provided the terrain is gentle enough and adequate water sources are available. The Bridger-Teton NF has few sites where this would be effective.

Prescribed Burning – Burning alone is seldom an effective weed control measure unless combined with other measures such as herbicide application and seeding. Many noxious weeds regenerate rapidly after a burn and compete with desirable species. Their populations can increase dramatically in response to the release of nutrients and the suppression of native competitors.

Prescribed burning suppresses or temporarily eliminates some native species and promotes regeneration of others. Most grasses, many forbs and some woody species resprout readily after a cool burn or their seeds are adapted to take advantage of the newly bare soil. Most plant communities on the Bridger-Teton NF evolved with fire and can recover if not hampered by invasive species, heavy grazing or browsing, or severe weather events such as prolonged drought.

Big sagebrush, a dominant shrub on the Bridger-Teton NF, is often killed by fire, especially by fires occurring in the summer and fall. For big sagebrush to reclaim a site, it has to sprout from seed. Good spring conditions for sagebrush seed germination are often intermittent, so sagebrush recovery can take a long time on some sites or begin within a few years. Annual weeds such as cheatgrass and medusahead can dominate a plant community after a fire because they are able to take advantage of the flush of available nitrogen. This is particularly true in big sagebrush plant communities. Big sagebrush is effective in tying up nitrogen and when it is killed by fire soil nitrogen becomes available to aggressive annuals like cheatgrass and medusahead (Dakheel et al. 1993; Harris 1967; Lowe et al. 2002; Young & Allen 1997).

Biological Control Agents – On the Bridger-Teton NF, insects are the only biocontrol agents that have been released and most have had limited effectiveness. At present, there are no biological control agents available for many of the invasive species of concern. Biocontrol agents will never eradicate target weeds, but they can decrease populations and reduce seed production. They are usually a slow and partial weed treatment option.

Biological agents are selected and approved based on their host specificity and usually have little or no impact on native plant species. One exception has been the musk thistle seedhead weevil (*Rhinocyllus conicus*) which also infests native thistles that have large blossoms, such as the meadow thistle (*Cirsium scariosum*). In some areas, the meadow thistle now produces less viable seed due to infestation by this weevil.

The musk thistle seedhead weevil was the first biocontrol insect used on the Bridger-Teton NF and was released in the early 1990s. The screening process employed by the Animal and Plant Health Inspection Service (APHIS) is much more rigorous than it was at that time and none of the biocontrol insects released since the musk thistle seedhead weevils have been found infesting native plants. Despite rigorous screening, there is some potential for biocontrol agents to begin feeding upon native plant species. Once released, biological control agents can be difficult or impossible to eradicate if they become established and are found to have negative effects on native plant or animal species.

Use of biological control insects on the Bridger-Teton NF has been only partially successful. It may take years to build a population that produces observable results in weed populations and we may not know for years whether released biocontrol agents have successfully established. Some may not survive and reproduce in all the habitats in which the target weed exists, particularly in harsher high elevation sites. On some sites, the insect/weed life cycles may not be in good synchrony. On the Bridger-Teton NF, the musk thistle seedhead weevil normally completes is life cycle before the musk thistle plant has finished blooming, so the weevils do not damage the seed of late-flowering plants.

Alternative 1 - No Action

Under this alternative, present management practices authorized by the 2005 NEPA decision would continue. An estimated 3,000-5,000 acres would be treated annually if present funding levels continue. A portion of these acres would be re-treatment, since many infestations require multiple treatments for eradication or containment. Effects of the mechanical, cultural and biological treatment components of this weed management program are described above in the *Effects Common to All Alternatives* section. The ground application herbicide treatment and adaptive management tools available under this alternative are discussed below.

Under Alternative 1, lack of aerial treatment limits the Bridger-Teton NF's opportunities to work with surrounding landowners for a landscape approach to invasive species management. Because aerial application has not been available as a treatment method, Forest Service land managers have not participated in cooperative weed management efforts to treat infestations that spread across Forest, BLM, State and private land. In some cases, the treatment projects could not be carried out without federal participation and had to be abandoned. In other instances, NFS lands were left untreated adjacent to the treated areas, creating a weed seed source to re-infest the treated acres that were privately owned or managed by state or other federal agencies.

Effects on invasive species

Under this alternative, some weed species may be eradicated and some prevented from spreading, but overall, acres of infestation are likely to increase. The limitations under this alternative – no new herbicides, no aerial application and no treatment of weed species that are not listed by Wyoming – reduce weed management effectiveness.

Few, if any, cheatgrass infestations would be treated under this alternative because most of the infestation on the Bridger-Teton NF are in remote location of inaccessible terrain and aerial treatment is not an option. Livestock grazing is the only other treatment that could be applied to large cheatgrass patches and it can only be used on specific accessible locations. Large cheatgrass patches on steep or broken terrain (many of them on big game winter range sites) would not be treated under this alternative and would continue to spread in suitable habitats.

Effects on native vegetation

Use of any of the herbicides available under this alternative could result in some damage to native vegetation; however, the protection measures, label restrictions and selectivity of some of the herbicides minimize those negative effects. Since all herbicide application would be ground- based, there is little chance of herbicide drifting onto non-target areas.

Many native grasses and forbs eventually die out on a heavily infested cheatgrass site that remains untreated. They are unable to compete effectively for limited resources, especially moisture. Mature shrubs such as big sagebrush, bitterbrush and serviceberry can persist in cheatgrass stands, but young replacement seedlings generally cannot become established.

Alternative 2 - Proposed Action

Under this alternative mechanical, cultural, biological and herbicide weed treatment methods would be used in combination to control, contain and/or eradicate populations of weed species and aerial application of herbicide would be authorized. This alternative has more treatment methods and includes treatment of all new invasive plant species and the use of newly developed herbicides. It is estimated that between 5,000 and 15,000 acres would be treated annually.

Most herbicide application would be ground-based, but aerial application would be used on some large and/or remote weed infestations, primarily cheatgrass. Some years no aerial application would occur, depending on treatment needs, annual weather conditions and available funding. Imazapic and rimsulfuron are the primary herbicides proposed for aerial application on the Bridger-Teton NF. In the future, if suitable, selective herbicides or biological control agents are developed and approved, they may also be aerially applied.

Aerial herbicide application under Alternative 2 (the proposed action) would facilitate cooperative treatments across ownership boundaries. Because aerial application has not been available as a treatment method, Forest Service land managers have not participated in cooperative weed management efforts to treat infestations that spread across Forest, BLM, State and private land. In some cases, the treatment projects could not be carried out without federal participation and had to be abandoned. In other instances, NFS lands were left untreated adjacent to the treated areas, creating a weed seed source to re-infest the treated acres that were privately owned or managed by states or other federal agencies.

About 3,000 to 5,000 acres of weed infestation would be treated annually using a combination of treatment methods other than aerial herbicide application. The most effective means for control and/or eradication would be chosen depending on the likelihood of long-term effectiveness or resource values at risk. The decision flow chart in Figure 2 and guidelines in Table 3 would guide treatment priority and methods, with emphasis generally being given to new invaders and species having the greatest risk of spread.

Effects of mechanical, cultural and biological treatments are discussed above in the *Effects Common to All Alternatives* section. Effects of herbicide use and aerial application of herbicides on invasive species and native vegetation are discussed below.

Effects of herbicide use and aerial application on invasive species

This is the only alternative that attempts to address the proliferation of cheatgrass documented on the Bridger-Teton NF since 2000. Without the ability to prevent or suppress cheatgrass invasion after a fire, the Bridger-Teton NF has had to curtail its prescribed fire program. This has negative consequences for shrubland and grassland plant communities where fire is an important tool for creating diversity in structural and successional stages and for the wildlife that depend on them. Cheatgrass control has both a direct and indirect benefit to big sagebrush/grass plant communities. The direct benefit is restoration of native plant species diversity. The indirect benefit is prevention of a shift from a relatively long natural fire return interval of 25-50 or more years to a short fire return interval of potentially 4-5 years, which could eventually eliminate big sagebrush over large areas and perpetuate a cheatgrass monoculture (Pellant 1996).

Herbicides provide the most cost effective and successful control of weeds in most instances, particularly for those species for which hand-pulling or other non-herbicide treatment methods are largely ineffective or too damaging to native plant communities. Leafy spurge, yellow toadflax, Dalmatian toadflax, saltcedar, hoary cress, Russian olive, Canada thistle, field bindweed, oxeye daisy, Russian knapweed, squarrose knapweed, common tansy, perennial pepperweed, quackgrass, medusahead and cheatgrass are all species that are very difficult or impossible to control using mechanical, biological or cultural treatment methods (see Appendix C for more information on effectiveness of various treatments by species).

Imazapic is effective on annual plants at low concentrations when applied as a pre-emergent to control cheatgrass, medusahead and North Africa grass.

Effects of herbicide use and aerial application on native vegetation

All of the herbicides considered in this analysis are likely to kill or damage some native plant species that are immediately adjacent to or interspersed with target weed species. Negative effects to native plants can be reduced by selecting the appropriate herbicide application method, rate, timing and surfactant. All of the laws, regulations, standards and guidelines that apply to herbicide use, as well as the protection measures in Appendix A, minimize negative effects to native plant communities and other resources.

Glyphosate is the least selective of the herbicides proposed for use. It would be used primarily for grounds and building maintenance situations where removal of all vegetation is required and native plant communities are not at risk. It may also be appropriate for limited shrubland and grassland applications if it is applied at low concentrations when most native species are not actively growing. Under those conditions, it does not affect all native species.

Monocots (grasses, grass-like plants, lilies, orchids and related families) are tolerant of dicamba because of rapid metabolism (Sheley and Petrof 1999).

Repeated clopyralid use over multiple years may have a long-term detrimental effect on legume populations. Legume species are important components of rangelands, pastures and wildlands, and are nearly as sensitive to clopyralid as yellow starthistle, one of the invasive plants clopyralid is used to control.

At higher concentrations, imazapic is a broad spectrum herbicide. Imazapic can damage or kill native grass, forb and shrub species, especially if they are actively growing when the herbicide is applied. If applied early spring or fall, when most perennials are dormant, it has the most effectiveness on the target annual weeds and the least negative effect upon native species.

Imazapic has been used on BLM and State of Wyoming lands in Sublette and Lincoln Counties in western Wyoming. Many of these lands are directly adjacent to NFS lands in need of treatment. Line point intercept transects established to monitor the results of the treatments showed little to no non target mortality of native species. Four native species were negatively affected by the herbicide: arrowleaf balsamroot (*Balsamorhiza sagittata*), snowberry (*Symphoricarpos sp.*), antelope bitterbrush (*Pershia tridentate*) and currant (*Ribes sp.*). These plants were not killed but had stunted growth and/or yellowed leaves the spring following treatment. Other cheatgrass treatment trials with imazapic in Colorado, Wyoming, Oregon and Montana found variable native species response depending upon application rate, surfactant, timing, density of cheatgrass, amount of accumulated cheatgrass litter and native species present (Ogg et al. 2003; Schoup 2003; Vollmer 2003; Rice & Sutherland 2006; Sebastian et al. 2003; Elseroad & Rudd 2011; Baker et al 2009; Sebastian et al 2016).

Aerial herbicide application is most likely to affect non-target native plants because this method applies herbicide to all plants in the treatment area and drift can affect plants outside the treatment area. Protection measures in Appendix A would minimize the risk of drift, computer-controlled aerial application technology allow more precise application in terms of the area where the herbicide is applied and the application rate.

Alternative 3 - No Aerial Application of Herbicides

Aerial application of herbicide would not be authorized under this alternative. All other weed management is the same as under Alternative 2. Approximately 3,000-5,000 acres would be treated annually. The effects of mechanical, cultural and biological treatment methods on weeds and native vegetation are discussed in the *Effects Common to All Alternatives* section. The effects of herbicide treatment and the adaptive management options are summarized below and compared with the effects of the other alternatives. See the effects discussion under Alternative 2 for more information.

Lack of aerial treatment under this alternative would limit the Forest Service's opportunities to work with surrounding landowners for a landscape approach to invasive species management. Because aerial application has not been available as a treatment method, Forest Service land managers have not participated in cooperative weed management efforts to treat infestations that spread across Forest, BLM, State and private land. In some cases, the treatment projects could not be carried out without federal participation and had to be abandoned. In other instances, NFS lands were left untreated adjacent to the treated areas, creating a weed seed source to re-infest the treated acres that were privately owned or managed by state or other federal agencies.

Effects on invasive species

Alternative 3 provides more effective weed control than Alternative 1 and less effective control than Alternative 2. Very little cheatgrass would be treated under Alternative 3 because aerial application would not be available. Cheatgrass would be treated on a few areas using targeted grazing or ground application of imazapic and it would likely increase in extent and density as a result.

Effects on native vegetation

This alternative would have a lower impact on native vegetation than Alternative 1 because more selective herbicides are available. It would also have slightly less impact to native vegetation than Alternative 2, because it does not include aerial herbicide application.

However, the ecological consequences of unchecked cheatgrass spread are likely to be very high for native grassland and shrubland communities on the Bridger-Teton NF. Cheatgrass already occupies more acres than all other invasive plants on the Bridger-Teton NF combined.

Issue #2: Threatened, Endangered, or Sensitive Species and Their Habitats (Plants and Wildlife)

Section 7 of the Endangered Species Act of 1973, as amended, requires federal agencies to ensure actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of listed or proposed species, or result in the destruction or adverse modification of their critical habitats. The proposed actions contained in this document will have no effect on threatened, endangered species. Therefore, a biological assessment (BA) (FSM 2670.31-2670.32) was not prepared in addition to this DEIS document. All the information used to make these determinations is included in this DEIS.

Plants

Affected Area

The analysis area for threatened, endangered and sensitive (TE&S) plants includes all vegetation communities near the proposed treatment areas or those habitats where weeds have potential to invade. These plant communities have the potential to be directly impacted by weeds and proposed treatment methods.

Analysis Methods

Occurrence records, habitat needs and ecological requirements were derived from Forest Service records and files, USDA plants database, Wyoming Natural Diversity database and published research.

Affected Environment

The list of threatened and endangered species for the Bridger-Teton NF was consulted and two species, Ute ladies'-tresses and whitebark pine were considered. Similarly, Region 4 Sensitive Species listed for the Bridger-Teton NF were considered. Of these designated species, those with potential to be affected by implementation were analyzed. In general, the threat of weeds across the forest is categorized by habitat types with grasslands and sagebrush communities having the highest threat from weed infestation, particularly from cheatgrass.

Threatened and Endangered Species

All Threatened and Endangered plant species that are known to occur or for which available habitat may exist on the Bridger-Teton NF were considered in this analysis. The table below addresses expected impacts for each proposed alternative. Both Ute ladies'-tresses and whitebark pine were excluded from further analysis based on a low probability of impacts from the proposed alternatives in wet meadows and at high elevations. Protection measures may differ based on habitat but will be implemented in both wet areas and at high elevations. Effects of herbicides may also vary depending on a plant's growth form.

Table 10. USFWS listed terrestrial plant species and growth forms known or suspected to occur on the Bridger-Teton NF, considered for analysis and long-term benefits/ rationale for determination by alternative.

Species	Scientific Name	USFS Designation	Habitat	Growth Form	Present on Forest	Impacts Expected			Detailed Analysis
						Alt 1	Alt 2	Alt 3	
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	Low elevation (below 6,800 ft.) wet meadows	Forb	No known occurrence	No	No	No	No
Whitebark Pine	*Pinus albicaulis*	Candidate	Subalpine old growth	Tree	Yes	No	No	No	No

Ute Ladies'-Tresses

Ute ladies'-tresses (*Spiranthes diluvialis*) is a perennial, terrestrial orchid found in relatively low elevation riparian, spring and lakeside wetland meadows in three general areas of the interior western United States. Ute ladies'-tresses has not been documented anywhere on the Bridger-Teton NF. The potential for suitable habitat was analyzed on the Bridger-Teton NF. Habitat analysis and field surveys have determined that suitable habitat may exist in select wet areas; however, no populations of Ute ladies'- tresses have been discovered to date.

The invasion of exotic species into Ute ladies'-tresses habitat is thought to pose a serious threat to the species' viability (USFWS 1995; Heidel and Fertig 2007). It does not tolerate dense competing vegetation. Canada thistle (*Cirsium arvense*), Japanese brome (*Bromus japonicus*) and other weedy species that commonly invade riparian areas may pose a threat. Herbicides may also pose a threat to this species. Research is limited, but it is likely that broad-leaf herbicide would damage or destroy Ute ladies'-tresses. It is not known how a selective herbicide, such as imazapic, might affect this species. Other threats to Ute ladies'-tresses include habitat loss, habitat modification and over-collection.

Under all alternatives proposed here, protective measures outlined in Appendix A would be employed when treatments were conducted in wet meadows. These protective measures would mitigate any potential impacts to Ute ladies'-tresses. Therefore, the actions that would be implemented under Alternative 1, 2 or 3 would result in a determination of *No Effect* to Ute ladies'-tresses.

Whitebark Pine

Whitebark pine (*Pinus albicaulis*) is a long-lived, fire-resistant tree and occurs as seral to subalpine fir as a climax species. Individual whitebark pine may also occur as a very minor component of lower-elevation conifer forests. Whitebark pine is well documented on the Bridger-Teton NF. Exotic weed species are not thought to pose a serious threat to the species viability given the high elevations at which it is generally found (typically above 8,500 ft.). However, stand replacing fires or competition from other species may hinder this species reproductive abilities since it depends on ground disturbance and seed dispersal (typically by wildlife) for reproduction. The trend for the species is downward at both regional and landscape scales and is predicted to continue due to compounding effects from climate change.

Under Alternatives 1, 2 and 3, treatments in high, subalpine, alpine and boreal environments are unlikely. Individuals are well documented and the likelihood of weed treatments in known stands are limited. In the event that a treatment is required, protective measures as outlined in Appendix A will be employed to ensure that whitebark pine are not impacted by treatments. Neither ground based nor aerial weed treatment activities pose a threat to the low-density species. The actions that would be implemented under Alternative 1, 2 or 3 would result in a determination of *No Effect* to whitebark pine.

Sensitive Species

The Region 4 Forest Service sensitive species list was updated by the regional forester in June 2016 (US Forest Service 2016). All R4 sensitive species that are known to occur or are suspected to occur on the Bridger-Teton NF were considered in this analysis. The following table lists the sensitive species known or suspected to occur on the Bridger-Teton NF and their habitat preferences.

The species are organized according to their growth form (i.e., forbs/herbs, grasses, trees, shrubs). Protection measures may differ based on habitat and the effects of the herbicides may vary depending on a plant's growth form. For example, graminoids (grasses and grass-like plants) are generally not at risk from herbicides that target broadleaf plants (forbs/herbs).

The table below addresses if impacts are expected from the proposed alternatives for each species. The plants in the shaded rows were excluded from further analysis typically based on a low probability of effects from the proposed alternatives in a given habitat based on protective measures outlined in Appendix A. Foundational species information is discussed for all species in the section following the table.

Table 11. Region 4 sensitive terrestrial plant species and growth forms known or suspected to occur on the Bridger-Teton NF, considered for analysis and long-term benefits/ rationale for determination by alternative. Shaded rows were excluded from further analysis.

Species	Scientific Name	Habitat	Growth Form	Present on Forest	Impacts Expected			Detailed Analysis
					Alt 1	Alt 2	Alt 3	
Sweet-flowered rock jasmine	*Androsace chamaejasme ssp. Carinata*	Rocky ridges and slopes	Forb	Known/ suspected	Yes	No	Yes	Yes
Starveling milkvetch	*Astragalus jejunus var. jejunus*	Rocky ridges and slopes	Forb	Known/ suspected	Yes	No	Yes	Yes
Payson's milkvetch	*Astragalus paysonii*	Disturbed areas (burns, clearcuts)	Forb	Known/ suspected	Yes	No	Yes	Yes
Peculiar moonwort	*Botrychium paradoxum*	Montane to subalpine grasslands and meadows. Disturbance aids establishment and persistence.	Forb	Confirmed	Yes	No	Yes	Yes
Payson's bladderpod	*Lesquerella paysonii*	Rocky ridges and slopes, sagebrush	Forb	Known/ suspected	Yes	No	Yes	Yes
Naked-stemmed parrya	*Parrya nudicaulis*	Alpine and subalpine rocky ridges and slopes	Forb	Known/ suspected	Yes	No	Yes	Yes
Creeping twinpod	*Physaria integrifolia var. monticola*	Rocky ridges and slopes	Forb	Known/ suspected	Yes	No	Yes	Yes
Aster mollis	*Symphyotrichum molle*	Deep soild in sagebrush and meadows	Forb	Known/ suspected	Yes	No	Yes	Yes
Narrowleaf goldenweed	*Ericameria discoidea var. linearis*	Dry, gravel area above streams	Shrub	Known/ suspected	Yes	No	Yes	Yes
Scalloped moonwort	*Botrychium crenulatum*	Wet meadows	Forb	Confirmed	No	No	No	No
Meesia moss	*Messi triquetra*	Wet alpine/ subalpine	Moss	Confirmed	No	No	No	No
Pink agoseris	*Agoseris lackschewitzii*	Subalpine wet meadow	Forb	Known/ suspected	No	No	No	No
Meadow milkvetch	*Astragalus diversifolius var. diversifolius*	Wet meadows	Forb	Known/ suspected	No	No	No	No
Wyoming tansymustard	*Descurainia torulosa*	Cliff bottoms, sandy soil	Forb	Known/ suspected	No	No	No	No
Rockcress draba	*Draba densifolia var. apiculata*	Alpine meadows	Forb	Known/ suspected	No	No	No	No
Wooly daisy	*Erigeron lanatus*	Alpine	Forb	Known/ suspected	No	No	No	No
Greenland primrose	*Primula egaliksensis*	Wet meadows	Forb	Known/ suspected	No	No	No	No
Weber's saussurea	*Saussurea weberi*	Alpine talus slopes	Forb	Known/ suspected	No	No	No	No
Seaside sedge	*Carex incurviformis*	Wet alpine/ subalpine	Sedge	Known/ suspected	No	No	No	No
Black and purple sedge	*Carex luzulina var. atropurpurea*	Subalpine wet meadow	Sedge	Known/ suspected	No	No	No	No

The risk of habitat degradation from cheatgrass expansion (and other non-native species) would be greater for some sensitive species because cheatgrass is more prevalent and has greater abundance in some habitats. The following sensitive species occur near, or have habitat in, grassland and shrub communities of the sage steppe and foothills or depend on disturbances and could therefore be most negatively affected by uncontrolled cheatgrass expansion.

Forbs Growth Form

Rocky Ridges and Slopes

- Sweet-flowered rock jasmine (*Androsace chamaejasme ssp. Carinata*)
- Starveling milkvetch (*Astragalus jejunus var. jejunus*)
- Payson's bladderpod (*Lesquerella paysonii*)
- Naked-stemmed parrya (*Parrya nudicaulis*) – This species tends toward alpine and subalpine rocky ridges and slopes but is included here because of its propensity toward natural disturbance habitats.
- Creeping twinpod (*Physaria integrifolia var. monticola*)

Disturbed Burns and Clearcuts

- Payson's milkvetch (*Astragalus paysonii*)

Montane and Subalpine Grasslands and Meadows

- Peculiar moonwort (*Botrychium paradoxum*) – This species is found in montane to subalpine grasslands or forb dominated meadows. Disturbance is an important factor for its establishment and persistence.

Sagebrush Shrublands

- Aster mollis (*Symphyotrichum molle*) – This species depends on deep soils in sagebrush and meadows. Sagebrush is one of the habitats most impacted by cheatgrass invasion.

Shrubs Growth Form

The shrub listed as a sensitive species for the Bridger-Teton NF is narrowleaf goldenweed (*Ericameria discoidea var. linearis*). This shrub is found in dry gravel areas generally above streams. This shrub was carried forward for further analysis since this is an area that is typically prone to disturbance and therefore sensitive to invasion by non-native, disturbance dependent species.

Species Excluded from Further Analysis

Exclusion from further analysis was typically based on a low probability of impacts from the proposed alternatives. In most cases, the low probability of impacts results from protective measures pertaining to control treatment type and application techniques. Details on these protective measures are included in Appendix A. While protection measures may differ based on habitat, the intent of all is to avoid undue or unintentional harm to sensitive plant species based on application of control treatments.

Sensitive species associated with wet meadow habitats at high elevations (montane, subalpine and alpine) and therefore excluded from further analysis are:

- Scalloped moonwort (*Botrychium crenulatum*),
- Meesia moss (*Messi triquetra*)
- Pink agoseris (*Agoseris lackschewitzii*)
- Meadow milkvetch (*Astragalus diversifolius var. diversifolius*)
- Rockcress draba (*Draba densifolia var. apiculata*)
- Wooly daisy (*Erigeron lanatus*)
- Greenland primrose (*Primula egaliksensis*)
- Seaside sedge (*Carex incurviformis*)
- Black and purple sedge (*Carex luzulina var. atropurpurea*)

Application techniques in riparian, aquatic and wet habitats will be spot specific and will not include broad dispersal application techniques (e.g. broadcast spraying, etc.). Therefore, aquatic, riparian and wet habitats and the species that depend on them are not expected to be impacted from any of the alternatives.

Sensitive species associated with cliff bottoms (sandy soils) and talus slope habitats that were excluded from further analysis are:

- Wyoming tansymustard (*Descurainia torulosa*) – This species has 8-11 known occurrences in Wyoming and is restricted to the southern Absaroka Range (Fremont, Park and Teton Counties) and the Rock Springs Uplift (Sweetwater County). Wyoming tansymustard grows in sandy soil at the base of volcanic breccia or sandstone cliffs under slight overhangs and in cavities or on ledges. This species is typically found between 7,700 and 10,500 feet in elevation. There are two known occurrences on the Bridger-Teton NF of this state endemic species (Fertig 2000a).
- Weber's saussurea (*Saussurea weberi*) – This species has been found in six locations in Wyoming all of which are within wilderness areas (Bridger, Fitzpatrick and Gros Ventre Wilderness Areas). These Wyoming wilderness areas are located in the Gros Ventre and Wind River ranges in Sublette, Fremont and Teton counties. The species' habitat is restricted to small areas of suitable habitat in alpine talus slopes and gravel fields and found mostly on limestone-derived substrates from 9,600 to 11,500 feet in elevation (Fertig 2000b).

Application techniques in above habitats will be spot specific and will not include broad dispersal application techniques (e.g. broadcast spraying, etc.). The likelihood of aerial herbicide application techniques impacting these two species is low and would not result from a direct application technique. Therefore, cliff bottom and rocky habitats and the species that depend on them are not expected to be impacted from any of the alternatives.

<u>Environmental Effects</u>

Effects Common to All Alternatives

Under all alternatives, the Bridger-Teton NF will continue to integrate mechanical, biological and cultural treatments to slow the spread of invasive plants and eradicate some infestations. The techniques covered below will often be employed in combination or independently based on the optimum scenario that produces a positive result from the treatment for TE&S species. The resource protection measures below apply under all alternatives. Resource protection measures for when biological, mechanical, or cultural weed control methods are used to treat invasive plants are included in Appendix A.

The effects to rare plants common to all alternatives include direct and indirect impacts associated with mechanical, biological and cultural invasive species control measures. Effects to rare plants also include the beneficial effects of avoiding herbicide use.

Mechanical treatments are typically small scale and uncommon due to cost restraints. These treatments have the potential to damage plants and plant parts by pulling, crushing, burying and removing or damaging above-ground biomass. Some plants respond favorably to mechanical treatments like haying, while others experience mortality or reduced vigor. Protection measures that insure survey and avoidance of rare plant species are designed to protect plants from these impacts.

In general, biological control agents are a low-risk treatment method because agents are not approved for use until they are subjected to rigorous screening to ensure they avoid non-target vegetation. However, even with the extensive testing, biological controls are not risk-free. Protection measures have been designed to restrict the use of biological control agents that may pose a threat to rare plants. Ute ladies'-tresses in particular is not closely related to any of the current weed species of concern on the Bridger-Teton NF, thus, if present, it is not likely to suffer impacts from biological control agents.

Cultural methods such as seeding and grazing pose a minimal risk to rare plants. Some plant species are damaged by grazing while others respond with stimulated growth. Wet meadow habitats benefit from and are maintained by light grazing regimes. Seeding can cause problems if non-native or contaminated seed is used, but forest-level restrictions require the use of native plants and certified weed-free seed during seeding projects.

Effects from Herbicide Use

Alternatives 1, 2 and 3 include the use of herbicides applied using ground-based methods. In addition, there is an extensive list of protection measures for herbicide application in Appendix A. The protection measures for water resources and wetlands would help prevent effects to the wet habitat preferred by several sensitive species. The measures for threatened, endangered and sensitive plant species survey and avoidance would protect occurrences of these species if any are discovered in the project areas.

Direct impacts from the use of herbicides may cause death or damage to plants by unintentional direct herbicide spray, herbicide drift, wind erosion of contaminated soils, or herbicide transport in water. Indirect effects include herbicide-caused death to pollinating insects.

Ground-based herbicide application often involves spraying roadsides and trails using motorized spraying equipment or spraying more remote populations with horse or backpack sprayers. Herbicide use and impacts are concentrated along roads and trails due to accessibility but also because travel corridors act as transportation vectors for weeds and are therefore often the site of the worst weed infestations. Herbicide use along roads could impact existing occurrences of roadside sensitive species (US EPA 2005).

Herbicide drift has been found to adversely affect sensitive plants up to 10 meters from the application site and sediments from wind-eroded soils have been found to transport recently applied herbicides to new environments. The unintended movement of herbicides may cause foliar or reproductive damage to rare plants that may result in mortality. Protection measures to limit these effects are described in Appendix A. The risk of unintended herbicide movement is lower with ground application of herbicide (Alternatives 1, 2 & 3) than with aerial application (Alternative 2).

Herbicides that target broad-leaf invasive species would likely cause foliar and/or reproductive damage or plant mortality to the sensitive species with forb growth habits (see Table 11). Most of the sensitive plants on the Bridger-Teton NF fall into this category. Those that are found in wetland areas would be protected by the measures mentioned above. Many of the wet environments that support these species are not commonly conducive to weed invasion.

Sensitive wetland species in low lying wet meadows may be threatened by herbicide contamination of water bodies and streams adjacent to occupied wetlands. Doppler et al (2012) has shown that recently applied herbicide may be transported from point of origin to small depressions or surface water via overland flow from rain events. Since wetlands tend to occupy low spots and depressions on the landscape, it is possible herbicides may migrate to these areas during rain events.

Herbicides have been known to cause mortality in sensitive pollinators such as butterflies (LaBar and Schultz 2012; Stark et al. 2012) and damage habitat for native bees by decreasing larval food plants and safe sites (Moreby & Southway 1999). Conversely, use of herbicides to remove non-native species and the subsequent increase in native plant abundance has also been shown to benefit native pollinators, specifically native bees (Hanula & Horn 2011). Since most sensitive species are at least partially, if not completely, dependent on insect pollination to complete sexual reproduction, the enhancement or protection of pollinators and their habitats is an important component to the conservation of sensitive species.

Beneficial effects from the proposed action may take the form of lowering competition from aggressive, non-native plants, improving pollinator habitat by increasing native plant diversity, or improving soil health by removing weeds.

Potential adverse effects from herbicide use under Alternative 1 and 3 would likely be less than under Alternative 2 because ground-based herbicide applications typically treat smaller areas than aerial application. There may also be less beneficial effects because fewer acres and species are proposed for treatment. Aerial application increases the number of acres that could be treated which could result in both adverse and beneficial effects. Initially, aerial application would use imazapic and rimsulfuron to treat large infestations of cheatgrass across the Bridger-Teton NF, on crucial big game winter ranges and on previously burned areas on the Bridger-Teton NF. Imazapic and rimsulfuron are selective herbicides and available information does not indicate adverse effects to the sensitive species. However, imazapic targets specific species in the grass family, *Poaceae*, and little research has been done on impacts to rare plants, so adverse effects remain possible.

With aerial application, coverage is broader then when using other methods and the total amount of herbicide used on a landscape is typically greater. This means the threat of water contamination through herbicide mobilization is also greater. Despite wetland and no-application buffer zones, wetland species may be affected by selective herbicides applied to adjacent upland areas. As described above, rain events may transport the herbicide to small depressions, such as wetlands or surface water via overland flow (Doppler et al. 2012). This is more likely in areas where the topography of wetlands follows this description such as potholes surrounded by sagebrush and in areas where aerial application of herbicides will be used as a primary tool. The risk of herbicide drift and wind erosion of contaminated soils is inherent in the aerial application techniques. Resource protection measures control aerial spraying techniques to minimize risk and create buffer zones limiting activities around rare plants to help prevent adverse effects.

Alternative 2 is expected to have the greatest beneficial effects to sensitive species that occur in grassland and shrub communities of the sage-steppe and foothills, such as Wyoming tansymustard, sweet-flowered rock jasmine, starveling milkvetch, Payson's milkvetch, Payson's bladderpod, creeping twinpod, aster mollis and narrowleaf goldenweed. These communities would be widely treated for the control of cheatgrass, and other invasive annual grasses should they occur, which could make significant long-term improvements in grassland and shrub habitats. It also has the greatest threat of short-term adverse impacts if selective herbicides unintentionally damage or destroy any of these or other sensitive plant species. Effects of selective herbicide on sensitive species, although presumed low, have not been studied in detail. Aerial herbicide application is more closely calibrated and controlled than ground based application and has less probability of damaging sensitive species when applied at label rates. Other beneficial effects of aerial herbicide application include less chance of trampling of sensitive plants and less soil disturbance caused by the multiple trips required across the landscape to access invasive and noxious weed invasions with backpack and packhorse sprayers.

Cheatgrass is expected to increase in extent and density under Alternatives 1 and 3 because very little treatment would occur without aerial application. Cheatgrass invasion is a conservation concern for

Wyoming tansymustard, sweet-flowered rock jasmine, starveling milkvetch, Payson's milkvetch, Payson's bladderpod, creeping twinpod, aster mollis, narrowleaf goldenweed. Expansion of cheatgrass constitutes a high risk for the persistence of these and other rare plant species.

Determinations of effects have been made for all sensitive species and are summarized in Table 13.

Cumulative Effects

Threatened & Endangered

The cumulative effects analysis for Ute ladies'-tresses and whitebark pine only considered future activities that are reasonably certain to occur in the action area, the Bridger-Teton NF, or immediately adjacent to the Bridger-Teton NF. The cumulative effects are not expected to contribute to a change in status or viability for threatened and endangered plant species.

Ute Ladies'-Tresses

Identified threats to Ute ladies'-tresses include habitat loss and modification through urbanization, water development and conversion of wetlands to agriculture, over collection, competition from exotic weeds, herbicide use (USFWS 1992), vegetation succession, road and other construction, hydrologic change, grazing (domestic livestock and wildlife), recreation, flooding; haying/mowing, loss of pollinators, and drought (Fertig et al. 2005). Of these, competition from invasive species and vegetation success are the greatest threat to existing populations of Ute ladies'-tresses (Fertig et al. 2005).

The proposed action may contribute adverse cumulative effects to Ute ladies'-tresses range wide if undiscovered populations are damaged by herbicides or pollinator loss. Adverse effects would be mitigated by the protection measures (e.g., pre-treatment surveys, no-activity and limited-activity buffers for riparian areas and wetlands) detailed in Appendix A.

Because invasive species are an identified threat to Ute ladies'-tresses, the proposed action may beneficially contribute to the species by reducing cheatgrass and restoring habitats to native vegetation. This would offset adverse effects from the activities listed above. Ute ladies'-tresses have not been found on the Bridger-Teton NF. However, suitable habitat may be present.

Whitebark Pine

Identified threats to whitebark pine include stand replacing fires, competition from other species that hinder reproductive abilities, limitations to seed dispersal (typically by wildlife), blister rust, bark beetle infestations and climate change (Fryer 2002). The proposed action may contribute beneficial cumulative effects to whitebark pine range wide by protecting undiscovered populations from invasion by noxious weeds and the conservation of alternative habitats for seed dispersers. Direct adverse effects would be mitigated by the protection measures (e.g., pre-treatment surveys, no-activity and limited-activity buffers for subalpine and alpine areas) in Appendix A.

Because changes in fire regimes are an identified threat to whitebark pine, the proposed action may beneficially contribute to the species by reducing cheatgrass and restoring neighboring habitats to native vegetation and thereby fire regimes. Whitebark pine are well documented on the Bridger-Teton NF.

Sensitive Species

The temporal boundary for the effects analysis is 10 years into the past and 10 years into the future, which is an adequate length of time to record vegetation changes. The spatial boundary is the Bridger-Teton NF. The following past, present and reasonably foreseeable future actions were considered in the cumulative effects analysis for sensitive species: livestock grazing, timber harvest and thinning, motorized and non-motorized recreational use, road and trail building and maintenance, fire suppression, prescribed fire, mining, road construction and urban development (sub-dividing and development of neighboring private land). The following table lists the actions and their potential effects on sensitive plants.

Table 12. Past, present and reasonably foreseeable future actions considered in the cumulative effects analysis for T&E and sensitive plants

Action	Potential Effects
Improper livestock grazing	Trampling, compacting soils, changing plant composition, causing downcutting and degradation of streams and subsequent drying of adjacent meadows and introducing invasive species.
Timber harvest and thinning	Increasing the amount of light reaching the forest floor, disturbing and compacting soils and introducing invasive species. Increases recreation effects by improving access.
Recreation use	Motorized and nonmotorized recreation: Soil disturbance, compaction and erosion as well as introducing invasive species.
Road and trail construction and maintenance	Soil disturbance and erosion, fragmenting and destroying habitat, introducing invasive species. Increases recreation effects by improving access.
Wildfire suppression	Soil disturbance, compaction, erosion and introducing invasive species.
Prescribed fire	Create or improve habitat for select plant species by opening up meadows and/or reducing the litter accumulation and competition from other plants. Could burn T&E or sensitive species or their habitat, sterilize the soil and eliminate fungal species that are necessary for the survival of others.
Mining	Habitat destruction, introducing invasive species.
Urban development	Destroys neighboring habitat, fragments populations and increases the risk of weed invasion and fire.

The cumulative effects listed above are not expected to contribute to a change in status or viability for sensitive plant species.

All of the activities in the table above have the potential to introduce invasive species which can threaten sensitive plant species and their habitat as discussed earlier. Alternatives 1, 2 and 3 would reduce this threat to some degree because they allow herbicide treatment of invasive species. While there is potential for damage from the herbicides, the protection measures in Appendix A would reduce the risk of damage to sensitive plants and their habitats.

Other potential effects (e.g. soil compaction, habitat destruction, habitat fragmentation) from projects with discrete ground-disturbing actions (e.g. timber harvest, road construction) may be mitigated by including forest plan direction for sensitive plants in project design. Alternatives 1, 2 and 3 could help decrease any potential adverse effects to sensitive plants by reducing existing invasive species infestations and controlling new ones. Protection measures in Appendix A would add to the protection from forest plan standards and guidelines. This would help offset the potential adverse effects from herbicide use.

Livestock grazing and recreation may have adverse effects on sensitive plants and habitat as described in the table above. Unlike timber harvest and road construction, grazing and recreation occur across the landscape therefore surveying for sensitive plant occurrences and then avoiding them is not an option.

Determination of Effects

The table below summarizes the determination of effects for threatened, endangered and sensitive plant species. The species in the shaded rows below were excluded from further analysis.

Table 13. TE&S plant species determination of effects for all alternatives.

Common Name	Scientific Name	Determination		
		Alternative 1	Alternative 2	Alternative 3
Candidate				
Whitebark pine	*Pinus albicaulis*	NE	NE	NE
Threatened				
Ute ladies'-tresses	*Spiranthes diluvialis*	NE	NE	NE
Sensitive				
Sweet-flowered rock jasmine	*Androsace chamaejasme ssp. Carinata*	MIIH	MIIH	MIIH
Starveling milkvetch	*Astragalus jejunus var. jejunus*	MIIH	MIIH	MIIH
Payson's milkvetch	*Astragalus paysonii*	MIIH	MIIH	MIIH
Peculiar moonwort	*Botrychium paradoxum*	MIIH	MIIH	MIIH
Payson's bladderpod	*Lesquerella paysonii*	MIIH	MIIH	MIIH
Naked-stemmed parrya	*Parrya nudicaulis*	MIIH	MIIH	MIIH
Creeping twinpod	*Physaria integrifolia var. monticola*	MIIH	MIIH	MIIH
Aster mollis	*Symphyotrichum molle*	MIIH	MIIH	MIIH
Narrowleaf goldenweed	*Ericameria discoidea var. linearis*	MIIH	MIIH	MIIH
Scalloped moonwort	*Botrychium crenulatum*	NE	NE	NE
Meesia moss	*Messi triquetra*	NE	NE	NE
Pink agoseris	*Agoseris lackschewitzii*	NE	NE	NE
Meadow milkvetch	*Astragalus diversifolius var. diversifolius*	NE	NE	NE
Wyoming tansymustard	*Descurainia torulosa*	NE	NE	NE
Rockcress draba	*Draba densifolia var. apiculata*	NE	NE	NE
Wooly daisy	*Erigeron lanatus*	NE	NE	NE
Greenland primrose	*Primula egaliksensis*	NE	NE	NE
Weber's saussurea	*Saussurea weberi*	NE	NE	NE
Seaside sedge	*Carex incurviformis*	NE	NE	NE
Black and purple sedge	*Carex luzulina var. atropurpurea*	NE	NE	NE

Determination Codes
Federally Listed Species
NE - No Effect
NLAA - May Affect, Not Likely to Adversely Affect
LAA - May Affect, Likely to Adversely Affect

Forest Service Sensitive Species
NI - No Impact
MIIH - May Impact Individuals or their Habitat, but Will Not Likely Contribute To A Trend Towards Federal Listing or Loss of Population Viability
WIFV - Will Impact Individuals or Their Habitat That May Contribute To A Trend Towards Federal Listing or Cause A Loss of Population Viability
BI - Beneficial Impact

Forest Plan Consistency

Relevant standards and guidelines for the forest plans were reviewed. The effects of the three alternatives and the protection measures in Appendix A were evaluated to determine if they were consistent with forest plan direction. The alternatives will meet the standards and guidelines when the resource protection measures in Appendix A are applied.

Wildlife

Affected Area

The analysis area for threatened, endangered and sensitive (TE&S) wildlife species includes all habitat near the proposed treatment areas or those habitats where weeds have potential to invade across the Bridger-Teton NF. These habitats have the potential to be directly or indirectly impacted by weeds and proposed treatment methods.

Analysis Methods

Herbicide fact sheets and SERA and BLM ecological risk assessments were used to complete this analysis and evaluate toxicity of herbicides on mammalian and avian wildlife species. The risk assessments and herbicide fact sheets relate the expected direct effects of exposure and ingestion. They do not address the indirect effects of habitat alteration.

The risk characterizations for both mammal and bird species are limited by the relatively few animal species on which data are available compared to the large number of species that could potentially be exposed. The majority of the information comes from experimental animals such as mice, rats, dogs, mallards, or quail and then is extrapolated to mammal or bird species in general. This limitation and consequent uncertainty is common to most, if not all, ecological risk assessments.

Risk levels for herbicide use are calculated in a very conservative manner and worst-case exposure scenarios have been studied for most herbicides. Lethal dose 50 (LD50) values are used as a measure of toxicity and are defined as the quantity of chemical per unit body weight that would cause lethal effects in 50% of a study population with a single dose. Reported LD50 values for herbicides were sometimes highly variable, reflecting differences among studies such as use of different species or exposure techniques, varying sample sizes, etc. Despite this variability, data are sufficient to determine that the herbicides proposed for use under the proposed action are generally of low toxicity to mammalian and avian wildlife. As a result, analysis primarily focused on the effects on habitat and the resulting indirect effects on mammalian and avian wildlife species listed below.

Tables 14 and 15 below summarize the threatened, endangered and sensitive species considered for analysis. Impacts to habitat from alternatives were considered within the framework of protective measures detailed in Appendix A. Alternatives were considered to have no impacts if the techniques used in an alternative would not impact the habitat or species. For instance, in conifer forests, invasive species treatments will primarily be conducted through the use of ground herbicide treatment techniques as well as non-herbicide treatment techniques common to all alternatives regardless of the alternative analyzed (Alternatives 1, 2 & 3). Therefore, impacts from these alternatives are not expected ("No" in Tables 14 and 15 under Impacts Expected) because the treatments in these areas and resulting habitat conditions would be the same regardless of the alternative chosen. Upland sagebrush, grasslands and shrub/ grass cover types are the habitat at the greatest risk from non-native species invasion. Therefore, the species found in this habitat type were the most likely to be carried forward for detailed analysis. Species found primarily in aquatic habitats are protected from impacts under all alternatives based on protective measures in place (Appendix A). Protective measures detailed in Appendix A intend to protect both aquatic habitats and the species that use this habitat from impacts.

Affected Environment

The list of threatened and endangered species for the Bridger-Teton NF was consulted and three species, Canada lynx, Yellow-billed cuckoo and North American wolverine were identified for analysis. Similarly, Region 4 Sensitive Species listed for the Bridger-Teton NF were analyzed. Of these designated species, those with potential to be affected by implementation were analyzed. In general, the threat of weeds across the forest is categorized by habitat types with grasslands and sagebrush communities having the highest threat from weed infestation, particularly from cheatgrass.

Threatened & Endangered Species

All threatened and endangered wildlife species that are known to occur or for which available habitat may exist on the Bridger-Teton NF were considered in this analysis. The following table lists the threatened and proposed species with known occurrence or for which available habitat may exist on the forest. No species were considered for further full analysis since their habitats are not expected to be impacted. While protection measures may differ based on habitat, exclusion from further analysis was typically based on a low probability of impacts from the proposed alternatives. Foundational species information and primary rationale for exclusion from further analysis is discussed in the species information section following the table.

Table 14. USFWS listed terrestrial wildlife species and habitats known or suspected to occur on the Bridger-Teton NF, expected impacts for each alternative and consideration for detailed analysis

Species	Scientific Name	USFS Designation	Habitat	Present on Forest	Impacts Expected			Detailed Analysis
					Alt 1	Alt 2	Alt 3	
Canada lynx & critical habitat	*Lynx canadensis*	Threatened	Montane Forest	No current known observations; Habitat designated	No	No	No	No
Yellow-billed cuckoo	*Coccyzus americanus*	Threatened	Riparian Cottonwood	No current known observations; No critical habitat designated	No	No	No	No
North American wolverine	*Gulo gulo luscus*	Proposed Threatened	Alpine/ Boreal Forest	Yes	No	No	No	No

Canada Lynx and Critical Habitat

Although historic observations have been documented on the Bridger-Teton NF, recent intensive surveys conducted from 2015 to present indicate no presence of lynx on the forest. Critical habitat for the Canada lynx is designated on the Bridger-Teton NF but will not be impacted by the proposed invasive species treatments.

The following is a summary of impacts for each treatment action:

- For bio-controls, no impacts to lynx would occur, since the bio-control agent would pose no disturbance to breeding, foraging or denning.
- Re-vegetation and cultural efforts will not impact lynx since this species is a wide-ranging carnivore and these projects are small in scale relative to the Lynx Analysis Unit (LAU).
- Grazing as a weed treatment technique is both temporally and spatially small scale. Therefore, grazing efforts as a weed treatment will not impact lynx since this species is a wide-ranging carnivore and these projects are small in duration and scale relative to the lynx annual cycle and the size of the LAU.
- No direct impacts to lynx are anticipated with the use of mechanical treatments, since these techniques would not be employed in lynx habitat.

- No prescribed burning would occur in lynx habitat that would result in stands returning to stand initiation structure stage. Thus, no impacts to lynx from prescribed burning will occur. Prescribed burning may occur in non-lynx habitat, which may create positive, indirect effects for alternate prey species habitat within a LAU.
- No impacts to lynx are anticipated from the use of herbicides. The doses required to produce harmful effects are many times higher than a lynx would encounter from application of herbicides in the field even under worst-case scenarios.
- No impacts to lynx from aerial herbicide treatments are anticipated, since treatments will occur outside of lynx habitat (Alternative 2).

As detailed above, no impacts to lynx are anticipated from invasive species treatments under these alternatives. Treatments will be small in extent when compared to the size of the LAU. Even in the case where multiple treatments may be used (e.g., grazing in combination with herbicide application), it is not anticipated that habitat would be reduced further for lynx or their prey. These treatments may reasonably be considered as insignificant when compared proportionally to the habitat available.

Under all alternatives the use of herbicides or other treatments has the potential to maintain or promote habitat quality for lynx prey species, snowshoe hares and red squirrels, by reducing the risk that non-native plant species invade disturbed areas and limit the regeneration of aspen and lodgepole pine in the future. The actions that would be implemented under Alternative 1, 2 or 3 would result in a determination of *No Effect* to lynx or designated lynx habitat.

Yellow-billed Cuckoo

The distinct population segment of the yellow-billed cuckoo west of the Continental Divide is listing as Threatened under the ESA (79 FR 59992; October 3, 2014). The available literature suggests that the breeding population of the yellow-billed cuckoo within Wyoming is extremely low, numbering in the single digits and potential nesting habitat is very limited (78 FR 61621). These cuckoos typically nest below 6,000 feet. Nesting has not been confirmed on the Bridger-Teton NF and is not expected due to inadequate nesting habitat. No designated critical habitat is present on the Bridger-Teton NF (79 FR 48548).

With the protection measure outlined in Appendix A, none of the alternatives will degrade communities of cottonwood, riparian habitats. Therefore, impacts to Yellow-billed Cuckoos or their habitat are not expected. To protect yellow-billed cuckoos, no prescribed burning, herbicide, mechanical or aerial herbicide treatments will be conducted in suitable habitat (e.g., cottonwood, riparian habitats) during their nesting period, June 1-Aug 30. If treatments are needed in suitable habitat during this time frame, mandatory surveys will be completed prior to implementation and a finding of no occurrences documented will be required for treatment implementation.

With the protection measures listed above and outlined in Appendix A, the actions that would be implemented under Alternative 1, 2 or 3 would result in a determination of *No Effect* to yellow-billed cuckoos or suitable cottonwood, riparian habitat.

North American Wolverine

The North American wolverine in the western United States was accorded proposed threatened status on October 18, 2016 (FR 81:71670-71671). Threats to the wolverine include loss of habitats with persistent snow cover resulting from climate change and increasing temperatures. Neither ground-based nor aerial weed treatment activities pose a threat to the low-density and wide-ranging species. As with the lynx, treatments that may take place will be both temporally and spatially small in scale relative to the wolverine’s wide-spread habitat use and movement patterns. Treatments in high alpine/ boreal environments are unlikely.

The following is a summary of impacts for each treatment action:

- For bio-controls, no impacts to wolverine would occur, since the bio-control agent would pose no disturbance to breeding, foraging or denning.
- Re-vegetation and cultural efforts will not impact wolverine since this species is a wide-ranging carnivore and these projects are small in scale relative to the species home-range.
- Grazing as a weed treatment technique is both temporally and spatially small scale. Therefore, grazing efforts as a weed treatment will not impact the wolverine since this species is a wide-ranging carnivore and these projects are small in duration and scale.
- No direct impacts to wolverine are anticipated with the use of mechanical treatments, since these techniques would not be employed in wolverine habitat.
- No prescribed burning for weed treatment would occur in wolverine habitat that would result in stands returning to stand initiation structure stage. Thus, no impacts to wolverine from prescribed burning will occur. Prescribed burning may occur in non-wolverine habitat, which may create positive, indirect effects for alternate prey species habitat.
- No impacts to wolverine are anticipated from the use of herbicides. The doses required to produce harmful effects are many times higher than a wolverine would encounter from application of herbicides in the field even under worst-case scenarios.
- No impacts to wolverine from aerial herbicide treatments are anticipated, since treatments will occur outside of wolverine habitat (Alternative 2).

The actions that would be implemented under Alternative 1, 2 or 3 would result in a determination of *No Effect* to the North American wolverine or for alpine/ boreal forests.

Sensitive Species

The following table lists the Region 4 sensitive wildlife species considered. Species with individuals or habitat within the Bridger-Teton NF were evaluated to determine if implementation of the proposed action or alternatives would result in direct, indirect, or cumulative impacts. Species in the shaded rows do not have habitat in the primary treatment areas and will not be negatively affected by the proposed alternatives. Therefore, these species, primarily based in aquatic or forested habitat, were excluded from further analysis.

All Region 4 sensitive wildlife species that are known to occur or for which available habitat may exist on the Bridger-Teton NF were considered in this analysis. The table below lists species considered and whether impacts are expected for each alternative. While protection measures may differ based on habitat, exclusion from further analysis was typically based on a low probability of impacts from the proposed alternatives. Foundational species information and primary rationale for exclusion from further analysis is discussed in the species information section following the table.

Table 15. Region 4 sensitive wildlife species known or suspected to occur on the Bridger-Teton NF, expected impacts for each alternative and consideration for detailed analysis

Species	Scientific Name	Habitat	Present on Forest	Impacts Expected Alt 1	Impacts Expected Alt 2	Impacts Expected Alt 3	Detailed Analysis
Bighorn sheep	*Ovis canadensis*	Alpine/ Meadows	Yes	Yes	No	Yes	Yes
Peregrine falcon	*Falco peregrinus*	Cliffs	Yes	Yes	No	Yes	Yes
Townsend's big-eared bat	*Corynorhinus townsendii*	Forests/ Shrublands/ Grasslands	Yes	Yes	No	Yes	Yes
Bald eagle	*Haliaeetus leucocephalus*	Riparian Cottonwood	Yes	No	No	No	Yes
Greater sage-grouse	*Centrocercus urophasianus*	Sagebrush	Yes	Yes	No	Yes	Yes
Migratory birds	various	All	Yes	Yes	No	Yes	Yes
Spotted bat	*Euderma maculatum*	Cliffs/ Shrublands	No occurrences recorded; habitat present	Yes	No	Yes	No
Trumpeter swan	*Cygnus buccinator*	Aquatic	Yes	No	No	No	No
Common loon	*Gavia immer*	Aquatic	Yes	No	No	No	No
Harlequin duck	*Histrionicus histrionicus*	Aquatic	Yes	No	No	No	No
Northern goshawk	*Accipiter gentilis*	Forest	Yes	No	No	No	No
Boreal owl	*Aegolius funereus*	Forest	Yes	No	No	No	No
Fisher	*Martes pennanti*	Forest	Yes	No	No	No	No
Three-toed woodpecker	*Picoides tridactylus*	Forest	Yes	No	No	No	No
Flammulated owl	*Psiloscops flammeolus*	Forest	Yes	No	No	No	No
Great gray owl	*Strix nebulosa*	Forest	Yes	No	No	No	No

Bighorn Sheep

Populations of Rocky Mountain bighorn sheep experienced significant declines across their range from the 1800s to the mid- 1900s due to intense competition from livestock, unregulated hunting, habitat loss and disease introduced from domestic sheep. Translocation and reintroduction programs in the 1960s increased the bighorn populations; however, human disturbance, habitat loss and respiratory disease from domestic sheep are still large threats (Beechman et al. 2007). Additionally, non-native plants on the Bridger-Teton NF have invaded important big game winter ranges, reducing forage available for over-wintering ungulates including bighorn sheep. Without aggressive management of invasive species, stopping or reversing the invasion of weeds onto big game winter ranges would be extremely difficult and the habitat would likely change in the future.

There are three primary bighorn sheep herds that utilize the Bridger-Teton NF, the Targhee Herd, Jackson Herd and Darby Herd. A few other herds utilize small areas of Bridger-Teton NF, but the majority of their range is off the Bridger-Teton NF. The Targhee Herd in the Teton Mountain Range is estimated to be 60-80 sheep. This herd disperses their habitat utilization between the Caribou-Targhee and Bridger-Teton NFs as well as Grand Teton National Park. The Jackson Herd ranges throughout the Gros Ventre Mountain Range and to the north end of the Wyoming Range near Clause Peak/Ramshorn Peak. This herd's habitat is almost exclusively on the Bridger-Teton NF and the herd is estimated at 425 sheep. The Darby Herd is found in the southern Wyoming Range, is almost exclusively found on the Bridger-Teton NF and is estimated to be 60-75 sheep (A. Courtemanch, WGFD Jackson Wildlife Biologist, *pers. commun* 2018).

Peregrine Falcon

Removed from the Endangered Species list in 1999, the subspecies American peregrine falcon (*Falco peregrinus anatum*) is the form most likely to be encountered in Wyoming (WGFD 2017). During the 1940s to the 1970s, peregrine falcon numbers declined sharply due to DDT and other pesticides (WGFD, 2017). Laws banning these chemicals were considered a major turning point for the species' population trends. Today peregrine falcon numbers across Wyoming are thought to have stabilized and nearly all of its historic range has been repopulated (WGFD 2017). Current threats to the species include low productivity rates resulting from climate change and human disturbance stresses as well as the continued threat of chemical poisoning from pesticides.

Peregrine falcons are habitat generalists across its range. On the Bridger-Teton NF, this species typically nests on cliffs above open areas for foraging such as sagebrush and grassland habitats while feeding primarily on smaller birds, rodents and mammals (WGFD 2017).

Townsend's Big-Eared Bat

Wyoming is located on the northeastern edge of the Townsend's big-eared bat distribution area (WGFD 2017). While a commonly detected species during hibernacula surveys, the population in Wyoming and on the Bridger-Teton NF is largely unknown. The presence of suitable, undisturbed roost sites on the landscape may be a limiting factor for this species. Furthermore, Townsend's big-eared bat may also be vulnerable to White-Nose Syndrome which has led to large declines in several bat species particularly in eastern North America.

Townsend's big-eared bat is insectivorous and forages primarily on small moths. Suitable roost habitat is found in a variety of xeric and upland habitats ranging from shrublands to woodlands and montane forests. Natural caves and abandoned mines provide suitable roost sites. Human disturbance in these cave-like features and external stressors such as White-Nosed Syndrome appear to be the primary threats to this sensitive species.

Bald Eagle

As with peregrine falcons, bald eagle populations declined in the mid-1900s due to use of pesticides such as DDT. Today bald eagle numbers across Wyoming have stabilized. While bald eagles are present throughout Wyoming, the most significant concentrations are found in Teton, Sublette and Carbon counties. Within these counties, the Snake and Green Rivers, both located on the Bridger-Teton NF, host a large portion of Wyoming's bald eagle population (WGFD, 2017).

Bald eagles are typically associated with aquatic habitats and primarily feed on fish or carrion. Nests are usually constructed in the dominant or co-dominant tree of a stand (Johnsgard 1990). Wintering eagles tend to aggregate at roosting sites, often where food concentrations are higher. Threats to bald eagles stem from human disturbance, loss of habitat (particularly nesting), a decrease in prey availability and illegal shooting. Bald eagles are also susceptible to West Nile Virus, lead and other heavy metal poisoning and other environmental toxins (WGFD 2017).

Greater Sage-Grouse

Thirty-seven percent of North America's greater sage-grouse population is found in Wyoming. This species population has declined historically but these population declines have moderated since the mid-1990s with significant state-wide conservation efforts. A small number of leks are present and sage-grouse are known to utilize lands on the Bridger-Teton NF year-round for both summer and winter habitat. Neighboring lands of the BLM and private ownership are contained in the Governor's Designated Core Area and host the majority of leks in the region.

Greater sage-grouse are a sagebrush obligate species dependent on sagebrush for much of their food and cover requirements throughout the year (Connelly et al. 2004). This species is dependent on large areas of contiguous sagebrush that contain a variety of semiarid shrub and grassland habitats. Greater sage-grouse are considered a landscape species and conservation of the species and their habitats is important to the sagebrush ecosystem (Naugle et al. 2011). Current threats are largely due to loss of suitable sagebrush habitat through conversion, degradation and fragmentation (Knick and Connelly 2011) and the effects of West Nile virus (Naugle et al. 2004). Invasive grasses represent a significant threat to sagebrush environments through an increase in fire frequency and reduction in the amount of sagebrush habitat available (WGFD 2017). Without aggressive management of invasive species, stopping or reversing the invasion of weeds in sagebrush habitats would be extremely difficult and the habitat would likely change in the future.

Migratory birds

Migratory birds, particularly birds of conservation concern and raptors that use sagebrush and grassland habitats as hunting and breeding grounds, are vulnerable to habitat loss and degradation resulting from invasive, non-native plant species. Migratory bird species can be found in all habitat types on the Bridger-Teton NF. Changes to habitat resulting from increased fire frequency, alterations in understory species and canopy cover as well as changes in water regimes can all have negative effects on migratory bird species that typically use habitats found on the Bridger-Teton NF during the critical nesting periods of their annual life cycle.

Species Excluded from Further Analysis

Exclusion from further analysis was typically based on a low probability of impacts from the proposed alternatives. In most cases, the low probability of impacts results from protective measures pertaining to control treatment type and application techniques. Details on these protective measures are included in Appendix A. While protection measures may differ based on habitat, the intent of all is to avoid undo or unintentional harm to wildlife species based on application of control treatments.

Sensitive species associated with aquatic habitats and excluded from further analysis are trumpeter swan, common loon and harlequin duck. Application techniques in riparian and aquatic habitats will be spot specific and will not include broad dispersal application techniques (e.g. broadcast spraying, etc.). Therefore, aquatic habitats and the species that depend on them are not expected to be impacted from any of the alternatives.

Similarly, sensitive species associated with forested habitat (e.g. deciduous and coniferous forests) excluded from further analysis were northern goshawk, boreal owl, fisher, three-toed woodpecker, flammulated owl and great gray owl. As with aquatic habitats, application techniques in forested habitats will be spot specific and will not include broad dispersal application techniques (e.g. broadcast spraying, etc.). Therefore, forested habitats and the species that depend on them are not expected to be impacted from any of the alternatives.

The spotted bat was excluded from further analysis because while suitable habitat, shrublands, juniper and conifer forests and subalpine meadows, is present on the Bridger-Teton NF, there are no recorded occurrences on the Bridger-Teton NF. All records for Spotted Bat in Wyoming have occurred in the Bighorn Basin and the lower portion of the Green River Basin both of which are outside of the Bridger-Teton NF.

Environmental Effects

Effects Common to All Alternatives

The following effects are common to all alternatives analyzed.

Successful implementation of bio-controls would have beneficial impacts by restoring native vegetation and reducing or preventing spread of noxious weeds as a component of a multi-technique treatment plan.

- Cultural treatments (e.g. seeding native plants, short-term grazing and use of fertilizer) could have some short-term impacts through disturbance to individuals during project implementation, but impacts would not be significant. Cultural treatments would have secondary, beneficial impacts on habitat by restoring native vegetation and reducing or preventing spread of noxious weeds and invasive species.
- Overgrazing by domestic sheep and goats could affect wildlife with low mobility such as small mammals and ground-nesting birds. Sheep and goats could disturb individuals and change vegetation cover and composition. Smaller, ground dwelling species may be temporarily disturbed and leave the area. The concentration of grazing animals used to remove weeds could cause smaller, ground-dwelling and low shrub nesting species to temporarily leave the sites. At most, relatively small isolated areas across the entire forest would be treated annually, disturbing no more than a portion of a few territories at one time. Disturbed species could return to the sites immediately after treatment occurs. If used appropriately, sheep and goat grazing could have long-term beneficial impacts on wildlife habitat by restoring native vegetation and reducing or preventing spread of invasive plant species.
- Mechanical treatment methods could have site-specific impacts by disturbing individuals during breeding, foraging, nesting, or denning, but the impacts would be short-duration and therefore insignificant. Mechanical treatment would have beneficial impacts on wildlife habitat by restoring native vegetation and reducing or preventing spread of invasive plant species.
- Prescribed fire would be implemented in conjunction with other treatment methods. Prescribed burning would impact some individuals that occur in areas of treatment through disturbance, direct mortality in some cases and temporary loss of habitat until burned areas recover. The long-term effects would be beneficial by restoring native vegetation and reducing or preventing spread of invasive species. The protection measures in Appendix A would limit short-term impacts.
- Consultation with WGFD will occur before domestic sheep or goat grazing will be implemented to prevent disease transmission to bighorn sheep.

Biological, mechanical and cultural treatments alone have limited effectiveness for controlling invasive species and failure to control invasive species could adversely impact habitat for many species on the Bridger-Teton NF. Invasive weeds species have the ability to compete with native vegetation and, in some cases, replace native vegetation in riparian habitats. This becomes important when managing for small populations that have low habitat connectivity and mobility.

On the Bridger-Teton NF, cheatgrass invasion into big sagebrush stands degrades habitat for sagebrush dependent species like the greater sage-grouse and songbirds. Once cheatgrass dominates the spaces between sagebrush plants, it increases the likelihood of wildfire. Repeated wildfire eventually eliminates big sagebrush, thereby eliminating sage habitat. Climate change models for the sagebrush region suggest increasing temperatures, atmospheric carbon dioxide levels and episodes of severe weather that will both support the further spread of cheatgrass and increase fire disturbance to the detriment of sagebrush communities (Miller et al. 2011).

Effects from Herbicide Use

Exposure of terrestrial animals to herbicides may result from several direct effects which include direct spray; ingestion of herbicide affected plants, prey, or water; ingestion through grooming; or inhalation of spray. In addition, wildlife might spend long periods in contact with contaminated vegetation.

During laboratory studies, exposure to extremely high levels of most herbicides through direct ingestion of the herbicide or spraying often led to death or a variety of sub-lethal toxic effects including damage/irritation to the nervous system, kidneys, eyes and skin and inhibition of reproduction. However, the doses required to produce such effects were many times higher than those wildlife would encounter from application of herbicides in the field even under worst-case scenarios.

Biomagnification is also a potential effect from herbicide use. Biomagnification is the increase in concentration of chemicals from one link in the food chain to the next. The result is that small concentrations of chemicals can lead to toxic effects for organisms high in the food chain. However, for biomagnification to occur, the chemical must be long-lived, mobile and fat-soluble. Chemicals that are water-soluble rather than fat-soluble will be excreted by an organism. The herbicides proposed for use in this project appear to be rapidly excreted and do not accumulate in tissues, although data were often limited. Because of this rapid excretion, these herbicides present little or no potential for bioaccumulation.

Herbicides can affect habitat by killing, injuring or suppressing non-target vegetation that is necessary or desirable habitat for wildlife species. On the Bridger-Teton NF, this is a concern for species associated with particular grass, forb, or shrub species for food or cover during their life cycle (e.g. greater sage-grouse) and with low mobility to move into different areas when their habitats are impacted (e.g. species with high fidelity to roost sites). The degree to which herbicides affect non-target vegetation varies by specific herbicides, with some having more broad impacts than others. Protection measures identified in Appendix A would minimize the effects of herbicides on habitat.

Alternative 1 – No Action

<u>Region 4 Sensitive Species</u>

For sensitive species, the actions that would be implemented under Alternative 1 would result in a determination of *may impact individuals or their habitat, but will not likely contribute to a trend towards federal listing or loss of populations viability*. Habitat availability and quality will remain the same under current management, which includes a limited amount of cheatgrass treatment. However, over time, there could be a reduction in quality and quantity of habitat available for sage- and or grass-dependent species if cheatgrass persists without more intensive management treatment options like those available under the proposed action (Alternative 2).

Under this alternative, some invasive plant species may not be controlled. This alternative would not reduce negative effects of cheatgrass (species which infests the most acres on the Bridger-Teton NF) or other invasive species not listed as noxious farm weeds by the State of Wyoming. Therefore, some weed species will continue to increase, with negative consequences to native plant communities and dependent wildlife. The use of herbicides or other treatments has the potential to maintain or promote habitat quality for prey species by reducing the risk that non-native plant species invade disturbed areas in sagebrush or grasslands and limit the regeneration of aspen and lodgepole pine in the future.

Alternative 2 – Proposed Action

<u>Region 4 Sensitive Species</u>

For sensitive species, the determination under the proposed action (Alternative 2) is may impact individuals or their habitat, but will not likely contribute to a trend towards federal listing or loss of populations viability. There may be short-term impacts from disturbance associated with herbicide application (ground/aerial) for all species. However, these actions would result in long-term beneficial impacts by improving forage, habitat, and prey species habitat or by reducing potential disturbance from fire.

In general, aerial application of herbicide is a concern because there is more potential for drift of herbicide into non-target areas when compared with ground-based equipment application techniques. There is also potential for drift onto wildlife species during implementation, particularly species that have low mobility such as small mammals, nesting birds or insects. In following herbicide label instructions, this concern should be somewhat minimized.

On the Bridger-Teton NF, aerial application would be limited to relatively large, heavily infested areas or remote, inaccessible sites. In most cases, the target invasive species is cheatgrass which has invaded large areas, particularly on big game winter range and south facing, open grassland and shrub slopes. Impacts to migratory birds and raptors and their habitat should be minimized by implementing the resource protection measures listed in Appendix A.

Alternative 3 – No Aerial Application of Herbicides

Region 4 Sensitive Species

The effects of Alternative 3 would be similar to Alternative 1 with an expanded list of herbicides and adaptive management techniques available for use. Without aerial application, the extent of treatment is reduced and invasive species like cheatgrass would continue to spread. An expanded list of herbicides available for use would allow the specialization of herbicides for treating invasive species but would not increase the extent of the area accessible for treatments. The determination for sensitive species under this alternative is *may impact individuals or their habitat, but will not likely contribute to a trend towards federal listing or loss of populations viability* for sensitive species found in the project area.

Habitat availability and quality will remain similar to as under current management, which includes a limited amount of treatment on large expanses of invasive species (e.g. cheatgrass). Over time this lack of treatment on large expanses could result in a reduction in quality and quantity of habitat available, particularly in sage habitats. If cheatgrass persists without intensive and expansive management treatment options like those available under the proposed action (Alternative 2) this reduction in quality and quantity of habitat is likely.

Cumulative Effects

Threatened & Endangered

The cumulative effects analysis for Canada lynx, yellow-billed cuckoo and North American wolverine only considered future activities that are reasonably certain to occur in the action area, the Bridger-Teton NF, or immediately adjacent to the Bridger-Teton NF. The cumulative effects are not expected to contribute to a change in status or viability for threatened and endangered wildlife species.

Canada Lynx & Critical Habitat

Timber management has the greatest potential to affect individual lynx and habitat but will likely be limited on the Bridger-Teton NF. Existing forest stands provide multi-story habitat for lynx and their prey. Timber management is expected to impact small, isolated pockets of this habitat type. However, the impact of these small, isolated pockets on the wide-ranging lynx habitat will have minimal impact. These timber management projects could result in direct loss of potential foraging and denning habitat in the treated acres. The surrounding area on private land has the highest potential to contribute to a reduction in lynx habitat, as they may not follow the Northern Rockies Lynx Amendment guidance or consult with USFWS. Reduction of lynx habitat may contribute to reduced fitness and reproductive success in individual lynx but is not expected to impact the species at the population level.

Fire can also alter lynx habitat. There appears to be a negative correlation between lynx use and the amount of area burned. This short-term effect is likely due to the removal of cover which reduces snowshoe hare populations and possibly increases competition from coyotes in open habitats (Ruediger et al. 2000).

Yellow-billed Cuckoo

Improper or over-grazing and browsing in riparian areas has the greatest potential to impact yellow-billed cuckoo and habitat. Degradation of the cottonwood riparian community may result in reduced habitat for yellow-billed cuckoo by modifying the structure and composition of riparian plant species. Proper forest management policies should avoid this occurrence particularly in designated or known yellow-billed cuckoo habitat should any be identified on the Bridger-Teton NF.

North American Wolverine

The primary threat to wolverine is a loss of habitat resulting from climate change and increasing temperatures. Protection of subalpine and alpine habitats from changes in vegetative structure will aid in protecting the wolverine's high alpine habitat from accelerated structural changes. A reduction in wolverine habitat and available prey may contribute to reduced fitness and reproductive success.

Sensitive Species

The temporal boundary for the effects analysis is 10 years into the past and 10 years into the future, which is an adequate length of time to record population changes. The spatial boundary is the Bridger-Teton NF. The following past, present and reasonably foreseeable future actions were considered in the cumulative effects analysis for sensitive species: livestock grazing, timber harvest and thinning, motorized and non-motorized recreational use, road and trail building and maintenance, fire suppression, prescribed fire, mining, road construction and urban development (sub-dividing and development of neighboring private land). The following table lists the actions and their potential effects on sensitive wildlife species.

Table 16. Past, present and reasonably foreseeable future actions considered in the cumulative effects analysis for T&E and sensitive wildlife species

Action	Potential Effects
Improper Livestock grazing	Alteration of habitat through trampling, compacting soils, changing plant composition, causing downcutting and degradation of streams and subsequent drying of adjacent meadows and introducing invasive species.
Timber harvest and thinning	Alteration of habitat through increasing the amount of light reaching the forest floor, disturbing and compacting soils and introducing invasive species. Timber harvest increases recreation effects and temporary disturbance by improving access for humans into forested habitats by both motorized and non-motorized means.
Disease	The mosquito-borne West Nile virus is a fatal neuroinvasive disease in wild birds that has expanded quickly across the U.S. since 1999 (Walker and Naugle 2011). It was first identified in greater sage-grouse range in 2002 (Kilpatrick et al. 2007). Greater sage-grouse show little resistance to this virus and, due to its transmission, options for controlling the spread of West Nile virus are limited (Naugle et al. 2004). Bighorn sheep on the Bridger-Teton NF are susceptible to cyclical outbreaks of respiratory disease introduced from domestic sheep. Managers are actively working to understand and manage these outbreaks.
Recreation use	Disturbance from recreation activities including temporary disturbance by motorized and nonmotorized recreation, changes to habitat including soil disturbance, compaction and erosion as well as introducing invasive species. Direct impacts include increases in noise and increased stress levels and energy expenditure.
Road and trail construction and maintenance	Alteration of habitat through soil disturbance and erosion, fragmenting and destroying habitat and introducing invasive species. Roads and trails increase recreation effects by improving access.
Wildfire suppression	Alteration of habitat through soil disturbance, compaction, erosion and introducing invasive species.
Prescribed fire	Alteration of habitat by opening up meadows and /or reducing the litter accumulation and plant competition. Could also burn habitat, sterilize the soil and eliminate fungal species that lead to an alteration in plant species present.
Mining	Alteration of habitat through destruction and the introduction of invasive species.
Urban development	Destroys neighboring habitat, fragments populations and increases the risk of weed invasion and fire.

The cumulative effects listed above are not expected to contribute to a change in status or viability for sensitive wildlife species. All of the activities in the table above have the potential to introduce invasive species which can alter habitats as discussed earlier. However, when combined with the use of herbicide treatments of invasive species, cumulative effects would be limited. While there is potential for damage from the herbicides, the protection measures in Appendix A would reduce the risk of damage to sensitive wildlife species and their habitats.

Other potential effects (e.g. soil compaction, habitat destruction, habitat fragmentation) from projects with discrete ground-disturbing actions (e.g., timber harvest, road construction) may be mitigated by including forest plan direction for sensitive wildlife species in project design. Alternatives 1, 2 and 3 could help decrease any potential adverse effects by reducing existing invasive species infestations and controlling new ones. Protection measures in Appendix A would add to the protection from forest plan standards and guidelines. This would help offset the potential adverse effects from herbicide use.

Determination of Effects

A summary of the determination of effects for threatened, endangered and sensitive species is included in the table below. An explanation of the acronyms follows the table. The species in the shaded rows below were excluded from further analysis.

Table 17. TE&S species determination of effects for all alternatives and rationale for determination by alternative.

Species	Alternative 1 Determination	Alternative 2 Determination	Alternative 3 Determination
Threatened			
Canada lynx & critical habitat	NE	NE	NE
Yellow-billed cuckoo	NE	NE	NE
Proposed			
North American wolverine	NI	NI	NI
Sensitive			
Bighorn sheep	MIIH	MIIH	MIIH
Peregrine falcon	MIIH	MIIH	MIIH
Townsend's big-eared bat	MIIH	MIIH	MIIH
Bald eagle	MIIH	MIIH	MIIH
Greater sage-grouse	MIIH	MIIH	MIIH
Migratory birds	MIIH	MIIH	MIIH
Spotted bat	NI	NI	NI
Boreal toad	NI	NI	NI
Trumpeter swan	NI	NI	NI
Common loon	NI	NI	NI
Harlequin duck	NI	NI	NI
Columbia spotted frog	NI	NI	NI
Northern goshawk	NI	NI	NI
Boreal owl	NI	NI	NI
Fisher	NI	NI	NI
Three-toed woodpecker	NI	NI	NI
Flammulated owl	NI	NI	NI
Great gray owl	NI	NI	NI

Determination Codes
Federally Listed Species
NE - No Effect
NLAA - May Affect, Not Likely to Adversely Affect
LAA - May Affect, Likely to Adversely Affect

Forest Service Sensitive Species
NI - No Impact
MIIH - May Impact Individuals or their Habitat, but Will Not Likely Contribute To A Trend Towards Federal Listing or Loss of Population Viability
WIFV - Will Impact Individuals or Their Habitat That May Contribute To A Trend Towards Federal Listing or Cause A Loss of Population Viability
BI - Beneficial Impact

Forest Plan Consistency

Relevant standards and guidelines for the Bridger-Teton NF forest plan were reviewed. The effects of the three alternatives and the protection measures in Appendix A were evaluated to determine if they were consistent with the forest plan's direction. The alternatives will meet the standards and guidelines when the resource protection measures in Appendix A are applied.

Issue #3 Soil, Water and Aquatic Resources, Including Fisheries

Respondents expressed concern about effects of herbicides used for invasive plant and noxious weed control on aquatic organisms (fisheries, insects and amphibians) and water quality. Some respondents expressed concern about herbicide drifting from treatment areas into riparian areas, streams and other lands with unintended consequences.

Indicators for Issue #3 include impacts that exceed regulatory compliance thresholds and potential impact of herbicides to non-target resources.

Affected Environment

The central operational assumption informing this analysis is: herbicides that have been approved and registered by the Environmental Protection Agency to kill invasive, non-native plants are not expected to cause unreasonable adverse effects when used in accordance with the herbicide-label directions. Herbicide fact sheets and ecological risk assessments were used to complete this analysis and evaluate toxicity of herbicides on soil, water and aquatic resources, including fisheries.

Soil

There are hundreds of different soil types identified between the 4 soil survey areas within the Bridger-Teton NF. Due to this variability the soil section is broken up into dominant geologic parent materials of the Ranger Districts in the Bridger-Teton NF. The main soil characteristic used by the State of Wyoming to describe soil sensitivity to groundwater contamination by herbicides is saturated hydraulic conductivity. Soil saturated hydraulic conductivity is a quantitative measure of a saturated soil's ability to transmit water when subjected to a hydraulic gradient (Soil Survey Technical Note 6). Saturated hydraulic conductivity is measured in distance per time, usually millimeters per hour or inches per hour. Saturated hydraulic conductivity is dependent on the soil texture (percent sand, silt and clay particles), porosity of the soils, organic matter content and bulk density (Soil Survey Technical Note 6). The following soils information was obtained from Web Soil Survey for the following soil survey areas: ID758 – Targhee National Forest, Idaho and Wyoming. WY662 – Bridger National Forest, Wyoming, Eastern Part. WY663 Bridger National Forest, Wyoming, Western Part. Soils information was also obtained from the publication WY661 – Classification and Correlation of the Soils of the Teton National Forest, Wyoming. Printed by Soil Conservation Service, United States Department of Agriculture (7/11/1985).

Big Piney Ranger District

The Big Piney Ranger District is dominated by 3 different geologic parent materials along with areas of stream/river alluvium. The largest is sedimentary rock comprised of sandstones, shales, claystone, mudstones and limestones. The second largest is deposits of uniform conglomerate parent material. The third is glacial drift and small pockets of igneous granite.

The sedimentary parent material resides throughout the interior of the Wyoming Range including the foothills, mountains and alpine areas. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones, claystone and limestones. These soils are very variable due to a mixture of parent materials. These soils have pH's that range from moderately acid to strongly alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 1.8 mm/hour to 18 mm/hour (0.07 inches/hour to 0.7 inches/hour) (WY661, WY663).

The conglomerate parent material resides mostly on the north-east corner of the Big Piney Ranger District on Raspberry Ridge, East Rim, South Rim and Beaver Creeks. The conglomerate parent material is dominated by the Pass Creek Formation and the Lookout Mountain member of the Wasatch Formation. Both are mixed conglomerates and create uniform soils. The soils have pH ranges from moderately acid to slightly alkaline, poor nutrient concentrations and naturally low organic matter content. The sandy textured soils in the conglomerate have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textures soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY661, WY663).

The glacial drift and pockets of igneous granite parent material resides mostly in the base of the interior Wyoming Mountain Range along Cottonwood, Gibbs, Fish and Shoal Creeks. Glacial drift and igneous granite parent material consist of broken up soil particles and rock fragments deposited by glacial activity and in the Wyoming Range include large landslide deposits. These soils have pH's that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the glacial drift and igneous granite have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textures soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY661, WY663).

Stream and river alluvium soils are formed from mixed sources. Soils have pH's from strongly acid to strongly alkaline, poor to rich nutrient concentrations and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey texture alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (WY661, WY663).

Buffalo Ranger District

The Buffalo Ranger District is dominated by three different geologic parent materials along with areas of stream/river alluvium. The largest of the three parent materials is mixed clastic/volcanic. The second largest is sedimentary comprised of sandstones, shales, mudstones, conglomerates and limestones. The third parent material is landslides and glacial drift.

The mixed clastic/volcanic parent material resides mostly on the eastern half of the Absaroka Mountain Range including foothills, mountains and alpine areas. These soils have pH's that range from moderately acid to slightly alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the mixed clastic/volcanic have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour) (WY661).

The sedimentary parent material resides throughout the western edge of the Absaroka Range including the foothills, mountains and alpine areas. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones, conglomerates and limestones. These soils are very variable due to a mixture of parent materials. These soils have pH's that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY661).

The glacial drift and landslide parent material resides mostly in the interior pockets of the Absaroka Range. Glacial drift parent material consists of broken up soil particles and rock fragments deposited by glacial activity and in the Absaroka Range include large landslide deposits. These soils have pH's that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the glacial drift and landslide have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY661).

Stream and river alluvium soils are formed from mixed sources. Soils have pH’s from strongly acid to strongly alkaline, poor to rich nutrient concentrations, and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey texture alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (WY661).

Greys River Ranger District

The Greys River Ranger District is dominated by two different geologic parent materials along with areas of stream/river alluvium. The largest of the two parent materials is sedimentary comprised of sandstones, shales, mudstones and mixed clastic bedrocks. The second largest is limestone.

The sedimentary parent material resides throughout the interior of the Salt River Range including the foothills, mountains and alpine areas. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones and mixed clastic bedrocks. These soils are very variable due to a mixture of parent materials. These soils have pH’s that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured range from 1.8 mm/hour to 18 mm/hour (0.07 inches/hour to 0.7 inches/hour) (ID758, WY661, WY663).

The limestone parent material resides along the western boundary foothills of the Salt River Range, interior on Prader and Haystack Peaks and along Sheep Creek on the eastern boundary. The limestone parent material consists of soils weathered from limestone, dolomite and dolostone of different geologic formations. These soils have pH’s that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the limestone have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour) (ID758, WY661, WY663).

Stream and river alluvium soils are formed from mixed sources. Soils have pH’s from strongly acid to strongly alkaline, poor to rich nutrient concentrations, and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey texture alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (ID758, WY661, WY663).

Jackson Ranger District

The Jackson Ranger District is dominated by three different geologic parent materials along with areas of stream/river alluvium. The largest of the three parent materials is sedimentary comprised of sandstones, shales, mudstones and mixed clastic bedrocks. The second largest is limestone. The third parent material is landslides and glacial drift.

The sedimentary parent material resides throughout the interior of the Gros Ventre Range including the foothills, mountains and alpine areas. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones and mixed clastic bedrocks. These soils are very variable due to a mixture of parent materials. These soils have pH’s that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 1.8 mm/hour to 18 mm/hour (0.07 inches/hour to 0.7 inches/hour) (ID758, WY661).

The limestone parent material resides along the interior of the Gros Ventre Range mostly east of Jackson. The limestone parent material consists of soils weathered from limestone, dolomite and dolostone of different geologic formations. These soils have pH's that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the limestone have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour) (ID758, WY661).

The glacial drift and landslide parent material resides mostly in the interior pockets of the Gros Ventre Range. Glacial drift parent material consists of broken up soil particles and rock fragments deposited by glacial activity and in the Gros Ventre Range include large landslide deposits. These soils have pH's that range from moderately acid to moderately alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the glacial drift and landslide have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (ID758, WY661).

Stream and river alluvium soils are formed from mixed sources. Soils have pH's from strongly acid to strongly alkaline, poor to rich nutrient concentrations and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey textured alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (ID758, WY661).

Kemmerer Ranger District

The Kemmerer Ranger District is dominated by sedimentary parent material comprised of sandstones, shales, mudstones and limestones. These also include some mixed clastic materials, small landslide deposits associated with glacial drift and areas of stream/river alluvium.

The sedimentary parent material resides throughout the southern tip of the Wyoming Range including the foothills, mountains and alpine areas. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones and limestones. These soils are very variable due to a mixture of parent materials. These soils have pH's that range from moderately acid to strongly alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY663).

Stream and river alluvium soils are formed from mixed sources. Soils have pH's from strongly acid to strongly alkaline, poor to rich nutrient concentrations and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey textured alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (WY663).

Pinedale Ranger District

The Pinedale Ranger District is dominated by three different geologic parent materials along with areas of stream/river alluvium. The largest of the three parent materials is igneous dominated by granite along with some similar metamorphic gneiss. The second largest is glacial drift and glacial till. The third parent material is sedimentary comprised of sandstones, shales, claystone, mudstones and conglomerates.

The igneous parent material is mostly comprised of granite and resides along the interior foothills and mountains of the Wind River Range. Soils formed from dominantly granitic parent materials are inherently sandy to coarse sandy in texture, have moderately to slightly acidic pH's and have low nutrient concentrations. Organic matter content is also naturally low, but soils do accumulate leaf litter and other vegetative organic matter in the upper surface horizons. The saturated hydraulic conductivity for granitic soils ranges from 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour) (WY661, WY662).

The glacial drift and glacial till parent material resides mostly in the foothills of the Wind River Range, along the edges and interiors of the glacial lake valleys (Fremont, Willow, New Fork, Green River etc.) and in some interior valleys and alpine lakes (Raid Lake, Big Sandy Opening, Chicken Creek, Sweetwater Opening). Glacial drift and glacial till parent material consist of broken up soil particles and rock fragments deposited by glacial activity. Due to the surrounding granite parent material these soils also have moderately to slightly acidic pH's, low nutrient concentrations and naturally low organic matter content. The soils formed in glacial drift and till have sandy to loamy textures. The saturated hydraulic conductivity for glacial till and glacial drift soils ranges from 18 mm/hour to 180 mm/hour (0.8 inches/hour to 7 inches/hour) (WY661, WY662).

The sedimentary parent material resides in the Gros Ventre Range of the Bridger-Teton NF Pinedale Ranger District, the west side of the Upper Green River Valley and both Moose and Gypsum mountains. The sedimentary parent material consists of soils weathered from sandstones, shales, siltstones, mudstones, claystone, limestones and conglomerates. These soils are the most variable with pH's from moderately acid to strongly alkaline, poor to rich nutrient concentrations and naturally low organic matter content. The sandy textured soils in the sedimentary have a saturated hydraulic conductivity range of 50 mm/hour to 180 mm/hour (2 inches/hour to 7 inches/hour). The loamy textured soils range from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). The clayey textured soils range from 5 mm/hour to 18 mm/hour (0.2 inches/hour to 0.7 inches/hour) (WY661, WY662).

Stream and river alluvium soils are formed from mixed sources. Soils have pH's from strongly acid to strongly alkaline, poor to rich nutrient concentrations and low to high organic matter content. The saturated hydraulic conductivity for sandy textured alluvium range from 50 mm/hour to 540 mm/hour (2 inches/hour to 21 inches/hour). Loamy textured alluvium ranges from 18 mm/hour to 50 mm/hour (0.8 inches/hour to 2 inches/hour). Clayey textured alluvium ranges from 1.8 mm/hour to 18 mm/hour (.07 inches/hour to 0.7 inches/hour) (WY661, WY662).

Water Quality

Source waters such as rivers, streams, wells and intakes are vital sources of domestic and municipal water supplies in Wyoming. NFS lands comprise more than seventy percent of the delineated, source water areas in Wyoming. The surface-water quality in rivers, streams, lakes, ponds and reservoirs located within the Bridger-Teton NF are typically in compliance with federal and state water-quality standards. Groundwater sensitivities in the project area have not been assessed and mapped.

Water-quality conditions in streams, lakes and reservoirs located in the Teton, Gros Ventre and Bridger wildernesses are classified as outstanding waters by the State of Wyoming (Wyoming Department of Public Health and the Environment 2012). Streams outside the wilderness areas appear to exhibit water-quality conditions that comply with state and federal standards. None of the streams located in the Bridger-Teton NF have been listed by the Wyoming Department of Public Health and the Environment as impaired due to pesticide contamination.

The Sublette County Conservation District (SCCD) has eleven surface water monitoring sites on the Bridger-Teton NF. Water quality has been measured at these sites which includes nutrients, metals, general parameters such as alkalinity and field parameters including conductivity. Macroinvertebrates have also been sampled yearly at each of the eleven sites.

Wyoming Department of Environmental Quality (WDEQ) Surface Water Standard are used to check the data collected by the SCCD to determine whether the data is meeting the standards. Occasionally an exceedance of pH, temperature or dissolved oxygen has occurred. However no continuous pattern has been observed in the above mentioned parameters.

Based on the water-quality sampling that has been conducted through 2017 in Sublette County, water quality conditions on the Bridger-Teton NF appear to be typical to outstanding. None of the forest streams have been listed by the State as impaired due to pesticide contamination.

The State of Wyoming has implemented protocols to monitor groundwater contamination by agricultural chemicals, including herbicides; however, these protocols do not include NFS lands because they are considered to be low priority for monitoring.

Aquatic organisms and amphibians

Native and non-native fish known or suspected to occur in the Bridger-Teton NF have adapted to a variety of subalpine, montane and grassland aquatic, riparian ecosystems. The 2016 Regional Forester's R4 Sensitive Species list provides a comprehensive list of the federally listed species and R4 sensitive aquatic species suspected to occur in the project area. These species are listed in the following table and described below.

Table 18. Aquatic organisms and amphibians in the project area and their status

Common Name	Scientific Name	Present		Status	Comments	Carried Forward
		Species	Habitat			
FISH						
Kendall Warm Springs Dace	*Rhinichthys osculus*	Yes	Yes	Endangered	The only known distribution of Kendall Warm Springs Dace is in Kendall Warm Springs, which is located within the project area.	Yes
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisi*	No	No	Sensitive	The Westslope Cutthroat Trout is native to northwest Wyoming and does not occur within the project area.	No
Colorado River Cutthroat Trout	*Oncorhynchus clarki pleuriticus*	Yes	Yes	Sensitive	The Colorado River Cutthroat Trout is native to Wyoming in the Green River and found in the project area.	Yes
Bonneville Cutthroat Trout	*Oncorhynchus clarki utah*	Yes	Yes	Sensitive	The Bonneville Cutthroat Trout is native to Wyoming in the Bear River system and found in the project area.	Yes
Yellowstone Cutthroat Trout	*Oncorhynchus clarki bouvieri*	Yes	Yes	Sensitive	The Yellowstone Cutthroat Trout is native to the Yellowstone and Snake River systems and found in the project area.	Yes
Northern Leatherside	*Lepidomeda copei*	Yes	Yes	Sensitive	The Northern Leatherside is native to Wyoming, inhabiting streams in the Bear and Upper Snake systems and a few sites in the Upper Green. This species is found in the project area.	Yes

Table 18 continued. Aquatic organisms and amphibians in the project area and their status

Common Name	Scientific Name	Present		Status	Comments	Carried Forward
		Species	Habitat			
COLORADO RIVER SPECIES						
Bonytail Chub	*Gila elegans*	No	No	Endangered	This species does not occur within the project area and no new water depletion is expected under any alternative.	Yes
Humpback Chub	*Gila cypha*	No	No	Endangered	This species does not occur within the project area and no new water depletion is expected under any alternative.	Yes
Colorado Pikeminnow	*Ptychocheilus lucius*	No	No	Endangered	This species does not occur within the project area and no new water depletion is expected under any alternative.	Yes
Razorback Sucker	*Xyrauchen texanus*	No	No	Endangered	This species does not occur within the project area and no new water depletion is expected under any alternative.	Yes
PLATTE RIVER SPECIES						
Pallid Sturgeon	*Scaphirhynchus albus*	No	No	Endangered	This species does not occur within the project area and no new water depletion is expected under any alternative.	Yes
AMPHIBIANS						
Columbia Spotted Frog	*Rana luteiventris*	Yes	Yes	Sensitive	Habitat primarily includes oxbow ponds (without fish) and wetlands with emergent sedges located in wet meadows at the edge of lodgepole pine forests, present in the project area.	Yes
Boreal Toad	*Anaxyrus boreas boreas*	Yes	Yes	Sensitive	Boreal toads occupy montane forest habitats between 6,500’ and 12,000’ elevation and require breeding ponds, summer range and winter refugia, present within the project area.	Yes

Sensitive Species

A Sensitive Species is defined as those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by 1) Significant current or predicted downward trends in population numbers or density or 2) Significant current or predicted downward trends in habitat capability that would reduce a species existing distribution (FSM 2670.5). The Forest Service objective for Sensitive Species management is to "develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions" (FSM 2670.22).

Threatened and Endangered Species

Under provisions of the Endangered Species Act, Federal agencies are directed to seek to conserve Endangered and Threatened species and to ensure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of any Threatened or Endangered species, or result in the destruction or adverse modification of their Critical Habitat.

<u>Kendall Warm Springs Dace:</u>

Kendall Warm Springs dace (*Rhinichthys osculus thermalis)* were listed as endangered in 1970. The only known location of the species is within Kendall Warm Springs, located approximately 32 miles north of Pinedale, Wyoming. In 1999 the Forest Service decided that Kendall Warms Springs would be protected moving forward, with the designation of a 160 acre Special Interest Area (USFS 1999). Within this small watershed, Kendall Warm Springs forms a tributary to the Green River, which is isolated from the river by a 15 foot waterfall. The entire population resides in a 328 yard reach of the springs. The springs maintain a constant flow of approximately 8 cubic feet per second and a constant temperature of 85 ºF. The temperature of the stream channel fluctuates seasonally with winter temperatures cooler downstream and near the channel margins (USFWS 2010).

The Kendall Warm Springs dace use various habitats within the channel. Adult dace primarily occupy pools and the main channel, while juvenile dace are found mostly in slower channel margins. The dace are believed to spawn through the year. Aquatic vegetation provides important hiding cover for the dace (USFWS 1982). Small pools created by large ungulates are believed to provide valuable habitat for the dace, particularly juveniles (USFWS 2010). The Forest Service has monitored Kendall Warm Springs Dace with a Catch-Per-Unit-Effort protocol (Gryzka 1996). Surveys conducted biennially from 1997 to 2017, indicate that there was a sharp decline in the relative abundance of the species in the mid-2000s and has constantly declined since (report to the USFWS 2018).

<u>Cutthroat Trout Species</u>

All cutthroat trout species present on the Bridger-Teton NF are R4 Regional Forester's Sensitive Species (USFS 2016). Cutthroat trout require relatively cool, well-oxygenated water and the presence of clean, well sorted gravel with minimal fine sediment for successful spawning. They generally spawn in clear, cold, shallow riffles of small streams soon after ice is off in the spring. The initiation of spawning is influenced by water temperature, increased water discharge from runoff, elevation and latitude. The distance cutthroat trout travel to spawn is generally short and eggs hatch within one to two months depending on water temperature. Optimal stream habitat is characterized by clear, cold, relatively silt-free water with rocky substrate, which is often impacted by land management activities. Beyond habitat degradation such as erosion, siltation, de-watering and livestock grazing impacts, cutthroat trout on the Bridger-Teton NF are threatened by invading, non-native salmonids. The best monitoring information available for cutthroat trout in western Wyoming indicates that populations that are being invaded by competing salmonids, particularly brook trout and are experiencing population declines.

<u>Colorado River Cutthroat Trout</u> (*Oncorhynchus clarki pleuriticus)* occupy 13% of their historic range, in the Upper Colorado River Basin (Hirsch *et al.* 2013). They were petitioned in 1996 and again in 2006 to be protected under the Endangered Species Act of 1973. In both cases, the US Fish and

Wildlife Service determined that listing Colorado River Cutthroat Trout was not warranted. Current distribution on the Bridger-Teton NF occurs primarily in the headwaters of the Green River with several conservation populations along the western slope of the Wyoming Range. Colorado River Cutthroat Trout occupy approximately 217 miles of stream habitat on the Bridger-Teton NF.

Yellowstone Cutthroat Trout (*Oncorhynchus clarki bouvieri)* are widely distributed within their historic range in the states of Utah, Nevada, Idaho, Montana and Wyoming (May *et al*. 2003). They have been petitioned in the past to be protected under the Endangered Species Act of 1973. In 2001, the US Fish and Wildlife Service determined that listing Yellowstone Cutthroat Trout was not warranted. On the Bridger-Teton NF, Yellowstone Cutthroat Trout are found throughout their original range in the upper Snake River above Palisades Dam (Van Kirk and Benjamin 2001). There are approximately 1,537 miles of river and streams and 3,116 acres of lake on the Bridger-Teton NF that support Yellowstone Cutthroat Trout. These populations contain both historical and currently occupied habitat and encompass the headwaters of the Snake River, Gros Ventre, Greys-Hoback and Salt River watersheds.

Bonneville Cutthroat Trout (*Oncorhynchus clarki utah)* are native to the Bear River watershed. Thought extinct until the late 20th century, they are present in only 35% of their historic range (May and Albeke 2005). On the Bridger-Teton NF, the Smith's Fork and Salt Creek drainages are inhabited by several resident conservation populations, as well as a fluvial life history population that runs from the Bear River to the Bridger-Teton in the spring (May and Albeke 2005). Bonneville Cutthroat Trout occupy approximately 98 miles of river and streams and 450 acres of Lake Alice on the Bridger-Teton NF.

Colorado River Species

All four endangered Colorado River species, Colorado Pikeminnow (*Ptychocheilus Lucius),* Humpback Chub (*Gila cypha)*, Bonytail Chub (*Gila elegans)* and Razorback Sucker *(Xyrauchen texanus)*, are restricted to the Upper Colorado River system. This includes the Green River below Flaming Gorge Reservoir, where distribution and abundance are far below historic levels due to the effects of dams and introduced fish species. Although these four species do not occur within the Bridger-Teton NF boundary, any water depletion from the Colorado River Basin is considered to jeopardize the continued existence or adversely modify the critical habitat of these four Colorado River endangered fish species (50 CFR 17.95 (e)).

Platte River Species

The Pallid Sturgeon (*Scaphirhynchus albus)* is the only aquatic species of the protected Platte River Species. The Pallid Sturgeon experienced a dramatic decline throughout its range since the mid to late 1960s and was listed as endangered in 1990. Pallid Sturgeon inhabit the Missouri River, hundreds of miles downstream of the project area (USFWS 2018). The USFWS includes Platte River species on the list for the Bridger-Teton depending on whether the proposed action may lead to consumptive use of water or have the potential to affect water quality in the Platte River system.

Northern Leatherside **(***Lepidomeda copei)* is a R4 Regional Forester's Sensitive Species and were petitioned to be protected under the Endangered Species Act of 1973. In 2011, the US Fish and Wildlife Service determined that listing was not warranted (76 FR 63444). Although Northern Leatherside distributions are reduced and isolated across their historic range (Blakney *et al.* 2014), the populations in Wyoming appear to be relatively intact, with no apparent extirpations from confirmed historic habitat in the state (Schultz *et al.* 2016). Native populations in western Wyoming include those in the Bear and Snake River basins as well as two small populations, West Fork Hams and Slate Creek, confirmed in the Upper Green Basin (Blakney *et al*. 2014). This small, mid-elevation fish (UDNR 2009) is expected to occupy the lowest elevation tributaries on the Bridger-Teton NF. Research shows that in its current range, abundance was most closely tied to increased elevation, but the Bridger-Teton NF was generally above the most upstream occupied habitat. Additionally, those reaches with higher depth variability had increased abundance (Schultz *et al*. 2016), but the species prefers still pools with silted bottoms for spawning (NatureServe 2017). Threats include water diversion (isolation), habitat degradation as a result of land management practices, hybridization and non-native fish predators (UDNR 2009)

Amphibians

The Bridger-Teton NF supports two species of amphibians from the R4 Forester's Sensitive species list (USFS 2016), the Boreal Toad (*Anaxyrus boreas boreas)* and Columbia Spotted Frog (*Rana luteiventris)*. Amphibian habitats are typically wetlands and riparian areas that have non-flowing surface water and vegetative cover. Because the embryonic and tadpole/larval forms of these amphibians are aquatic obligates, wetlands must have standing water during the breeding season. For embryonic development to proceed to metamorphosis, breeding-site waters must not become anoxic. Suitable habitat types include wetlands such as lakes, small pools and wet meadows with little visible open water which are often seasonal. After the breeding season, wetland habitats occupied by amphibians become drier, including those with no surface water but with saturated soils. Their preference for water does not inhibit their use of drier habitat types and adult amphibians will travel long distances through uplands. As an example, adult male Columbia Spotted Frogs will travel over a mile (Pilliod *et al*. 2002) and female Boreal Toads have been recorded traveling nearly two and a half miles (Muths 2003, Bartelt *et al*. 2004, Pierce 2006, Goates *et al*. 2007).

Below is a brief background on the two amphibian species listed above. Additional information can be found in the Upper Green River Area Rangeland Project Final Environmental Impact Statement (USFS 2018). Additionally, a collaborative data collection effort between Wyoming Natural Diversity Database, the Wyoming Game and Fish Department and Forest Service has completed its fourth year and will hopefully shed light on updated amphibian population trends across the Bridger-Teton.

Boreal Toads occur from northern New Mexico to Alaska, including the Rocky Mountains and west to the Pacific Coast. Boreal Toads were formerly widespread and common, but have declined dramatically in the last three decades, likely related to chytrid fungus infections (*Batrachochytrium dendrobatidis)* (Carey 1993, Corn 1994, U.S. Fish and Wildlife Service 2012b). In Wyoming, their range is restricted to wet locations in mountains, foothills and subalpine habitats (Baxter and Stone 1985), ranging in elevation from about 6,500 to 12,000 feet (Wyoming Game and Fish Department 2005). They will also travel significant distances across upland habitats (Muths 2003, Bartelt *et al.* 2004, Pierce 2006, Goates *et al*. 2007). Boreal toads have been found to seek drier sites to rid themselves of the chytrid fungus, before returning to wetter habitats, however their probability of occurrence is inversely proportional to the distance from water (Barrile *et al* 2018). The species was petitioned for listing in 1995 and it was warranted but precluded and given candidate status. Then, in 2012 a petition to list the Southern Rocky Mountain population as a distinct population segment was not warranted. A compilation of data from before the turn of the century concluded that Boreal Toads were rare on the Bridger-Teton NF and that this species' status warranted local concern (Patla 2000). Currently, Boreal Toads are dispersed in small numbers across the entire Bridger-Teton NF, with highest concentrations on the Wyoming Range's eastern front and in the Upper Green River valley. Breeding centers for Boreal Toads on the Bridger-Teton are currently limited to the Hams Fork watershed, the Wyoming Range and a few other dispersed locations.

Columbia Spotted Frog's range extends from southern Alaska through the Pacific Northwest and Rocky Mountains (Patla and Keinath 2005), with the Bridger-Teton NF near the south-eastern extent of the species continental distribution (Patla 2000). Columbia Spotted Frogs are distributed across the Bridger-Teton NF, but have been historically absent from the Wind River Range and the southern portion of the Wyoming Range. A Species of Conservation Concern for Wyoming Game and Fish and a Sensitive Species on the Region 4 Regional Forester List, Columbia spotted frogs are considered "rare" in Wyoming (Wyoming Game and Fish Department 2010). Klaver *et al*. (2013) estimated regional occupancy at 35 percent of historic range, based on 235 wetland sites on federal lands in western Wyoming. Although the Wyoming Game and Fish Department indicated that declining populations and/or habitat losses are not suspected (Wyoming Game and Fish Department 2010), some regional studies have shown occupancy decreases (Hossack *et al*. 2015).

Environmental Effects

This analysis assumes the proper use of existing herbicides to treat invasive plants as directed by the product label and on the strict implementation of all the identified resource-protection measures pertinent to aquatic and amphibian biota, soils and water quality found in Appendix A.

Effects from Biological, Mechanical and Cultural Treatments Common to All Alternatives

The non-herbicide treatments proposed under all alternatives would be applied in such a manner that they would have negligible effects on soils, water resources and aquatic organisms. Release of biological control agents would have no direct effect on fisheries or surface water quality. These agents would not compete with aquatic insect species since their food base is very specific, nor would they provide more than an incidental food source for fish.

Mechanical treatments including but not limited to grazing, burning, tilling and mowing, could result in localized soil disturbance and potentially an increase in erosion and sedimentation into waterbodies. However, the risk of these impacts is minimal assuming the concurrent application of BMPs. Effects associated with increased erosion and sedimentation include alteration of channel morphology and functionality as well as decreased water quality and degraded riparian and aquatic habitats. Water quality constituents that could be impacted by mechanical treatments include but are not limited to suspended solids, dissolved solids, temperature and salinity. Mechanical treatment application areas would be selected so that the extent of soil disturbance associated with the treatment type is considered and appropriate for the localized landscape. For example, small-scale tilling would only be used in conjunction with riparian buffers. Mechanical treatments would be avoided in areas prone to erosion and sedimentation, i.e. steep slopes and riparian areas. Where necessary, areas of ground disturbance would be reseeded with a desirable species mix to expedite the establishment of soil stabilizing vegetation.

Impacts to surface water resources as a result of applying grazing to control invasive species would vary depending on the duration of application, the proximity to riparian areas and the species of animal grazed. Livestock typically used for treatment include cattle, sheep and goats. Cattle tend to concentrate and spend more time in riparian areas than sheep or goats which typically degrade riparian conditions more quickly. Removal of riparian vegetation, trampling/hoof action and increased fecal matter are the primary ways that grazing impacts riparian areas. Removal of riparian vegetation in conjunction with trampling and hoof action, if not managed properly, can lead to a concatenation of negative impacts including channel widening, incision and a drop in the localized water table, all of which inhibit proper riparian function.

Invasive species treatment utilizing prescribed burning has the potential to increase sediment in waterbodies. Prescribed burning removes vegetation that stabilizes soil which increases the risk of erosion on the burned area. Increases in sediment loading as a result of prescribed burning is dependent on the surface area of the prescribed burn, burn severity, topography and the distance between the burned area and a waterbody

Cultural treatments (seeding, transplanting and fertilizing) have a negligible risk of impacting water resources and aquatic habitat given their localized application nature. Fertilizers would not be applied in areas where storm water runoff would flow into waterbodies, risking an increase in nutrient loading to surface water. All Forest Service and manufacturer application guidelines would be adhered to. Seeding and transplanting would involve limited soil disturbance and would pose similar risks to water resources to mechanical treatments.

Lack of effective invasive species treatment would likely result in invasive plants, particularly cheatgrass, displacing native plant communities. Aquatic and soil ecosystems and water quality could then be negatively impacted indirectly if the expansion of cheatgrass increases the incidence of wildfire. An increase in wildfires could result in an increase in stream sedimentation as well as an increase in ash input. Runoff and sedimentation could also increase because invasive species generally provide less effective ground cover. Increased sedimentation could affect all aquatic species discussed in this analysis as water quality degradation often results in mortality to aquatic biota.

Effects from Herbicide Treatments under All Alternatives

The potential for effects to water quality and aquatic organisms is largely associated with herbicide application on and around streams, lakes or wetlands. Contamination can occur through direct herbicide contact with surface water from either inadvertent application or accidental spill. Risks vary with the persistence of active ingredients, soil and vegetation characteristics and condition and the intensity and timing of precipitation events following herbicide application.

Leaching through the soil profile is also a routing mechanism by which herbicides can come in contact with both surface water and groundwater. Risk to aquatic environments from leaching is minimized through proper application procedures.

Most groundwater contamination by herbicides results from point sources such as spills and leaks at storage and handling facilities, improperly discarded containers, or rinsing equipment at inappropriate locations. Point sources are generally localized, identifiable locations that discharge relatively high concentrations of herbicides. Point sources of contamination are avoided by implementing BMPs and proper handling of herbicide containers and application equipment.

The potential effects to fish and amphibians, relate primarily to water quality, sedimentation, loss of forage and direct or indirect contact with herbicides or surfactants. Effects of the proposed herbicides on aquatic plants and animals are reported in lengthy detail in the Environmental Risk Assessments, summarized below in Table 19. It is worth noting that in many cases, there are not requirements for the analysis to include amphibian toxicity studies. Research shows that fish are a sufficient surrogate for the aquatic life stages of amphibians and additional research on amphibians is not necessary for herbicide risk assessments (Weltje *et al*. 2013). There is the potential for direct physical contact (trampling, crushing) between individuals and applicators, as well as the potential for direct application, ingestion or indirect contact with residual herbicide. Finally, there is a potential for a loss of aquatic vegetation, macroinvertebrates, or allochthonous material resulting in a change in the available aquatic forage. All of these concerns are unlikely to cause measureable effects to aquatic and semi-aquatic species, either as a result of their negligible nature, or the protection measures put in place (Appendix A).

Protection measures in Appendix A are designed to reduce the potential for water contamination. Appendix A discusses how specific herbicides would be used (or not used) near surface waters. The protection measures take into account the specific properties of each herbicide and are intended to minimize contamination of water resources.

Municipal water sources are protected from herbicide contamination under these alternatives by the multiple resource protection measures. These include the requirement for an herbicide emergency spill plan which would address measures to be taken if an accidental spill should occur.

Alternative 1 – No Action

The effects discussed in the preceding section apply to this alternative. Because aircraft would not be used for herbicide application, this alternative would have less risk of a catastrophic herbicide spill which could contaminate water.

This alternative has the potential for adverse soil and water impacts because of reduced ability to effectively treat invasive species, cheatgrass in particular. Invasive species are generally less effective groundcover than native plants. Less effective ground cover increases the potential for surface erosion and reduces the amount of moisture in the soil due to an increase in exposed soil surface (Olson 1999). A monoculture of cheatgrass can also increase the incidence of wildfire and subsequent erosion and sedimentation. If the increase in invasive species affects water quality (e.g. increased surface erosion and sedimentation), aquatic organisms could be affected as water quality degradation often results in mortality to aquatic biota.

Effects of the following herbicides are discussed under Alternative 2: 2,4-D, aminocyclopyrachlor, aminopyralid, chlorsulfuron, clopyralid, glyphosate (aquatic and terrestrial), imazapic, imazapyr, indaziflam, metsulfuron methyl, picloram and rimsulfuron. Those effects also apply under Alternative 1.

<u>Effects determination for federally listed and R4 sensitive species</u>

The determination for Federally Listed Species is *No Effect* and for Sensitive Species is *May impact individuals but is not likely to cause a trend to federal listing or loss of viability*. Please see Table 20 below for detailed species determinations.

Endangered species determinations are based on the following:

- Resource protection measures mitigate all action-related foreseeable risks.

Sensitive species determinations are based on the following:

- The probability of the resource protection measures being effective in protecting occurrences of these species is very high.
- The possibility of individuals being inadvertently impacted during treatment is slight but does exist.
- There is a risk of increased weed infestation resulting from less effective weed control which could have indirect impacts by degrading species habitat.

Alternative 2 - Proposed Action

The effects of biological, mechanical, cultural and ground-based herbicide treatments (discussed previously) apply to Alternative 2, the proposed action.

Invasive species management under the proposed action is expected to have a beneficial effect on soils in the project area by increasing groundcover and reducing surface erosion. Under the proposed action, invasive species populations would decrease and native plant populations would increase. Native plants generally provide more effective groundcover than invasive plants and more effective groundcover reduces surface erosion (Olson 1999). Reduced surface erosion is a benefit not only to the soil ecosystems but also aquatic ecosystems as an improvement in water quality is expected.

The Environmental Risk Assessments considered two potential effects of herbicide use on soils: herbicide effects on soil microorganisms and water quality impacts due to runoff of soils contaminated with herbicides. Environmental Risk Assessments also determined potential effects to aquatic organisms from herbicide use. These effects are summarized in Table 19.

According to the Environmental Risk Assessments, none of the herbicides proposed for use are expected to have long-lasting effects on soil microorganisms so soil productivity is expected to remain unchanged. The potential for water quality impacts varies depending on the herbicide, soil properties and rainfall.

The potential for water quality impacts from herbicide use under this alternative is reduced with the proper implementation of the protection measures in Appendix A. There are general measures to prevent the potential contamination of any perennial or intermittent waterway, unprotected ephemeral waterway or wetland, protection measures specific to water resources, protection measures for wildlife/aquatics and water and woodlands and protection measures for environmentally sensitive areas that describe application restrictions for specific herbicides.

Table 19. Estimated effects of Alternative 2 proposed herbicide use on soil, soil organisms and aquatic organisms (SERA 2003-2012, BLM Risk Assessments and EPA Herbicide Fact Sheets).

Herbicide	Effects to Soil, Soil Organisms and Aquatic Organisms
2,4-D	Under arid conditions (i.e., annual rainfall of about 10 inches or less), there is no or very little runoff. At higher rainfall rates, runoff losses range from negligible to about 50% of the application rate, depending on the amount of rainfall and soil type. Could have a transient impact on algae in the soil when applied at rates at or above those used by the Forest Service. Effects to other soil microorganisms seem less likely according to other studies. Over the range of 2,4-D acid/salt application rates used in Forest Service programs (0.5 to 4 lb. a.e./acre), adverse effects on fish, amphibians and aquatic invertebrates are likely only with extreme exposure as would be the case in the event of an accidental spill and the upper ranges of application rates. With regard to 2,4-D esters, adverse effects on aquatic animals (fish, invertebrates, amphibians) are plausible in association with runoff (all application rates) and in cases of relatively large accidental spills. The ester formulations of 2,4-D are much more toxic to aquatic animals and adverse effects are plausible in sensitive species and sometimes in relatively tolerant species. Longer term exposure to 2,4-D concentrations associated with inadvertent contamination of water by runoff could affect sensitive species of aquatic macrophytes at the upper range of the application rates used in Forest Service programs. Damage to aquatic vegetation, particularly aquatic macrophytes, is likely in the event of an accidental spill.
Aminocyclopyrachlor	The runoff for aminocyclopyrachlor as a proportion of the application rate is taken as 0.05 (0.0005 to 0.9) is effectively zero—i.e., for sandy soils regardless of temperature and rainfall rates. The toxicity of aminocyclopyrachlor or metabolites of aminocyclopyrachlor to terrestrial microorganisms is not addressed in the available literature. There is no basis for asserting that adverse effects on fish are plausible for any exposure scenarios, including the accidental spill. The upper bound HQs for fish are 0.02 for the accidental spill, 0.002 for expected peak concentrations, and 0.009 for longer-term concentrations.

Herbicide	Effects to Soil, Soil Organisms and Aquatic Organisms
Aminopyralid	Except in areas that are highly susceptible to runoff such as hard-packed and predominantly clay soils, offsite losses associated with runoff do not appear to pose a substantial risk [to sensitive plants]. Runoff of about 1% to 5% of the applied aminopyralid from predominantly clay soils might be expected depending on rainfall rates. Much less runoff is expected from loam soils and virtually no runoff is expected from predominantly sand soils. Few studies address the effects of aminopyralid on soil microorganisms, but there does not appear to be a basis for suggesting that adverse effects are plausible. Aminopyralid has been shown to be practically non-toxic to fish and aquatic invertebrates. It is slightly toxic to eastern oyster, algae and aquatic vascular plants. Aminopyralid is not expected to build up in fish tissue. There are no acute or chronic risks to non-target endangered or non-endangered fish, birds, wild mammals, terrestrial and aquatic invertebrates, algae or aquatic plants.
Chlorsulfuron	Runoff will be negligible in relatively arid environments as well as sandy or loam soils. In clay soils, which have the highest runoff potential, off-site loss may reach up to about 55% of the applied amount in regions with very high rainfall rates. There is no basis for asserting that chlorsulfuron is likely to cause adverse effects in soil microorganisms under the conditions of application covered in this analysis. Chlorsulfuron appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low. At the maximum application rate of 0.25 lbs. /acre, the risk characterization is below the level of concern by a factor of 200. At the typical application rate, peak concentrations of chlorsulfuron in water could result in damage to aquatic macrophytes – i.e., hazard quotients ranging from 1.2 to about 24 based on an EC50 for growth inhibition. Thus, if chlorsulfuron is applied in areas where transport to water containing aquatic macrophytes is likely, it would be plausible that detectable damage could be observed. Aquatic algae do not appear to be as sensitive to chlorsulfuron; the hazard quotient is only modestly above the level of concern.
Clopyralid	Clopyralid does not bind tightly to soil; however, the potential for leaching or runoff is functionally reduced by its relatively rapid degradation. Leitch and Fagg (1985) monitored a maximum concentration 0.017 mg/L in stream water following a 5.2 inches of rain after the application of clopyralid at a rate of 1.90 lb. a.e./acre to predominately clay-loam soil. While the available toxicity data on soil organisms are limited, these projected maximum concentrations in soil are far below potentially toxic levels. Clopyralid appears to have low potential to cause adverse effects in any aquatic species. However, data are available on relatively few animal and plant species compared to the number of species that could potentially be exposed.

Herbicide	Effects to Soil, Soil Organisms and Aquatic Organisms
Glyphosate	In general, glyphosate will bind tightly to soil and its leaching capacity is extremely low. The upper bound of 0.089 lb. a.e./acre is the highest runoff proportion for an area with predominantly clay soils, cool temperatures and high rainfall. The lower bound value of 0.0000001 lb. a.e./acre would be expected in arid areas with predominantly loam or sandy soils. There is very little information suggesting that glyphosate will be harmful to soil microorganisms under field conditions and a substantial body of information indicating that glyphosate is likely to enhance or have no effect on soil microorganisms. The primary hazards to fish appear to be from acute exposures to the more toxic formulations. The risk characterization strongly suggests that the use of the more toxic formulations near surface water is not prudent. Use of glyphosate near bodies of water where sensitive species of fish may be found (i.e., salmonids) should be conducted with substantial care to avoid contamination of surface water. Concern for potential effects on salmonids is augmented by the potential effects of low concentrations of glyphosate on algal populations.
Imazapic	Runoff will be negligible in relatively arid environments as well as sandy or loam soils. In clay soils, which have the highest runoff potential, off-site loss may reach up to about 3.5% of the applied amount in regions with very high rainfall rates. No data are available on effects of imazapic on soil invertebrates or soil microorganisms. Evidence suggests no adverse effects in fish or aquatic invertebrates using typical or worst-case exposure assumptions at the typical application rate of 0.1 lb./acre or the maximum application rate of 0.1875 lb./acre. Aquatic animals appear to be relatively insensitive to imazapic exposures for both acute toxicity and reproductive effects. In acute toxicity studies, all tested species (channel catfish, bluegill, sunfish, trout and sheepshead minnow) evidenced relatively low toxicity. No effects on reproductive parameters were seen in a 32-day egg and fry study using fathead minnow. As in any ecological risk assessment, this risk characterization must be qualified. Imazapic has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available. In acute toxicity studies with aquatic invertebrates, no adverse effects were observed at concentrations of imazapic of up to 100 mg/L. Aquatic plants, particularly macrophytes, are much more sensitive to imazapic exposure than aquatic animals. Nonetheless, hazard quotients for unicellular algae are substantially below a level of concern with either acute or chronic exposure. Macrophytes appear to be more sensitive to imazapic than unicellular algae and at peak concentrations, some damage to macrophytes is plausible. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms.

Herbicide	Effects to Soil, Soil Organisms and Aquatic Organisms
Imazapyr	Imazapyr may persist in soil for a prolonged period of time, particularly in relatively arid regions and will not bind tightly to alkaline soils with low organic matter. In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible. Risks will be greatest in areas with predominantly clay soils and moderate to high rates of rainfall. Risks may also be relatively high in cool locations with predominantly loam soils. There does not appear to be any basis for asserting that imazapyr is likely to adversely affect microorganisms in soil. Adverse effects in aquatic animals do not appear to be likely. Evidence suggests no adverse effects in fish or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.45 lb. /acre or the maximum application rate of 1.25 lb. /acre. However, imazapyr has only been tested on a limited number of species and under conditions that may not represent populations of free-ranging nontarget animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.
Indaziflam	Indaziflam is expected to be moderately mobile to mobile in the soil (Koc < 1000 mL/g oc), moderately persistent to persistent in aerobic soil (half-lives > 150 days), persistent in anaerobic soil (stable), and persistent in aerobic (half-lives > 200 days) and anaerobic (stable) aquatic environments. Indaziflam is highly toxic (EC50 = 0.1 – 1 mg a.i. /L) to freshwater and estuarine/marine fish, moderately toxic (EC50 = 1 -10 mg a.i. /L) to highly toxic (EC50 = 0.1 – 1 mg a.i. /L) to estuarine invertebrates, and slightly toxic (EC50 = 10 - 100 mg a.i. /L) to moderately toxic (EC50 = 1 -10 mg a.i. /L) to freshwater invertebrates on an acute exposure basis. However, due to the proposed uses of indaziflam and its subjectivity to aqueous photolysis, exposure to freshwater and estuarine/marine fish and invertebrates is expected to be limited. All RQs for freshwater fish, aquatic-phase amphibians, and freshwater invertebrates are below the LOC for acute and chronic risk to listed and non-listed species. An estimate of the chronic endpoint for estuarine/marine fish is a NOAEC of 578 μg total a.i/L and RQs < 0.01. Based on this extrapolation, chronic risk to estuarine/marine fish is not expected.

Herbicide	**Effects to Soil, Soil Organisms and Aquatic Organisms**
Metsulfuron methyl	The offsite movement of metsulfuron methyl via runoff could be substantial under conditions that favor runoff – i.e., clay soils and high annual rainfall. Off-site loss may reach up to 60% of the applied amount in regions with very high rainfall rates. Soil microorganisms are sensitive to metsulfuron methyl at concentrations of 5 ppm. Most effects on soil microorganisms appear to be transient. Metsulfuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low. However, confidence in the risk characterization is reduced by the lack of chronic toxicity studies in potentially tolerant fish. At the maximum application rate of 0.15 lbs. /acre, all of the hazard quotients would be increased by a factor of about 5. However, this difference has no impact on the risk characterization for fish. Hazard quotients in aquatic invertebrates range from 7-10 (acute exposure in Daphnia) to 7-7 (acute exposure in Daphnia). Thus, there is no basis for asserting that adverse effects on aquatic animals are likely.

Picloram	Technical grade picloram contains low concentrations (3 ppm or less) of hexachlorobenzene (a carcinogen). Hexachlorobenzene is highly persistent in soil with metabolic half-lives of about 3 to 6 years. Conversely, hexachlorobenzene is relatively volatile and is expected to dissipate rapidly from soil surfaces. SERA estimated the simple first-order dissipation rate for hexachlorobenzene in the top one inch of soil at 0.0084 day-1 which corresponds to a half-life of about 80 days. The contamination of surface water following applications of picloram is expected to be minimal in relatively arid areas and even areas with normal rainfall, particularly in locations with predominantly loam or sandy soils. Watson *et al*. (1989) found no picloram in a stream after the application at rates of about 0.25 lb. /acre in areas with loam or sandy loam soil. Although picloram could have an effect on soil microorganisms, the consequences of such effects are not clear. Picloram has been used as an herbicide since 1964 (U.S. EPA 1995b). No field studies linking adverse effects on soil microorganism with detectable adverse impacts on soil productivity have been encountered. None of the hazard indices for fish, aquatic invertebrates, or aquatic plants reach a level of concern. There is substantial variability in toxicity to aquatic species; however, it has no substantial impact on the risk characterization. The risk characterization for both terrestrial and aquatic species is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed.
Rimsulfuron	The ERA predicted chronic risks to non-target aquatic plants in the pond when rimsulfuron applications occur in watersheds with sandy soils and at least 25 inches of precipitation per year (RQs ranged up to 6.5 at the typical application rate and up to 8.6 at the maximum application rate), in clay or clay/loam watersheds with at least 100 inches of precipitation per year (RQs ranged up to 3.3 at the typical application rate and up to 4.4 at the maximum application rate), and in loam watersheds with at least 50 inches of precipitation per year (RQs ranged up to 2.9 at the typical application rate and up to 3.8 at the maximum application rate). However, no acute risks were predicted for non-target aquatic plants in a pond. The ERA predicted no risk for adverse effects to non-target terrestrial plants, non-target aquatic plants in a stream, fish, aquatic invertebrates, or piscivorous birds as a result of surface runoff of rimsulfuron. Affects to soil microorganisms were not addressed in the BLM Ecological Risk Analysis. No direct risks to fish species (e.g., salmonids) were predicted in the modeling and salmonids are not likely to be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). However, species that depend on non-target plant species for habitat, cover, and/or food may be indirectly impacted by a possible reduction in terrestrial or aquatic vegetation. For example, accidental direct spray, off-site drift, and surface runoff may negatively impact terrestrial and aquatic plants, reducing the cover available to salmonids within a stream.

Resource protection measures (Appendix A) have been developed under all alternatives to reduce the effects disclosed above. Under the adaptive management strategy, any new herbicide that is proposed for use would be evaluated by the Forest Service assessment team. Such an assessment would include looking at effects to aquatic organisms.

Resource protection measures are expected to reduce effects to aquatic organisms from surfactants. Effects on aquatic organisms from surfactants are dependent upon the specific surfactant used, specific aquatic species, as well as differences within species depending upon age and stage of development. Measures include using only surfactants that are labeled for use in and around water in the Water Influence Zone (See appendix A for definition). When using herbicides that are labeled for aquatic use, only those surfactants specified on the label will be used.

Aerial spraying near aquatic zones has the most potential to affect water quality, either through direct application or drift. The greater potential for effects is due to the inability to target exact locations or completely control herbicide drift, both of which can result in unnecessary or inaccurate application of herbicides. There are resource protection measures established by the EPA on the herbicide labels which help reduce the potential for effects, including requiring buffers for aerial application of herbicide on each side of aquatic, streamside, or wetland areas and multiple measures designed to reduce spray drift. There are also resource protection measures that require a surface water quality risk assessment with site- specific information during the contract preparation for aerial application of herbicides, adding another layer of protection for surface water.

Herbicide drift is not expected to be environmentally deleterious over time. Herbicide residues on plants chemically decompose when exposed to sunlight and tend to have relatively short residence times in the environment. Herbicide residues are also subject to microbial decomposition in humus and mineral soils. During base flow conditions, herbicide residue entering the aquatic environment is diluted which would result in a dose lower than the threshold identified in the risk assessments.

The potential for catastrophic herbicide spills, which could contaminate soil and water, would be higher under this alternative because aircraft may be used for herbicide application. When an aircraft is involved, there is the potential, albeit small, for a crash that would result in a mixture of aviation fuel and herbicide. Such a crash could form a more environmentally destructive mixture than either herbicide or fuel alone. Appendix A contains a protection measure that requires the development and implementation of an herbicide emergency spill plan.

Because imazapic has been identified as the herbicide most likely to be aerially applied, a brief summarization of expected effects is included here. According to the ecological risk assessment for imazapic (Table 19 above; SERA 2004) no adverse effects in fish or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.1 lb./acre or the maximum application rate of 0.1875 lb./acre. For fish, the acute toxicity studies showed relatively low toxicity with 96-hour LC50 values of >100 mg/L for all species tested (channel catfish, bluegill, sunfish, trout and sheepshead minnow). *Lemna gibba* (duckweed), an aquatic macrophyte, appears to be more sensitive to imazapic exposure and under conditions in which runoff is favored (i.e. clay soils and relatively high rainfall rates) some aquatic macrophytes could be affected by peak but not longer-term concentrations of imazapic. Unicellar aquatic algae appear to be relatively insensitive and no effects to algae are anticipated. There is no evidence the imazapic is detrimental to soil microorganisms.

Tu *et al*. (2004) indicate that imazapic is moderately persistent in soils with a DT50 (time required for concentration in soil to reach 50% of initial measured concentration) of 7 to 150 days depending upon soil type and climatic conditions. It has limited horizontal mobility in soil and generally moves just 6 to 12 inches. Imazapic does not volatize from the soil surface and photolytic breakdown on soils is negligible, however, in water, imazapic is rapidly photodegraded, having a half-life of one to two days. Tu *et al*. (2004) go on to indicate that field studies do not indicate any potential for imazapic to move from soils with surface water, indicating low potential for effects to water quality.

Effects determination for federally listed and R4 sensitive species

The determination for Federally Listed Species is *No Effect* and for Sensitive Species is *May impact individuals but is not likely to cause a trend to federal listing or loss of viability*. Please see Table 20 below for detailed species determinations.

Endangered species determinations are based on the following:

- Resource protection measures mitigate all action-related foreseeable risks.

Sensitive species determinations are based on the following:

- The probability of the resource protection measures being effective in protecting occurrences of these species is very high.
- The possibility of individuals being inadvertently impacted during herbicide treatment is very slight but does exist.

Alternative 3 - No Aerial Application of Herbicides

Effects under Alternative 3 are expected to be similar to those discussed for Alternative 2 with the following exceptions:

- Effects from aerial application would not apply.
- Under Alternative 3, fewer infested acres could be treated with herbicide annually, resulting in less herbicide being applied across the landscape compared to Alternative 2. That would effectively reduce the risks to water quality and aquatic organisms from those described for Alternative 2.
- Because this alternative does not provide an effective tool for managing cheatgrass, there is potential for effects to soil, water quality and aquatic organisms due to wildfire as discussed under Alternative 1.
- There would be less potential for impacting source water areas as these areas are delineated and could therefore be more effectively avoided than with aerial application.
- Small unmapped wet areas of shallow water tables or groundwater-dependent ecosystems (GDEs) are less likely to be inadvertently sprayed with herbicide because hand application provides much more control. This would decrease the potential for impacts to water quality and aquatic organisms.

Effects determination for federally listed and R4 sensitive species

The determination for Federally Listed Species is *No Effect* and for Sensitive Species is *May impact individuals but is not likely to cause a trend to federal listing or loss of viability*. Please see Table 20 below for detailed species determinations.

Endangered species determinations are based on the following:

- Resource protection measures mitigate all action related foreseeable risks.

Sensitive species determinations are based on the following:

- The probability of the resource protection measures being effective in protecting occurrences of these species is very high.
- The possibility of individuals being inadvertently impacted during treatment is very slight but does exist.
- There is a risk of increased weed infestation resulting from less effective weed control which could have indirect impacts by degrading species habitat.

Cumulative Effects

The following activities have occurred and continue to occur on the Bridger-Teton: improper livestock grazing, timber harvest, transportation corridors such as roads, flow regulation by dams and diversions, placer and lode mining, oil and gas exploration and development and urbanization. These activities were considered in the cumulative affect analysis for aquatic and wetland habitats.

Activities considered in the cumulative effects analysis for soil, water and aquatic resources

Improper Livestock grazing	Bank alteration, stream channel over-widening, sediment introduction, loss of riparian vegetation
Timber harvesting	Sediment introduction, reduction of woody debris recruitment potential, modified water temperature regimes
Road construction and reconstruction	Sediment introduction, migration barriers
Dams and diversions	Altered water temperatures, fish migration barriers, altered sediment transportation, altered aquatic communities, altered flow regimes, reduction of instream flows
Mining	Water quality impacts associated with acid mine drainage, contaminated sediment from tailings
Oil and gas exploration and development	Sediment introduction from road construction and other disturbed sites, water quality contamination from spills or container failure, potential groundwater contamination, groundwater pumping and wastewater disposal
Urbanization	Increased runoff from loss of infiltration, water quality impacts from transport of contaminants from paved or hardened surfaces

Under Alternatives 1, 2 and 3, there is potential for herbicides to be introduced into streams and ponds via runoff. Activities that cause ground disturbance or reduce ground cover could cause more runoff and thus increase the potential for herbicides to be transported into water sources. This could impact aquatic organisms depending on the herbicide used. Some fish species (salmonids) are sensitive to glyphosate.

Alternative 2 could have the greatest cumulative impact on water quality and potentially to aquatic organisms, due to the potential for drift from aerial herbicide application added to water quality impacts from the actions listed in the table above. As noted above, damage to aquatic plants is plausible with imazapic, the herbicide initially proposed for use in aerial treatments.

There is also the potential for a cumulative increase in sediment from the ground disturbance associated with mechanical treatments (all Alternatives) in combination with the activities listed above. The incremental sediment contribution from mechanical treatment under any alternative would be localized and small due to the small size of the disturbed areas.

Under Alternatives 3 and 1, the cumulative impact of less effective invasive species treatment would be an increase sediments and nutrients into streams as a result of less effective ground cover and increased fire frequency. In turn, this could impact aquatic organisms and their habitat when combined with the potential sediment increases and changes to stream morphology from the activities listed above.

Effects Determinations for All Alternatives

Table 19. Summary of determination of effects for federally listed and sensitive species, including rationale for determination.

Species	Alternative 1		Alternative 2		Alternative 3	
	Outcome	Rationale	Outcome	Rationale	Outcome	Rationale
FISH						
Kendall Warm Springs dace	NE	1	NE	1	NE	1
Colorado River cutthroat trout	MI	3	MI	3	MI	3
Bonneville cutthroat trout	MI	3	MI	3	MI	3
Yellowstone cutthroat trout	MI	3	MI	3	MI	3
Northern leatherside	MI	3	MI	3	MI	3
COLORADO RIVER SPECIES						
Bonytail chub	NE	2	NE	2	NE	2
Humpback chub	NE	2	NE	2	NE	2
Colorado pike minnow	NE	2	NE	2	NE	2
Razorback sucker	NE	2	NE	2	NE	2
PLATTE RIVER SPECIES						
Pallid sturgeon	NE	2	NE	2	NE	2
AMPHIBIANS						
Columbia spotted frog	MI	3	MI	3	MI	3
Boreal toad	MI	3	MI	3	MI	3

Determination of effect codes for federally listed species: NE=No effect

Determination of effect codes for sensitive species: MI=May impact individuals, but not likely to cause a trend toward federal listing or result in a loss of population viability

Rationale explanations

1. Strict adherence to protection measures specific to Kendall Warm Springs outlined in Appendix A is necessary to prevent a determination of LAA

2. Alternative will have no measurable water withdrawal or water quality effects to downstream habitats for this species

3. Potential negligible effects to aquatic resources which are mitigated with protection measures (Appendix A)

No conferencing with the United States Fish and Wildlife Service was necessary since the project will not jeopardize the continued existence of Kendall Warm Springs Dace, the four Colorado River fish species, or the Platte River fish species nor will it result in the destruction or adverse modification of associated designated Critical Habitat for any of those species.

Across all Region 4 aquatic Sensitive Species, it is the case that some individuals may be affected, but these effects should not cause population level viability, nor affect the species in a way that it would trend toward federal listing.

Forest Plan Consistency

Under the three alternatives, the invasive plant treatments are consistent with forest plan direction for soil and aquatic resources, including threatened, endangered and sensitive aquatic species, because they include the resource protection measures described in Appendix A. Treatment under Alternatives 3 and 1 would be less effective than under Alternative 2 if less effective herbicides are used or fewer acres can be treated. Less effective treatment would allow invasive plant species to expand and reduce native plant communities, which often increases the amount of bare soil in those communities. This less effective treatment could result in conditions that would not be consistent with the following forest plan direction:

Vegetation: Range Standards and Guidelines

Fish; Wildlife; and Threatened, Endangered and Sensitive Species Standard

Range improvements, management activities and trailing will be coordinated with and designed to help meet fish and wildlife habitat needs, especially on key habitat areas such as crucial winter range, seasonal calving areas, riparian areas, sagegrouse leks and nesting sites. Special emphasis will be placed on helping to meet the needs of Threatened, Endangered and Sensitive species.

Protection: Pests Standards and Guidelines

Noxious Weeds Control Standard

Effective management of noxious weeds will be accomplished by cooperating with the Wyoming Department of Agriculture and County weed control districts, using Integrated Pest Management techniques, following the procedures outlined in the Bridger-Teton Environmental Assessment for noxious weed control and appropriate technical guides. No toxic herbicides will be applied in a manner that will adversely affect non-target species.

Issue #4 Human Health and Safety

Regulatory Framework

The direction, policies and requirements listed and discussed below apply to those herbicides currently in use or proposed for use in this project. The term *pesticide* is an all-inclusive term that means "killer of pests" and includes herbicides used for vegetation (FSH 2109.14(12)).

Safety standards for herbicide use are set by the Environmental Protection Agency (EPA), Occupational Health and Safety Administration, Code of Federal Regulations (40 CFR part 170) and individual states. In addition, several sections of the Forest Service manual (FSM 2150, 1994) and the Forest Service handbook (FSH 2109.14) provide guidance for handling and application of herbicides. These include the following:

- Forest Service Health and Safety Code Handbook (FSH) 6709.11 and Forest Service Manual (FSM) 2156 set forth requirements for consultation of pesticide handling (these references are on file in the project record).
- FSH 2109.14 - Pesticide-Use Management and Coordination Handbook (on file in the project record) directs the planning of all pesticide-use management and coordination:

Chapter 10, section 13.2 lists human health and safety as one of the components to be analyzed in environmental assessments for pesticide use.

Section 14.3 discusses preparation of project work plans with descriptions of required personal protective clothing and equipment.

Section 16 describes development of a safety plan to protect the public and employees from unsafe work conditions when pesticides are involved (FSM 2153.3).

Section 16.2 lists the completion of a job hazard analysis (form FS-6700-7) in addition to the safety plan. Job hazard analysis (JHA) is defined in FSH 6709.11. JHAs include requirements for personal protective equipment/clothing, training, qualifications and safety practices.

Chapter 20 describes the use of risk assessments to support decisions concerning the need for and extent of controls of exposure necessary to protect public health and the environment. A pesticide risk assessment is used to quantitatively evaluate the probability that a given pesticide use might harm humans or other species in the environment. Risk assessments used for this project are discussed in the *Analysis Method* section below.

Analysis Method

The indicators for assessing effects to human health and safety are **potential for exposure, including exposure from spray drift** and **doses in excess of reference doses**. For this analysis, the human health and safety risks from the use of herbicides are based on human health and ecological risk assessments conducted by Syracuse Environmental Research Associates (SERA) and on EPA's risk assessments for herbicides. Risk assessment methodology is well documented and generally accepted by the scientific community. The SERA risk assessments are incorporated into this analysis by reference and can be found at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml or in the project file.

Potential for exposure was assessed based on who would or might be exposed and how the exposure could happen. Potential for exposure was evaluated for the general public and for workers applying the herbicides. It was also evaluated by application method: backpack, ground- based, or aerial. Potential for exposure is only part of the assessment of health risk. Another part is comparing the estimated amount of herbicide received from an exposure scenario with a reference dose (RfD) which is an oral dose (mg/kg/day) not likely to be associated with adverse effects over lifetime exposure, in the general population, including sensitive subgroups. Adverse effects become more likely when exposure exceeds the RfD in frequency and/or magnitude (EPA 1993). RfDs are discussed in detail in the SERA risk assessments.

For this analysis, a limitation of the risk assessments is the method used to estimate exposure from aerial spraying. SERA's exposure estimates for aerial application are higher than those found in field conditions because of the calculations used. Another limitation is SERA's modeling of the aerial application of imazapic using only helicopters. Under the proposed action, fixed- wing aircraft may also be used to aerially apply imazapic. For the purposes of this analysis, we assume the risk to herbicide mixers/loaders and pilots is the same for helicopters and fixed-wing aircraft. The pilot in the helicopter or fixed-wing aircraft is not exposed because the spraying apparatus is mounted on a boom attached below the enclosed cockpit.

Affected Environment

For human health and safety, the description of existing conditions is restricted to herbicide use. No attempt was made to list all possible environmental factors or outdoor activities that could affect human health and safety of individuals or groups that might be using the forest.

To define baseline or existing conditions for human health and safety, against which the effects of the alternatives will be compared, we evaluated the current level of herbicide application on the forest. This gives us a starting point for estimating how alternatives would change potential exposure to herbicides and potential for doses exceeding RfDs. This existing condition is the description of Alternative 1 – no action, no change from current management.

The forest treats approximately 2,000-3,000 acres annually. Many of these acres are re-treatment acres, since some infestations require repeated treatment for 5 to 8 years to ensure effective control or provide containment. Treatment includes mechanical, cultural, biological and herbicide means. Cultural control is the establishment of competitive, desired vegetation.

Herbicides are applied with ground-based methods using backpack-mounted sprayers and vehicle-mounted sprayers. Backpack- and vehicle-mounted systems utilize handheld sprayers; vehicle-mounted systems can also have boom sprayers.

Twenty-three herbicides are available for routine weed control. The following sixteen are currently being used on the forest: 2,4-D, aminocyclopyrachlor, aminopyralid, aquatic glyphosate, chlorsulfuron, clopyralid, dicamba, glyphosate, hexazinone, imazapic, imazapyr, indaziflam, metsulfuron methyl, picloram, rimsulfuron and sulfometuron methyl. Seven of the twenty-three are not currently being used: atrazine, bromacil, diuron, mefluidide, simazine, tebuthiuron and triclopyr. Herbicides are applied according to label instructions and the person applying the herbicide is required to wear the appropriate personal protective equipment (PPE).

Environmental Effects

Invasive plant control may affect human health. Alternatives 1, 2 and 3 contain protection measures to minimize health risks to workers and the public. Risk assessments have been prepared for all the herbicides proposed for use (see table below). The process of risk assessment is used to quantitatively evaluate the probability (i.e., risk) that an herbicide might pose harm to humans. The complete SERA risk assessments (2003-2012) in the project record contain information about herbicide toxicity, exposure, dose-response relationships and risk characterization for workers and the general public.

The forest also uses manual and mechanical treatments to control invasive species. No significant human health effects are anticipated from manual or mechanical removal of weeds because required PPE (gloves, long- sleeved shirts, long pants, boots and safety glasses) and proper washing of contaminated PPE would prevent injuries or irritation.

This effects analysis assessed the **potential for exposure, including exposure from spray drift** and the **potential for doses in excess of EPA's reference doses (RfDs).** As mentioned in the *Analysis Method* section, no attempt was made to categorize all the possible effects to human health and safety that exist on the forest.

Table 20. Herbicides available for use by alternative

Herbicide	Alternative 1	Alternatives 2	Alternatives 3
2,4-D	X	X	X
Aminocyclopyrachlor*	X	X	X
Aminopyralid*	X	X	X
Aquatic Glyphosate*	X	X	X
Chlorsulfuron	X	X	X
Clopyralid	X	X	X
Dicamba	X		
Glyphosate	X	X	X
Hexazinone	X		
Imazapic*	X	X	X
Imazapyr	X	X	X
Indaziflam*	X	X	X
Metsulfuron methyl	X	X	X
Picloram	X	X	X
Rimsulfuron*	X	X	X
Sulfometuron methyl	X		
Atrazine			
Bromacil			
Diuron			
Mefluidide			
Simazine			
Tebuthiuron			
Triclopyr			

*Herbicides with an asterisk have been approved for use since the 2004 EA.

Herbicides in italics were approved in 2004 EA but are not currently in use and are not proposed for future use.

Effects Common to Alternatives 1, 2 and 3

Herbicides would be used in Alternatives 1, 2 and 3. All three alternatives include the use of backpack- and vehicle-mounted sprayers. Health risks from herbicide use depend on the toxic properties of the herbicide and the level and duration of exposure.

There is potential for exposure from spray drift with either ground-based or aerial application methods. Aerial herbicide application has a greater potential because the herbicide is released from a greater height. Herbicide labels describe conditions in which spraying – ground or aerial – should not be done.

Spray drift is largely a function of droplet particle size. The largest particles, being the heaviest, will fall to the ground quickly upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but virtually all of the particles fall within a short distance of the release point. A small percentage of the spray droplets are small enough to be carried in wind currents to varying distances beyond the point of release. Since these smallest droplets are a minor proportion of the total spray volume, their toxicological significance beyond the project area boundary rapidly declines as they are diluted in increasing volumes of air (Felsot 2001).

<u>Protection measures to reduce exposure</u>

Protection measures designed into these three alternatives would reduce the potential for exposure, including exposure from spray drift and the potential for doses in excess of the EPA’s reference doses.

Appendix A of the DEIS lists protection measures to reduce and monitor spray drift and to reduce exposure from ground-based or aerial herbicide application.

All herbicides would be applied according to label instructions to minimize exposure and adverse health effects. Label instructions include cautions about breathing and skin or eye contact with the herbicide, requirements for PPE (this is also a Forest Service requirement) and recommendations for washing hands and contaminated clothing. PPE generally means gloves, waterproof boots, long sleeved shirts and pants, though the herbicide labels list the PPE requirements for each herbicide. Following label instructions and using PPE would reduce exposure on sensitive areas of the body and protect worker health.

Label instructions for herbicides also include provisions for managing drift, including controlling droplet size and not spraying in the following conditions – high or gusty winds, high temperatures, low humidity and temperature inversions.

Any time herbicide use is proposed, there is a risk of indirect effects from accidental spills and concerns with storage, transport and disposal. The SERA risk assessments account for these indirect effects in their potential exposure scenarios. Alternatives 1, 2 and 3 all have the potential for these indirect effects; however, the risk is slightly higher under Alternative 2 because more acres are proposed for treatment so more herbicide would be used. Direction outlined in Forest Service Handbook 2109.12 Pesticide Storage, Transportation, Spills and Disposal would be followed for all three alternatives.

Alternative 1 – No Action

Alternative 1 includes the use of herbicides but does not allow the use of newly formulated herbicides and is limited to those listed in the 2004 EA and approved since 2004. Potential exposure and potential for doses exceeding RfDs would be limited to the sixteen herbicides listed in Table 21. Effects to human health from the herbicides listed in this alternative are discussed below in the section titled *Effects Common to Alternatives 2 and 3*. A more comprehensive risk discussion for each herbicide is available in the SERA risk assessments which can be found in the project file.

This alternative includes six herbicides that are not currently being used on the forest.

Effects Common to Alternatives 2 (Proposed Action) and 3 (No Aerial Application of Herbicides)

The herbicides proposed for use in Alternatives 2 and 3 are the same. The difference between the two alternatives is the option for aerial spraying under Alternative 2.

The adaptive management strategies available under Alternatives 2 and 3 would result in fewer risks to human health than under Alternative 1. New technology, biological controls and herbicides are likely to be developed within the life of this project. Under both Alternative 2 and 3, these new treatments would be considered if they would be more species-specific than methods currently used (Alternative 1), less toxic to non-target vegetation, capable of reducing human health risks, less persistent and less mobile in the soil, or more effective.

Under Alternative 2, aerial spraying would be used initially to treat cheatgrass with imazapic. In the future, aerial spraying may be used to treat cheatgrass with more effective and/or herbicides that pose less risk to health and safety, or to treat other invasive species with herbicides other than imazapic. The adaptive management strategy for selecting the most appropriate and effective control method is shown in Chapter 2 of the DEIS in Table 3 and in Figure 2.

Alternative 2 would pose less risk to workers than Alternatives 3 and 1 because it offers the option of aerial spraying which reduces exposure to the herbicide. The person who mixes and loads the herbicide has less contact time and the pilot who applies it is protected by the enclosed cockpit of the helicopter/fixed-wing aircraft.

The aerial spraying option under Alternative 2 could expose the public to drift from spraying; however, this potential exposure would be reduced by following the herbicide label instructions and implementing the protection measures in Appendix A. Herbicide labels describe conditions in which spraying – ground or aerial – should not be done and Appendix A of the DEIS lists the protection measures for aerial herbicide application under Alternative 2, including use of buffer zones and drift reduction agents and application restrictions for particular weather conditions.

Because aerial herbicide application is more efficient than backpack or vehicle spraying for control of cheatgrass (Haas 2011), Alternative 2 could reduce the number of treatments and thus the likelihood of exposure over the long-term. It is estimated that a helicopter can spray about 200 acres per day (50 acres/hour x 4 hours of flight time). A person can hand treat about 2 acres per day under optimal conditions. At this application rate, multiple treatments would be necessary.

According to the SERA risk assessments (2003-2012), herbicide applicators (workers) are at a higher risk than the general public from herbicide use because they receive repeated exposures that may remain on the skin for an extended period. As previously mentioned in the *Analysis Method* section, SERA's exposure estimates for aerial application are higher than those found in field conditions.

The following table summarizes the risks to workers and the general public. The risks are based on projected exposure and EPA's RfDs reported in the SERA risk assessments. Five of the herbicides have estimated chronic (i.e. longer term exposure such as exposure that occurs with multiple herbicide applications over time) and acute (i.e. the dose is delivered in a single event and absorption is rapid including accidental exposure) exposures less than the RfDs which means there is little risk to workers or the public from exposure. The remaining herbicides exceed the RfDs for chronic or acute exposure for the public or workers or both. In particular, workers applying hexazinone or 2,4-D could be exposed to doses in excess of the RfDs, making the requirements for PPE and proper handling of contaminated PPE particularly important. A reference dose (RfD) is an oral dose (mg/kg/day) not likely to be associated with adverse effects over lifetime exposure, in the general population, including sensitive subgroups. On the Bridger-Teton, the maximum a worker could conceivably apply herbicides would be 100 days in a given year over a career of 20 years, which is considerably less than daily exposure over a lifetime.

The values in Table 22 for workers and the public are the highest estimated chronic and acute exposures for each herbicide (taken from the SERA risk assessments). For the public, acute exposure scenarios include direct spray, dermal contact with contaminated vegetation and consumption of contaminated fruit, water and fish. Chronic exposure scenarios for the public also include consumption of contaminated fruit, water and fish but over a longer period. Most of these scenarios should be regarded as extreme, some to the point of limited plausibility (SERA 2003).

For the herbicides in the following table, when the maximum estimated exposure is less than the RfD, adverse human health effects are not likely. Herbicides where an estimated exposure is greater than the RfD are indicated in boldface type with additional discussion following the table. It is important to note that these figures depict estimated herbicide exposure according to SERA's exposure scenarios; they do not depict the exposure expected from Alternatives 2 and 3. With all resource protection measures in place, including the recent EPA worker protection standards, the exposure from Alternatives 2 and 3 is expected to be low.

Table 21. Comparison of risks to workers and the general public from herbicides available under all Alternatives.

	Reference Does (RfD) mg/kg/day		Workers Range mg/kg/day		General Public Range mg/kg/day	
Herbicide	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**	**Acute**
2,4-D	0.005	0.025	0.15	≤0.15	0.2	2.0
Aminocyclopyrachlor	0.35	No research	0.35	No research	0.35	3.5
Aminopyralid	0.5	1.0	0.012	.003	0.027	0.4
Chlorsulfuron	0.02	0.25	0.0045	≤0.0045	0.004	0.09
Clopyralid	0.15	0.75	0.05	≤0.05	0.2	1.8
Dicamba	0.045	0.10	0.007	≤0.007	0.008	1.0
Glyphosate	2.0	2.0	0.3	0.01	0.08	0.3-4
Hexazinone	0.05	4.0	0.16-0.3	0.23-0.33	0.006-0.16	4.0
Imazapic	0.5	0.5	0.008	≤0.008	0.004	0.5
Imazapyr	2.5	2.5	0.07	≤0.07	0.04	0.9
Indaziflam	0.02	.5	.0035	≤0.0035	.02	.5
Metsulfuron methyl	0.25	0.25	0.0045	≤0.0045	0.0024	0.034
Picloram	0.2	No research	0.05	≤0.05	0.07	0.7
Rimsulfuron	.118	NA	.011	≤0.011	Not Assessed	Not Assessed
Sulfometuron methyl	0.24	0.87	0.007	≤0.007	0.0016	0.094

Values indicate highest estimates. Source: BLM, EPA, SERA Risk Assessments

2,4-D: For workers, many chronic exposure scenarios exceed the level of concern and often by a very substantial margin. Workers involved in the application of 2,4-D could be exposed to levels greater than those generally regarded as acceptable. Aggressive measures are warranted to provide workers with adequate protective clothing and to keep the protective clothing free of gross contamination (SERA 2006).

For the public, the chronic exposure estimate of 0.2 mg/kg/day is associated with longer-term consumption of contaminated vegetation. The acute exposure estimate of 2 mg/kg/event is associated with a child’s consumption of contaminated water from an accidental spill. This exposure scenario is highly arbitrary. Other acute exposure scenarios lead to much lower dose estimates – 0.2 mg/kg/day or less (SERA 2006). However, these still exceed the RfD.

Aminocyclopyrachlor: For worker exposures in non-accidental scenarios involving the normal application of aminocyclopyrachlor, central estimates of exposure for workers are approximately 0.0037 mg/kg/day for backpack applications, 0.0063 mg/kg/day for ground broadcast applications, and 0.0041 mg/kg bw/day for aerial spray. Upper ranges of exposures are approximately 0.022 mg/kg/day for backpack and aerial applications and 0.042 mg/kg/day for ground broadcast applications. All of the accidental exposure scenarios for workers involve dermal exposures. The dose estimates for the accidental exposure scenarios are lower than those estimated for the general exposure of workers. This detail reflects the limited dermal absorption rates for aminocyclopyrachlor and the relatively brief periods of exposure (i.e., 1 minute and 1 hour) used for the accidental exposure scenarios.

For members of the general public, acute non-accidental exposure levels to aminocyclopyrachlor range from about 6x10-11 mg/kg/day (the lower bound of exposure for swimming in 33 contaminated water for 1 hour) to about 0.38 mg/kg bw (the upper bound associated with the consumption of contaminated vegetation). Of the accidental exposure scenarios, the greatest exposure levels are associated with the consumption of contaminated water by a small child—an upper bound of about 0.29 mg/kg bw for aminocyclopyrachlor (SERA 2012).

Aminopyralid: For workers applying aminopyralid, in non-accidental scenarios involving the normal application of aminopyralid, central estimates of exposure for workers are approximately 0.001

mg/kg/day for aerial and backpack workers and about 0.002 mg/kg/day for broadcast ground spray workers. Upper ranges of exposures are approximately 0.012 mg/kg/day for broadcast ground spray workers and 0.006 mg/kg/day for backpack and aerial workers. All of the accidental exposure scenarios for workers involve dermal exposures. Except for the scenario involving a spill on the lower-legs for 1 hour (an upper bound dose of 0.003 mg/kg/event), the accidental exposures lead to dose estimates that are substantially lower than the general exposure levels estimated for workers. This is not uncommon and it reflects the fact that the general exposure estimates are based on field studies of workers in which accidental and/or incidental events such as spills probably occurred and in some cases were specifically noted to occur.

For the general public, acute levels of exposures range from minuscule (e.g., 1x10-8 mg/kg/day) to about 0.4 mg/kg bw at the typical application rate of 0.078 lb. a.e./acre. The upper bound of exposure, 0.4 mg/kg bw, is associated with the consumption of contaminated water by a child shortly after an accidental spill. This exposure scenario is highly arbitrary. The upper bound of the dose associated with the consumption of contaminated vegetation, a more plausible but still extreme exposure scenario, is about 0.1 mg/kg bw. The other acute exposure scenarios lead to much lower dose estimates – i.e., ranging from near zero to about 0.042 mg/kg for the accidental direct spray of a child. The lowest acute exposures are associated with swimming in or drinking contaminated water. (SERA 2007)

Chlorsulfuron: For workers, central estimates of exposure for ground workers are approximately 0.0007 mg/kg/day for directed ground spray and 0.001 mg/kg/day for broadcast ground spray. Upper range of exposures are approximately 0.0045 mg/kg/day for directed ground spray and 0.0085 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers. (SERA 2004)

For the general public, the range of acute exposures is from approximately 0.0000002 mg/kg associated with the lower range for dermal exposure from an accidental spray on the lower legs to 0.09 mg/kg associated with the upper range for consumption of contaminated water by a child following an accidental spill of chlorsulfuron into a small pond. High dose estimates are also associated with consumption of contaminated fruit (approximately 0.01 mg/kg) and fish (approximately 0.008 mg/kg for subsistence populations). For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.000000001 mg/kg/day associated with the lower range for the normal consumption of fish to approximately 0.004 mg/kg/day associated with the upper range for consumption of contaminated fruit. (SERA 2004)

Clopyralid: Under normal conditions, members of the general public would not be exposed to substantial levels of clopyralid. The 0.2 mg/kg/day chronic exposure estimate assumes that an adult (70 kg male) consumes contaminated ambient water from a contaminated pond for a lifetime. The acute exposure estimate of 1.8 mg/kg/day is associated with the consumption of contaminated water by a child following an accidental spill of clopyralid into a small pond (SERA 2004).

Dicamba: The acute exposure estimate of 1.0 mg/kg/day is associated with consumption of contaminated water by a child following an accidental spill of dicamba into a small pond. Direct spray of a child yields an acute exposure estimate of approximately 0.17 mg/kg/day. Other acute exposures are lower by about an order of magnitude (SERA 2004).

Glyphosate: The acute exposure estimate of 0.3 to 4 mg/kg/day is associated with an accidental spill of 200 gallons of a field solution into a small pond. This is an extraordinarily extreme and conservative scenario used in all Forest Service risk assessments (SERA 2003).

Hexazinone: Unless workers follow prudent handling practices to minimize exposure, the chronic RfD is likely to be exceeded. For the public, the chronic exposure estimate range is associated with the longer-term consumption of contaminated vegetation. The difference in estimates is for granular versus liquid formulations and relates to well-documented differences in the deposition of hexazinone on vegetation between the two. The acute exposure estimate of 4 mg/kg/day is associated with an accidental spill into a small pond. This is a highly arbitrary exposure scenario. (SERA 2005).

Imazapic: The acute estimated exposure of 0.5 mg/kg/day is associated with the consumption of contaminated water by a child following an accidental spill of imazapic into a small pond. Direct spray of a child yields an acute exposure estimate of 0.145 mg/kg/day. Other acute exposures are lower by about an order of magnitude (SERA 2004).

Imazapyr: For terrestrial applications, in non-accidental scenarios involving the normal application of imazapyr, central estimates of exposure for workers are approximately 0.013 mg/kg/day for backpack applications, 0.02 mg/kg/day for ground broadcast applications, and 0.015 mg/kg bw/day for aerial spray. Upper ranges of exposures are approximately 0.08 mg/kg/day for backpack and aerial applications and 0.15 mg/kg/day for ground broadcast applications. Aquatic applications of imazapyr are associated with doses of 0.009 (0.004 to 0.02) mg/kg bw/day. All of the accidental exposure scenarios for workers involve dermal exposures. The accidental exposure scenarios lead to dose estimates which are less than those associated with the general exposure levels estimated for workers. This point reflects the limited exposure periods (i.e., 1 minute and 1 hour) used for the accidental exposure scenarios. For terrestrial applications, the upper bound estimate of the absorbed dose is about 0.03 mg/kg bw, if contaminated gloves are worn for 1 hour. If contaminated gloves were worn for an 8-hour workday, the absorbed dose would be about 0.24 mg/kg bw, which is higher than any of the dose estimates for general (non-accidental) exposure scenarios.

For the general public, acute non-accidental exposure levels associated with terrestrial applications range from very low (e.g., ≈9x10-6 mg/kg/day) to 1.35 mg/kg bw at the unit application rate of 1.0 lb. a.e./acre. The upper bound of exposure of 1.35 mg/kg bw is associated with the consumption of contaminated vegetation. The other acute exposure scenarios lead to lower and often much lower dose estimates. The lowest acute exposure levels are associated with swimming in or drinking contaminated water. Of the accidental exposure scenarios, the greatest exposure levels are associated with the consumption of contaminated water by a small child, for which the upper bound dose is about 2 mg/kg bw/day. For aquatic applications, the consumption of contaminated terrestrial vegetation is not a relevant route of exposure. The highest non-accidental exposure scenario for aquatic applications is associated with the consumption of contaminated water for which the upper bound of the estimated dose is about 0.04 mg/kg bw/day. (SERA 2011)

Indaziflam – Indaziflam has low acute toxicity via the oral, dermal and inhalation routes of exposure. It is not irritating to the eye or skin and is not a dermal sensitizer. For residential and occupational exposure, the EPA uses the term Margin of Exposure (MOE) to refer to the risk associated with the exposure estimate. The MOE is defined as the dose, usually the No Observed Adverse Effects Level (NOAEL), divided by the estimated human exposure. An MOE of 100 means that the estimated level of human exposure is 100 times lower than the highest dose that produced no adverse effects in the relevant toxicology study. The greater the MOE, the lower the risk. An MOE of 100 or greater indicates there are no risks of concern.

EPA assessed short-term dermal and inhalation exposures of occupational handlers. Combined inhalation/dermal MOEs for occupational handlers range from 100 to 840,000. Since all MOEs are greater than or equal to 100, short -term risks for handlers are not of concern.

Metsulfuron methyl: Central estimates of exposure for ground workers are approximately 0.0004 mg/kg/day for directed ground spray and 0.0007 mg/kg/day for broadcast ground spray. Upper range of exposures are approximately 0.0024 mg/kg/day for directed ground spray and 0.0045 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 0.000000014 mg/kg associated with the lower range for consumption of contaminated stream water by a child to 0.034 mg/kg/day associated with the upper range for consumption of contaminated water by a child following an accidental spill of metsulfuron methyl into a small pond. For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.00000000026 mg/kg/day associated with the lower range for the normal consumption of fish to approximately 0.0024 mg/kg/day associated with the upper range for consumption of contaminated fruit. (SERA 2005)

Picloram: The acute estimated exposure of 0.7 mg/kg/day is associated with the consumption of contaminated water by a child following an accidental spill of picloram into a small pond. The highest dose estimates (0.07 mg/kg/day) for non-accidental exposure scenarios are associated with the consumption of contaminated vegetation or fish. Exposures from dermal contact or drinking contaminated water are likely to be much lower (SERA 2003).

Rimsulfuron: The occupational risks associated with exposure to rimsulfuron are not expected to exceed EPA's level of concern for any of the potential occupational receptors under routine use scenarios.

Sulfometuron methyl: There are no occupational exposure studies in the available literature that are associated with the application of sulfometuron methyl. Central estimates of exposure for ground workers are approximately 0.0006 mg/kg/day for directed ground spray and 0.001 mg/kg/day for broadcast ground spray. Upper range of exposures are approximately 0.004 mg/kg/day for directed ground spray and 0.007 mg/kg/day for broadcast ground spray. All of the accidental exposure scenarios for workers involve dermal exposures and all of these accidental exposures lead to estimates of dose that are either in the range of or substantially below the general exposure estimates for workers.

For the general public, the range of acute exposures is from approximately 0.00000012 mg/kg associated with the lower bound for consumption of contaminated stream water by a child to 0.094 mg/kg/day associated with the upper bound for consumption of contaminated water by a child following an accidental spill of sulfometuron methyl into a small pond. For chronic or longer term exposures, the modeled exposures are much lower than for acute exposures, ranging from approximately 0.00000000023 mg/kg/day associated with the lower range for the normal consumption of fish by the general public to approximately 0.0016 mg/kg/day associated with the upper range for consumption of contaminated fruit. (SERA 2004)

Sensitive subgroups: Despite the limited risk of adverse health effects predicted based on EPA testing, label restrictions and the risk assessments, people who are hypersensitive to chemicals in the environment may be inadvertently exposed to and adversely affected by, herbicide residues if they use the localized sites where an herbicide has been applied. DEIS Appendix A contains the protection measures listed below to address this potential human health and safety risk. Posting signs in an area to be treated allows people to determine when to enter such an area. Each product label contains the re-entry interval for agricultural workers and non-agricultural workers specific to the herbicide.

- In public recreation areas (such as developed campgrounds, trailheads, other areas of concentrated use), install signs to inform the public that herbicide spraying is taking place. Signs would be posted at any conspicuous point or points of entry into the area being sprayed and would be in place until the beginning of the reentry period (as defined by the product label).
- For aerial herbicide application, appropriate public announcements will occur prior to treatment.

<u>Cumulative Effects – All Alternatives</u>

The analysis area for cumulative effects on human health and safety is the area in and immediately adjacent to the Bridger-Teton. The temporal boundary is 15 years, the expected length of this project. As noted previously, no attempt was made to categorize all the potential impacts to human health and safety that could occur on the Bridger-Teton NF. Therefore, the cumulative effects analysis considered past, present and reasonably foreseeable future aerial and ground application of herbicides on private and public lands in Wyoming including herbicide spraying along the highway rights-of-way by the

Wyoming Department of Transportation.

There would be no cumulative effects from herbicide treatments under Alternatives 1, 2, or 3 because there would be no exposure overlap in time (i.e. a person would not be exposed to multiple herbicide applications in the same 24 to 48 hour period).

Most invasive plant treatments on the Bridger-Teton are done cooperatively across ownership boundaries. The forest has weed management agreements with the counties. In these agreements, areas to be treated are mapped or the physical location is described and one entity is responsible for treatment of the infestation which means there is no treatment overlap in time and therefore no exposure overlap in time.

Forest Plan Consistency

The three alternatives are consistent with forest plan direction.

Wilderness, Wilderness Study Areas (WSA's), Inventoried Roadless Areas (IRA's), and Wild and Scenic Rivers (WSR's)

Regulatory Framework

The Wilderness Act of 1964 defined wilderness and established the National Wilderness Preservation System. Wilderness management occurs in accordance with the enabling legislation and Forest Service policy, which regulate human use and influence in order to preserve the quality, character and integrity of Wilderness.

BTNF Forest Plan management emphasis in Wilderness is to provide for the protection and perpetuation of natural biophysical conditions and a high degree of solitude for visitors but with some perceptible evidence of past human use. Section 4(c) of the Wilderness Act provides the opportunity for invasive plant treatment, including the use of mechanized equipment and herbicides, if such activities are the minimum required to administer a given area as Wilderness.

Two Wilderness Study Areas (WSA's) on the BTNF were designated by the 1984 Wyoming Wilderness Act for further review and consideration for Wilderness designation. WSA's are managed to retain the qualities that make them eligible for potential Wilderness designation. Activities that would be prohibited in designated Wilderness, such as motorized use, may be allowed in WSA's.

In 1979, Inventoried Roadless Areas (IRA's) on the Bridger-Teton National Forest were evaluated for potential addition to Congressional designated Wilderness during the Roadless Area Review and Evaluation I and II processes. In 1983, these areas were further evaluated and Roadless boundaries were altered to reflect Roadless acreage on the Forest. The purpose of these studies was to identify areas with primitive character, located outside of designated Wilderness, for possible future addition to the National Wilderness Preservation System. In 1984, the Wyoming Wilderness Act designated the Gros Ventre Wilderness and added portions of the West Slope Inventoried Roadless Area to the 1964 Bridger Wilderness. IRA's are managed according to the 2001 Roadless Rule and desired conditions identified within each IRA. Those IRA's with exceptional Wilderness qualities are managed similarly to Wilderness Study Areas so that they remain suitable and eligible for potential Wilderness designation.

The Wild and Scenic Rivers Act of 1968 established the National Wild and Scenic Rivers System for protection of selected national rivers and their immediate environments, which possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values which are to be preserved in free-flowing condition. Rivers determined eligible for WSR designation on the BTNF are identified in the Forest Plan. These eligible rivers are required to be managed so they remain suitable and eligible for WSR designation.

The 2009 Craig Thomas Snake River Headwaters Legacy Act designated eligible Wild and Scenic Rivers on the BTNF. In 2014 the Snake River Headwaters Comprehensive River Management Plan (CRMP) established management direction for designated Wild and Scenic River segments within the BTNF. The CRMP established river corridor boundaries and incorporated river-specific goals, objectives, desired future conditions, standards and guidelines, user capacities, monitoring, and other management practices necessary to achieve desired resource conditions. All designated river segments are managed to protect and enhance their outstandingly remarkable values, free-flowing condition, and water quality for future generations. Invasive plants are of concern for designated and eligible WSR's if they threaten water quality, recreation opportunities, and scenic quality, or other outstandingly remarkable values.

Analysis Method

The potential effects of invasive plant treatment on Wilderness, WSA's, IRA's, and designated and eligible WSR's were identified as a concern by some scoping respondents and Forest Service specialists.

The analysis for Wilderness, WSA's, IRA's, and WSR's evaluated the potential for invasive plant treatment alternatives to affect the ecological condition and/or social environment within these designated or eligible areas.

Affected Environment

Wilderness, WSAs, and IRA's

The Bridger-Teton administers the entirety of the Bridger, Gros-Ventre, and Teton Wilderness Areas, together which comprise 1.33 million acres. In addition, the BTNF manages the Palisades and Shoal Creek WSA's. Table 23 describes Wilderness, WSA's, and IRA's on the BTNF.

Table 22. Wilderness, Wilderness Study Areas (WSA's) and Inventoried Roadless Areas (IRA's) on the Bridger-Teton.

Wilderness Areas	Acres on BTNF
Bridger Wilderness	428,087
Gros Ventre Wilderness	317,784
Teton Wilderness	585,238
Total Wilderness Acres	**1,331,109**

All three Wilderness Areas and both WSA's have known populations of noxious weeds such as Canada and musk thistle. There are cheatgrass infestations at lower elevations along access roads and at the trailheads and on the periphery of each area. Invasive weed treatments are necessary within Wilderness, WSA's, and IRA's to provide for the protection and perpetuation of natural biophysical conditions, while also maintaining a high degree of solitude for visitors. Some lower-priority weeds (e.g., houndstongue) can be effectively controlled by pulling or grubbing, after which the weeds are bagged and hauled out of the wilderness. However, virtually all of the high-priority species cannot be controlled in that manner and may even spread with such attempts. For these, herbicide application is the only long-term solution to eliminate them and maintain native plant communities and the wilderness character.

Designated & Eligible Wild & Scenic Rivers:

Congress established the Wild and Scenic Act to protect rivers and their immediate environments for the benefit and enjoyment of present and future generations; to preserve selected rivers in their free-flowing condition; and to protect water quality and fulfill other vital national conservation purposes. The goal of the National System is not to halt use of a river but to preserve the character of a river. Uses compatible with the management goals of a particular river are allowed; change is expected to happen. However, development must ensure the river's free flow and protect its "outstandingly remarkable resources." The intent of Congress was to create a national system of protected rivers that co-exist with use and appropriate development.

Rivers and streams on the BTNF have been evaluated for Wild and Scenic eligibility. The 2009 Craig Thomas Snake River Headwaters Legacy Act designated several of these waterways into the WSR system. The following table lists designated and eligible rivers, along with their length and designated (or potential) classification. Nearly all the eligible wild and scenic rivers have known populations of high-priority noxious weeds and all have at least some areas with cheatgrass infestations.

Table 23. Designated or eligible Wild and Scenic Rivers on the Bridger-Teton.

Designated WSR	Segment Length (miles)	2009 Designated Classification
Bailey Creek	6.9	Wild
Blackrock Creek	21.7	Scenic
Buffalo Creek	84.4	Wild/Scenic
Crystal Creek	19.2	Wild/Scenic
Granite Creek	18.2	Wild/Scenic
Gros Ventre River	56.6	Scenic
Hoback River	10.7	Recreational River
Pacific Creek	29.3	Wild/Scenic
Shoal Creek	8.5	Wild
Snake River	32.7	Wild/Recreational
Willow Creek	16.2	Wild
Wolf Creek	7	Wild
Total Designated WSR Miles		
Eligible WSR	**Segment Length (miles)**	**Recommended Classification**
Greys River	56	Recreational
Salt River	11	Wild/Recreational
Green River	37	Wild/Scenic

Environmental Effects

Invasive weed treatments proposals for each alternative were evaluated to determine their potential effects on Wilderness, WSA's, WSR's, and IRA's. It is important to note that effects identified for Issues 1, 2, 3, and 4 (regarding native vegetation, invasive plant species, Threatened, Endangered, and Sensitive species and their habitat, soil, water, aquatic resources, fisheries, and human health and safety) all pertain to overall effects to Wilderness, WSA's, designated and eligible WSR's, and IRA's. Each of these specially designated or eligible areas have potential to be affected directly or indirectly by invasive weeds and proposed treatment methods to control these invasives, as described for Issues 1, 2, 3, and 4.

Indicators Used for Comparison of Alternatives

The following two indicators were used for comparison of alternatives for Wilderness, WSA's, and IRA's:

1. Alternative's ability to provide for the protection and perpetuation of natural biophysical conditions.
2. Alternative's ability to provide or sustain a high degree of solitude for visitors with minimal perceptible evidence of past human use.
3. Untrammeled/natural integrity.

The following two indicators were used for comparison of alternatives for designated and eligible Wild & Scenic Rivers:

1. Alternative's ability to protect and enhance outstandingly remarkable values related to biophysical conditions.
2. Alternative's ability to protect and enhance outstandingly remarkable values related to recreation opportunities and scenic quality.

Also considered were conclusions drawn by Resource Specialists for other resources, particularly Vegetation, Wildlife, Fisheries, Hydrology & Aquatic Habitat, Soils, and Human Health & Safety.

Appendix A contains a complete list of protection measures that apply to all resources (plants and wildlife, soil, water, aquatic resources and fisheries, human health and safety, cultural resources, and recreation. All of these resources are components of Wilderness, WSA's, IRA's, and designated and eligible WSR's, and most of these protective measures apply within these designated or eligible areas.

Effects Common to the All Alternatives

Environmental effects, including cumulative effects, to Wilderness, WSA's, IRA's, and WSR's Wild are based upon known existing conditions, trends, and expected responses to the proposed action and alternatives. As discussed above, effects identified for other resource areas (Vegetation, Hydrology, Fisheries, Wildlife, Soils, and Human Safety), have potential to also affect Wilderness, Wild & Scenic Rivers, research natural areas, and special interest areas, particularly where ecological function is out of balance within these areas.

Invasive weeds will continue to spread throughout the BTNF without aggressive prevention and weed treatments, as they have on other public and private lands across the nation.

Alternative 1 – No Action

Wilderness, WSA's, IRA's, and WSR's: Backpack and horse-transported herbicide sprayers, as well as hand-pulling of invasive plants, would continue inside Wilderness, WSA's, and IRA's. Herbicides would also be applied by motorized vehicle inside accessible portions of IRA's and WSRs as well. Protective measures described in the 2004 EA would continue.

Alternative 1 - Effects to Wilderness, WSA's, and IRAs:

1. **Natural Biophysical Conditions**: This alternative would continue to have limited positive effects to Wilderness, WSA's, and IRA's as invasive weed treatments would continue. However this alternative would have the least positive effect on natural biophysical function compared to Alternatives 2 and 3 because newer, more effective herbicides would not be available, new invasive species would not be treated, adaptive management would be limited, and protective measures would not be updated. As a result, cheatgrass and other highly invasive species would be expected to be introduced and/or spread further into Wilderness, WSA's, and IRA's on the Forest, thus disrupting ecosystem function by directly displacing native plant species with invasives, which adversely affects terrestrial and aquatic ecosystem function.
2. **High degree of solitude for visitors:** Opportunities for Wilderness solitude could be directly, adversely impacted by the presence of workforce and equipment engaged in treatment activities, but these impacts would be minimal, sporadic, and temporary, and thus minor. Opportunities for solitude in Alternative 1 would be expected to be about the same as Alternative 3, but greater than Alternative 2 because Alternative 2 would allow aerial application of herbicides within or near these designated areas. A Minimum Requirements Analysis (per Appendix A) would be required for consideration of aerial application inside Wilderness under Alternative 2.

Effects to **Designated & Eligible Wild and Scenic Rivers:**

1. Outstandingly remarkable values related to biophysical conditions: Direct effects of the current treatment approach on outstandingly remarkable river values would be negligible with this alternative. However, as recreation, domestic livestock, and other uses facilitate the spread of invasive weeds within river corridors, more acres of native plant communities would be expected to become overtaken with invasive weeds with this alternative than the other two alternatives, resulting in direct and indirect adverse impacts to outstandingly remarkable values for designated and eligible rivers.
2. Recreation opportunities and scenic quality: This alternative would be expected to result in continued treatment of invasive weeds, however these treatments would be less effective than alternatives 2 and 3, resulting in eventual adverse effects to recreation opportunities and scenic quality in designated and eligible WSR's.

Overall, Alternative 1 affords less protection of natural integrity and ecological processes within Wilderness, WSA's, and designated or eligible WSR's than Alternatives 2 and 3 because: new invasives would not be treated; newer and more effective herbicides would not available; adaptive and integrated management options would not be updated; protective measures would not be updated, and aerial herbicide would not be used. Large populations of invasives such as cheatgrass would not be effectively treated outside these areas and therefore would have higher potential to spread into these areas. Treatment activities would initially impact the untrammeled, natural integrity of wilderness, but these adverse impacts would be offset by the beneficial long-term positive impact of maintaining or re-establishing natural integrity/ecological processes when invasive plants are eradicated.

Alternative 2 - Proposed Action

Wilderness, WSA's, IRA's, and WSR's: With Alternative 2, backpack and horse-transported herbicide sprayers, as well as hand-pulling of invasive plants, would continue inside Wilderness, WSA's, and IRA's. New invasives would be treated, newer and more effective herbicides would available, protective measures and adaptive management options would be updated, and aerial herbicide treatments would be employed where determined necessary and appropriate. Herbicides would be applied by motorized vehicle inside accessible portions of IRA's and WSRs as well. Protective measures described in the 2004 EA would continue.

Alternative 2 - Effects to Wilderness, WSA's, and IRAs:

1. **Natural Biophysical Conditions**: This alternative would be expected to have the greatest positive effects to natural biophysical conditions of Wilderness, WSA's, and IRA's of the three alternatives because more effective herbicides would be available, new invasive species would be treated, and adaptive management and protective measures would be updated, and aerial herbicide application would be available where determined needed and appropriate. As a result, cheatgrass and other highly invasive species would be expected to be more effectively controlled outside of designated areas, preventing further infestations inside designated areas. This alternative would therefore be expected to result in preventing disruption of ecosystem function inside Wilderness, WSA's, and IRA's.
2. **High degree of solitude for visitors:** Opportunities for Wilderness solitude could be directly, adversely impacted by the presence of workforce and equipment engaged in treatment activities, and these impacts would be expected to be minimal, sporadic, and temporary, and thus minor. Opportunities for solitude in Alternative 2 would be expected to be about the same as Alternative 3, but less than Alternative 1 because Alternative 2 would allow aerial application of herbicides within or near these designated areas. Aerial treatment would only be used in Wilderness if considered necessary through Minimum Requirements Analyses to be necessary to re-establish and/or protect native plant populations (per Appendix A).

Effects to **Designated & Eligible Wild and Scenic Rivers:**

1. Outstandingly remarkable values related to biophysical conditions: Direct effects of invasive weed treatment on outstandingly remarkable river values would be most positive in Alternative 2 compared to Alternatives 1 and 3 because Alternative 2 would allow aerial spraying, which has been determined to be the most effective treatment for large infestations such as cheatgrass. The option to use newer, more selective and effective herbicides would be expected to reduce the potential adverse effects of invasive species introduction and spread from various uses within these river corridors.
2. Recreation opportunities and scenic quality: This alternative would be expected to result in continued treatment of invasive weeds, with the most effective outcome than alternatives 1 and 3 because aerial spraying would be utilized if determined appropriate and necessary. Aerial spraying may result in temporary adverse effects to recreation opportunities and scenic quality in designated and eligible WSR's, but these short-term effects would be minimal compared to the long-term effects of invasive species.

Overall, Alternative 2 affords the most beneficial effects to protection of natural integrity and ecological processes within Wilderness, WSA's, and designated or eligible WSR's compared to Alternatives 1 and 3 because: new invasives would be treated; newer and more effective herbicides would be available; adaptive and integrated management options and protective measures would be updated, and aerial herbicide would be available to be used where determined appropriate and necessary. Large populations of invasives such as cheatgrass would be more effectively treated outside these areas and therefore would have less potential to spread into these areas. Treatment activities would initially impact the untrammeled, natural integrity of Wilderness, but these adverse impacts would be offset by the beneficial long-term positive impact of maintaining or re-establishing natural integrity/ecological processes when invasive plants are eradicated.

If aerial application is used to treat cheatgrass, impacts on opportunities for solitude would be greater under the proposed action than under Alternatives 1 and 3. However, these impacts would be expected to be short-term and minimal because most cheatgrass infestations are at lower elevations and most Wilderness and WSA's are located at elevations above 8000 feet.

Alternative 3 – Same as Alternative 2 but No Aerial Application of Herbicides

Alternative 3 - Effects to Wilderness, WSA's, and IRAs:

1. **Natural Biophysical Conditions**: Alternative 3 would be expected to have more positive effects to natural biophysical conditions of Wilderness, WSA's, and IRA's than Alternative 1, but less positive effects than Alternative 2 because aerial herbicides would not be available. As a result, cheatgrass and other highly invasive species would be expected to be less effectively controlled outside of designated areas, spreading within, or further within these designated areas, resulting in disruption of ecosystem function.
2. **High degree of solitude for visitors:** Opportunities for Wilderness solitude could be directly, adversely impacted by the presence of workforce and equipment engaged in treatment activities, and these impacts would be expected to be minimal, sporadic, and temporary, and thus minor. Opportunities for solitude in Alternative 3 would be expected to be about the same as Alternative 1, but greater than Alternative 2 because aerial application of herbicides would not be used within or near these designated areas.

Effects to **Designated & Eligible Wild and Scenic Rivers:**

1. Outstandingly remarkable values related to biophysical conditions: Direct effects of invasive weed treatment on outstandingly remarkable river values would be less positive in Alternative 3 compared to Alternative 2, and more positive than Alternative 1. The option to use newer, more selective and effective herbicides would help reduce the potential adverse effects of invasive species introduction and spread from various uses within these river corridors, but without aerial spraying, larger infestations such as cheatgrass will likely spread further into these corridors, disrupting biophysical conditions.
2. Recreation opportunities and scenic quality: This alternative would be expected to result in continued treatment of invasive weeds, with a more effective outcome than Alternatives 1, but less than Alternative 3 because aerial spraying would not be available. Aerial spraying would therefore not result adverse effects to recreation opportunities and scenic quality, but increased weed infestations would disrupt recreation opportunities and scenic quality.

Overall, Alternative 3 affords less beneficial effects to protection of natural integrity and ecological processes within Wilderness, WSA's, and designated or eligible WSR's compared to Alternatives 2, but more beneficial effects than Alternative 1.

If aerial application is used to treat cheatgrass, impacts on opportunities for solitude would be greater

Cumulative Effects

There are no past, present, or reasonably foreseeable future actions that, when combined with any of the three alternatives, would adversely affect the positive results of treating invasive weed species within or near Wilderness, Wilderness Study Areas, Inventoried Roadless Areas, or Wild & Scenic Rivers.

Special Interest Areas and Research Natural Areas

Special Interest Areas (SIA) are managed with emphasis on protecting or enhancing areas of unusual characteristics. This includes botanical characteristics such as uncommon plant habitats or rare plant species. Research Natural Areas (RNA) are selected to provide a spectrum of relatively undisturbed areas representing a wide range of natural variability within important natural ecosystems. RNAs are often areas with special or unique characteristics or scientific importance. Some RNAs represent key elements of plant diversity on the Bridger-Teton because they include sites with rare plants and specialized plant habitats.

Affected Environment

No significant issues related to these resources were identified during public scoping. However, the potential effects of invasive plant treatment on RNAs and SIAs were identified as a concern.

The Bridger-Teton established four Research Natural Areas and two Special Interest Areas in April 1999. The following areas were found suitable and have been established as Research Natural Areas: Afton Front RNA; Swift Creek RNA; Gros Ventre RNA (previously Horse Creek Proposed RNA; name changed to avoid duplication in the National RNA network); and Osborn Mountain RNA. Kendall Warm Springs and Big Fall Creek have been established as Special Interest Areas.

Invasive weed populations exist in both of the SIAs on the forest. Canada thistle (*Cirsium arvense*) is common in wetland and riparian areas across the forest and infestations of cheatgrass (*Bromus tectorum)* are present across the Bridger-Teton NF.

- If any treatment is desired within RNA boundaries, concurrence must be obtained from the forest botanist, cooperating USFS Research Station and all other relevant partners prior to treatment implementation.
- If treatment is desired in Special Interest Areas that have special botanical values, treatment must be planned and executed with concurrence from the forest botanist. If treatment is desired in the Kendall Warm Springs Special Interest Areas, treatment must be planned and executed with concurrence from the forest fisheries biologist. Treatment in SIAs with other characteristics such as historic or zoological values, must be coordinated with relevant natural resource specialists prior to implementation.

Environmental Effects

To protect the values for which the SIAs and RNAs were identified, the measures listed below would be implemented. Appendix A contains a complete list of protection measures, including those that apply to threatened, endangered and sensitive plant species and riparian/wetland areas.

- If any treatment is desired within RNA boundaries, concurrence must be obtained from the forest botanist, cooperating USFS Research Station and all other relevant partners prior to treatment implementation.
- If treatment is desired in SIAs that have special values, treatment must be planned and executed with concurrence from the appropriate forest program manager for that value.

The effects analysis focused on those SIAs designated to protect and enhance botanical values since they are most likely to be affected by treatment of invasive plant species. For effects to SIAs with historical components, see the discussion in the *Cultural Resources* section. Zoological effects are covered in the wildlife section. Effects to scenic values would be similar to those discussed above for wilderness and wild and scenic rivers.

Alternative 1 – No Action

Hand-pulling of weeds is unlikely to adversely impact the special qualities of SIAs and RNAs, but may be a low-impact method of reducing small-scale weed infestations.

Herbicide use in SIAs and RNAs would be tightly controlled and herbicides would only be used when deemed necessary by specialists from multiple disciplines and/or outside agencies. This would greatly reduce or prevent possible adverse effects. Herbicide treatments should be avoided when possible in other areas with high wetland cover and where sensitive species and wetland/water body buffer zones are difficult to administer.

The beneficial effects of weed control in RNAs and SIAs are potentially great. The ability to treat infestations as they are discovered and before they threaten local vegetation on a large scale may be vital to preserving the natural and undisturbed nature of native vegetation and high-value plant communities. If weed invasions were allowed to occur unchecked, some SIAs and RNAs could experience shifts in vegetation. Changes in species composition and related effects on soils and fire regimes could compromise the utility of SIAs and RNAs for conservation, research, education and as reference landscapes. Treating weed infestations as they occur is also consistent with the forest plan and specific guidance for established RNAs and some SIAs.

Alternative 2 - Proposed Action

Alternative 2 includes all of the actions and associated beneficial and adverse effects of Alternative 1. Additional treatments proposed in Alternative 2 include the use of herbicides and biocontrol mechanisms that are developed in the future and are not yet approved and the use of aerial spraying to apply selective herbicides. Aerial application of herbicide is unlikely to be frequently used on RNAs and SIAs.

Aerial application would be controlled by protection measures and used only when deemed necessary by specialists from multiple disciplines and/or outside agencies. This would greatly reduce or prevent many possible adverse effects. Aerial spraying is not recommended in any SIA or RNA that has high wetland cover or abundant sensitive species because spray buffers may be hard to administer and windy conditions may cause excessive herbicide drift.

Alternative 3 - No Aerial Application of Herbicides

The effects of this Alternative would be the same as those described for Alternative 2 (proposed action) minus the effects of aerial herbicide application.

Cumulative Effects

There are no cumulative effects because we don’t allow any activities in RNAs and SIAs that could jeopardize the reasons for which they were designated so we don’t have any past, present, or reasonably foreseeable future actions affecting these areas.

Recreation

Analysis Method

No significant issues related to these resources were identified during public scoping. However, the potential effects of invasive plant treatment on recreation users were identified as a concern.

The recreation aspect evaluated is loss of opportunity as measured by persons at one time (PAOT) days and visitor satisfaction. PAOT days are objective measures of the quantity of opportunities and visitor satisfaction is a measure of the quality of opportunities. Loss of opportunity can also be measured by a change in the recreation opportunity spectrum (ROS). However ROS is not a meaningful metric for this analysis since none of the alternatives would change ROS classes on the Bridger-Teton.

Persons at one time is a common measure of recreation capacity most often used at developed areas. PAOTs may also be estimated for dispersed-use areas. PAOT days are calculated by multiplying the PAOT capacity of a site by the operating season. A reduction in PAOT days represents a reduction in supply. The practical impact of a reduction may be tempered because few sites operate at maximum capacity. Visitor satisfaction is generally characterized as the difference between a visitor’s expectations and experiences. This is widely used as a surrogate for recreation quality.

Affected Environment

The Bridger-Teton's ability to meet a growing demand for recreation is being undermined by factors that are reducing the range, nature and quality of existing recreation opportunities. Recreation opportunities on the two forests are already limited by a short season. Added tothat are impacts to popular recreation sites from the regional bark beetle epidemic and recreation facilities that are not being adequately maintained or are being closed. The net effect is that developed recreation supply is limited or even declining while demand increases.

According to surveys conducted in 2007 and 2008, about 2.7 million recreation visits are made to the Bridger-Teton each year (USDA Forest Service, no date). The Bridger-Teton maintains hundreds of recreation sites, with varying levels of development from remote trailheads to developed campgrounds. PAOT-days capacity is about 1,800,000 (this is a measure of total annual capacity).

Surveys conducted in 2007 and 2008 indicate that most Bridger-Teton visitors are satisfied with the recreation services and facilities they encounter. However, satisfaction tends to be lower at developed areas and lowest at campgrounds where visitors expressed some dissatisfaction with the condition and cleanliness of facilities and the availability of information, among other items (USDA Forest Service, no date).

Environmental Effects

The primary mechanism by which invasive plant treatment could affect recreation users is loss of opportunity due to area/trail/road closures or warnings according to herbicide label directions or other safety protocols associated with treatment activities. Loss of opportunity could also result wherever invasive plants present a physical barrier or otherwise limit access or specific activities (e.g. thorny or bristly plants such as musk thistle, plants that obstruct waterways).

Invasive plant treatment could affect satisfaction if visitors are exposed to odors, noise or other evidence of treatment activities. Satisfaction could also be affected if invasive plants impede travel or cause discomfort or if they cause changes in the perceived environment

Alternative 1 – No Action

Ground-based, herbicide treatments occurring at the same time and place that visitors are recreating could result in a short-term loss of recreation opportunity. Closures for herbicide treatments would typically last less than 48 hours and might occur at a handful of sites each year. As an extreme example, if 25% of all the developed recreation sites on the Bridger-Teton experienced a 48 hour closure for weed treatment every year, the result would be a less than 1% reduction in PAOT days. ROS class and the percentage of acres assigned to each ROS class would not change. Both beneficial and adverse impacts would likely occur to visitor satisfaction: adverse impacts where visitors are directly exposed to treatment activities and beneficial impacts where treatments are effective in reducing or eliminating bothersome/nuisance plants.

Alternative 2 - Proposed Action

The effects of the proposed action on recreation users would be similar to those described under Alternative 1, except that more temporary closures could occur due to additional treatment acres. Any increase in closures and related impacts would be minimal.

The main target for additional treatment acres would be expansive areas where aerial application of herbicides is the most practical option. Aerial application would not be used in developed campgrounds and dispersed recreation is most common in forested areas and near water-bodies where aerial application would likewise be restricted or not used.

Alternative 3 – No Aerial Application of Herbicides

The effects of this Alternative would be the same as those described for Alternative 2 (proposed action). The absence of aerial spraying would not change the effects described above for the proposed action because aerial spraying is expected to have minimal, if any, impact on recreation areas.

Cumulative Effects

The temporal boundary for this cumulative effects analysis is 10-15 years. 2008 is generally recognized as the year the ongoing mountain pine beetle outbreak really took hold on the Bridger-Teton, resulting in a number of hazard mitigation actions such as temporarily closing recreation sites and clearcutting campgrounds to remove dead and dying trees. The spatial bounds for the analysis include all lands administered by the Bridger-Teton, as well as adjacent communities and regional population centers where changes in recreation supply and demand could affect use on the forest.

Cumulative impacts would be greatest under Alternative 2 because of the greater possibility of short-term area closures for spraying. This effect, combined with the effects of the mountain pine beetle epidemic and reduced maintenance at facilities or their closure, has the greatest likelihood of reducing recreation opportunity and visitor satisfaction. Alternatives 1 and 3 would have similar cumulative effects but the effects would be less than under Alternative 2 because aerial spraying of large areas is not part of Alternatives 1 & 3.

Forest Plan Consistency

The three alternatives are consistent with standards and guidelines for recreation in the forest plan.

Cultural Resources

Regulatory Framework

Under the terms of the 2009 Programmatic Agreement (PA) between the Wyoming State Historic Preservation Office (SHPO), the Advisory Council on Historic Preservation (ACHP) and National Forests in Wyoming, the application of pesticides that do not have the potential to affect access to or use of resources by Native Americans can be excluded from further review. SHPO and Native American Tribes have been notified of this project, and the project will be documented in the Annual FS Report to SHPO. No cultural resource concerns have been identified through project notification of consulting parties. Further, the PA exempts mowing treatment with a brush hog or similar rubber-tired equipment from review and/or consultation unless managers, planners, or heritage staff have reason to believe that a specific undertaking may affect historic properties.

Analysis Method

The following assumptions were used in assessing the environmental effects of treating invasive plants:

- Cultural resources are managed according to existing laws, regulations and programmatic agreements to protect these resources.
- Cultural resource sites are numerous and only significant cultural sites warrant intensive consideration for analyzed effects.
- A historic property – a cultural site that is eligible for inclusion in the National Register of Historic Places – is a useful means of ascribing significance to a cultural site. Additionally, potential Traditional Cultural Properties (TCPs), sacred sites, and traditional Native American gathering and use areas that have not been recorded can also be considered possible significant cultural sites.
- Ground disturbing activities, auditory, chemical and visual impacts have the potential to affect cultural resources.
- Adverse impacts to significant Native American cultural sites can come from disturbances to traditionally used plant communities.
- Pesticide presence can be detrimental to human consumption and use of plants.

Adverse effects or impacts are defined as those which compromise the integrity of a resource and may affect its eligibility for inclusion in the National Register of Historic Places or which compromise the integrity or use of a sacred or traditional site.

Affected Environment

A wide variety of cultural site types are present on the Bridger-Teton representing at least 12,000 years of human history. Known prehistoric sites types include lithic procurement areas, lithic production areas, habitation sites, food processing sites, rock cairns and alignments, trails, sacred sites, and rock art. Additionally, current Native American resource gathering areas, sacred sites and TCP's are considered a part of the affected environment for cultural resources. Historic period sites such as emigrant trails, homesteads, mines, cowboy camps, and tie hack camp sites illustrate the initial westward expansion and settlement of Euro-Americans into the general area. Lodges, resorts and campgrounds document the evolution of outdoor recreation movements in the Late 19th and Early 20th Centuries. Depression-era structures built by the Civilian Conservation Corps, such as early Forest Service guard stations and lookout towers, continue to illustrate past social and economic investment in federal land management.

Environmental Effects

Invasive plant management activities have the potential to affect significant cultural resources.

Alternative 1 – No Action

Activities that do not cause ground disturbance, such as the current hand application of herbicides, do not pose significant or notable effects to the majority of cultural resource sites, such as most historic sites or prehistoric sites. Sacred sites and TCP's may be temporarily affected by very minimal auditory and visual factors as well as human presence during application. Additionally, traditional plant gathering areas may be affected by the application of pesticides on plants that Native Americans may use for consumption or other traditional uses. The degree of the effect of the presence of herbicides on gathered plants could be measured by the amount of herbicides present on collected plants and the frequency, intensity, and nature of human use and/or consumption of the plant. No documentation of pesticide use at traditional plant gathering areas located on the Bridger-Teton NF exists. Complicating relevant factors include that the presence of herbicides may not be known to Native Americans, and that minimal levels of pesticide and herbicide are approved by the USDA. Current pesticide use has been conducted to a degree that it has not had a measurable effect nor an adverse effect to significant cultural resources and historic properties. Beneficial impacts include management actions and policies that result in preserving and restoring traditional plant species.

Alternative 2 - Proposed Action

Aerial application of herbicides has the potential to affect significant cultural resources in a manner similar to Alternative 1, however the scale of herbicide application and number of sites to potentially affect cultural resources would increase. Potential auditory and visual potential impacts to sites would shift from ground-based only to include air-based. Integrated Pest Management (IPM) tools have the potential to impact significant cultural resources. Prescribed fire and livestock grazing are both common impacts on the Bridger-Teton NF, and both activities are independently analyzed for impacts to cultural resources and are managed with the goal of avoidance of adverse effects to historic properties. Hand pulling, mowing or cutting weeds has the potential to affect prehistoric sites, however the potential effect is minimal and highly unlikely to affect the integrity of a site. Mechanical disking clearly has the potential to adversely affect historic properties, most notably archaeological sites. Disking would necessitate cultural resource survey aimed at identification of sites and avoidance during implementation.

If invasive plant treatment moves existing vegetation back to native plant communities, it could be beneficial to any Traditional Cultural Properties (TCPs) and sacred sites. Native plant communities would benefit the perception of the site setting as well as potential Native American plant use of the lands. This would be more likely under Alternatives 2 and 3 because of the option to treat larger areas under Alternative 2 and the option to use newer, more selective/effective herbicides under Alternatives 2 and 3. Alternative 1 could achieve this result to a lesser degree.

Alternative 3 – No Aerial Application of Herbicides

Alternative 3 would pose the same potential IPM effects to significant cultural resources as mentioned in Alternative 2, as well as the ground based application effects described in Alternative 1.

Cumulative effect

Because all actions that involve ground-disturbing activity will be surveyed for historic properties and the standard for these projects is to avoid any adverse effects to significant historic properties, there should be no measurable cumulative effects to historic properties under any alternative.

Forest Plan Consistency

All alternatives are consistent with the cultural resources standards and guidelines in the forest plan.

Social and Economic Aspects

Analysis Method

The analysis considered potential impact to adjacent landowners and other partners working to reduce/eliminate the occurrence and spread of noxious weeds and invasive plants within the analysis areas. No specific social and economic issues were highlighted during the scoping process.

Data on acres treated for invasive plants on private, county, or other ownerships and their effectiveness or rate of reintroduction were not collected or were not available for this analysis. A qualitative description of potential impacts was completed based on the assumption that other land owners would complete treatments similar to those on NFS lands. The analysis assumed treatments would continue on NFS lands and adjacent lands in the analysis areas for 10 to 15 years.

Affected Environment

Five counties and their associated communities were considered in the analysis: Fremont, Lincoln, Park, Sublette and Teton.

Environmental Effects

Alternative 1 – No Action

It is unlikely that the spread of noxious weeds across the Bridger-Teton would be controlled under Alternative 1 because of the limited number of acres that would be treated annually and the limited range of treatment options available. Weeds would likely spread onto adjacent non NFS lands.

The economic impacts of this invasive species spread could be reduced forage for livestock and wildlife, lower land values and an inability to participate in or maintain effective weed control partnerships with adjacent landowners. Adjacent communities in the analysis areas could see an economic impact of the invasive species since these communities rely, to varying degrees, on the resources available on the Bridger-Teton.

Alternative 2 - Proposed Action

The more effective treatment options in Alternative 2 would reduce the economic impacts of invasive species and allow improvement in the quantity and quality of native vegetation. This would maintain and/or increase the value of the land and resources in the analysis area. Weeds would spread onto fewer adjacent and intermingled private and state acres.

Economic impacts would occur where noxious and invasive plants begin to die off and native plant populations begin to recover. In some areas, soil conditions may require additional, short- term expenditure to prevent or reduce the risk of erosion-related impacts and to hasten the restoration of native plants, where appropriate. These impacts should decrease as native plant populations recover.

The Bridger-Teton would continue to build partnerships with federal, state and county agencies and cooperators such as grazing associations and oil and gas companies as part of an integrated invasive species and noxious weed treatment program.

Alternative 3 - No Aerial Application of Herbicides

This Alternative would have smaller beneficial economic effects than Alternative 2 because it does not include aerial spraying for cheatgrass or other annual invasives should they be discovered. It would still limit the spread of invasive species, improve native vegetation and maintain the value of the land and resources to a limited degree.

Cumulative Effects

The past, present and reasonably foreseeable future actions considered in this cumulative effects analysis were decreasing land values and decreasing livestock market values in the analysis area. Existing invasive species infestations and their potential spread can further reduce land values and can reduce available forage making it more expensive to run domestic livestock. Habitat for sage-grouse and other sagebrush-dependent species could be reduced or locally eliminated.

Crucial big game winter ranges, especially for mule deer, could experience increased infestations of cheatgrass and huntable populations could be reduced. This decrease of goods and services from the natural environment impacts the economic well-being of the rural areas and communities in the analysis area and the economic stability of these areas becomes strained.

Adverse cumulative effects under the proposed action (Alternative 2) would be less than the other alternatives. With more acres treated and more treatment options, communities in the analysis areas would see little economic impact from invasive species. Grazing, wildlife habitat, ecosystem function and recreational opportunities would continue to benefit the economic well- being of rural communities. Adjacent landowners and managers and county, state and other federal agencies providing cooperative weed treatment support would have greater success with treatments on their lands because NFS would be more likely to match or exceed adjacent landowner programs.

Adverse cumulative effects from Alternatives 1 and 3 would fall between those described above. Cumulative effects from Alternative 3 would be less than those from Alternative 1.

Forest Plan Consistency

There are no forest plan standards and guidelines specific to social and economic resources as they relate to invasive or noxious weeds. Forest Plan Goal 1.1 relates to community prosperity, which has objectives relating to recreation, wildlife migration and livestock forage. All are impacted by invasive species. Alternative 2 does more to meet these long-term goals and objectives as they relate to the impacts of invasive and noxious weeds than Alternatives 1 and 3.

Climate Change

Rising CO_2 levels, increasing surface temperature and the likely instability of weather and precipitation patterns have the potential to increase the spread of invasive species (Ziska et al. 2010). Alternatives 1 would limit the Bridger-Teton's ability to effectively treat invasive species. Alternatives 2 and 3 would provide more treatment options and allow treatment of new invasive species. This would improve the Bridger-Teton's ability to manage climate-change-induced invasive species spread. Alternative 2 would add the option of treating large infestations (particularly cheatgrass) with aerial herbicide application.

There is no way to quantify increases or decreases in CO_2 between the proposed action (Alternative 2) which treats the maximum acres of invasive species and Alternative 1 which treats the minimum.

Forest Plan Consistency

There is no forest plan direction specific to climate change.

Other Resources in the Project Area

The IDT evaluated the following resources and determined there were no effects from the proposed action or alternatives. None of the resources listed was identified as an issue during scoping or a concern by the IDT.

Table 24. Project area resources that were not included in the DEIS.

Resource	Summary of Potential Effects
Livestock grazing	Possible effects to livestock grazing have been analyzed in other resource sections: native vegetation, human health, hydrology, soils and socio-economic aspects. The alternatives are consistent with standards and guidelines for livestock use, range and livestock grazing in the forest plan.
Fire and fuels	Invasive plant species can affect fuel type and fuel loading and continuity. Cheatgrass increases the frequency with which areas burn. With more frequent fires, native shrubs and perennial grasses cannot recover and a cheatgrass monoculture can develop. This monoculture further increases the frequency of fires and increases the dominance of cheatgrass in the area. Cheatgrass potentially could colonize areas that would normally be bare ground adding to the fuel continuity and therefore increasing the fire hazard adjacent to private lands and infrastructure. Alternative 2 is consistent with standards and guidelines for fire, fire suppression, fuels treatments and prescribed fire in the forest plan.
Minerals and special uses	Failure to effectively treat invasive species on the Bridger-Teton can make it more difficult for permit holders – both minerals and special uses – to meet weed treatment terms and conditions in their permits. Alternative 2 (proposed action) would minimize this impact to permit holders; The three alternatives are consistent with standards and guidelines for mineral and energy resources in the forest plan.

Short-term Uses and Long-term Productivity

NEPA requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony and fulfill the social, economic and other requirements of present and future generations of Americans (NEPA Section 101).

Alternatives 1, 2 and 3 may result in the short-term loss of non-target species and localized biodiversity in areas where herbicides, some mechanical treatment and fire treatment methods are used. Grazing and some mechanical treatments may affect non-target species through temporary loss of biomass but these plants are generally not killed by these types of treatment actions. Biological agents are host specific and do not have an effect on non-target species. In this analysis, the overall, long-term effect of all identified noxious weed treatments is increased biodiversity and restoration of the natural productivity through the eradication of noxious weeds.

Alternatives 1 and 3 may result in losses of native plant communities, biodiversity, forage production and wildlife habitat due to the anticipated continued spread of noxious weed species, particularly cheatgrass. Greater sage-grouse and other sage-dependent wildlife species may be affected by this loss of habitat.

Unavoidable Adverse Effects

Under Alternatives 1 and 3 loss of native plant communities is a potential unavoidable adverse impact. Since these two alternatives do not have measures to effectively control the existing 25,000+ acres of cheatgrass on the Bridger-Teton, the loss of native plant communities could easily exceed 100,000 acres.

Herbicide treatments proposed in Alternatives 1, 2 and 3 could have some unavoidable environmental impacts. Adverse effects would primarily involve localized, short-term impacts to non-target plants. Although it is possible that small amounts of herbicide could migrate from treatment sites, the resource protection measures in Appendix A would prevent environmentally significant concentrations of herbicide from reaching surface or groundwater. Following label instructions and the use of prescribed personal protection equipment would protect applicators and the public from unacceptable exposure to herbicides and threats to human health.

Mechanical, biological and cultural treatments under all the alternatives have no known unavoidable adverse effects. Thus, under reasonably foreseeable circumstances, there would be no significant environmental effects.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. There would be no irreversible commitment of resources under any alternative.

Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

Under Alternatives 1 and 3 the expected continued expansion of noxious weeds, particularly cheatgrass, could irretrievably reduce or eliminate existing plant diversity and associated resource values, including overall ecosystem function.

Alternatives 1, 2 and 3 may result in some short-term irretrievable commitments of resources as some non-target species of vegetation could be affected by herbicide use in the short-term but would be regained in the long-term. These commitments would be localized and would not have significant effects on biodiversity, wildlife habitat, or forage production.

There would be no irretrievable commitment of resources involving threatened, endangered, proposed, or sensitive wildlife species or other wildlife species of concern from implementing any alternative. Impacts from actions would be short-term. No long-term loss of plant species is predicted from herbicide applications and native forb species reduced by herbicide applications are expected to recover within a few years after treatment and thrive after reduction from weed competition. Under the Alternatives 1 and 3 weed infestations would continue to intensify and spread, grass and forb cover would be reduced and wildlife would be indirectly impacted. The longer weeds are allowed to propagate, the longer it may take to recover plant and animal communities after treatment is undertaken.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with …other environmental review laws and executive orders."

The proposed action is consistent with the Endangered Species Act of 1973. Informal coordination with the U.S. Fish and Wildlife Service (USFWS) began in early 2011 and is ongoing.

The Forest Service consulted with the Wyoming State Historic Preservation Office to ensure compliance with the National Historic Preservation Act of 1966, as amended in 1999. The terms found in the 2009 programmatic agreement (PA) between the Wyoming SHPO and the Bridger-Teton allow for the application of pesticides that do not have the potential to affect access to, or use of, resources by Native Americans to be considered undertakings exempt from further review and/or consultation. Forest managers, planners and heritage staff do not have to notify or consult with SHPO's or other parties about these projects. Further, the PA also allows for mowing treatment with a brush hog or similar rubber-tired equipment to be exempt from review and/or consultation unless managers, planners or heritage staff has reason to believe that a specific undertaking may affect historic properties. A letter was sent to the Wyoming SHPO informing them of the project; no further compliance or concurrence is needed.

The proposed action is consistent with The Clean Water Act of 1972 as amended in 1977 and 1987. Consistency with the act is assured through the application of the resource protection measures identified in Appendix A.

Executive Order 12898, issued in 1994, ordered federal agencies to identify and address the issues of environmental justice (i.e., adverse human health and environmental effects of agency programs that disproportionately impact minority and low income populations). The environmental justice analysis conducted for this DEIS determined that the proposed action will not have a disproportional impact on minority or low income populations.

All alternatives are consistent with Environmental Protection Agency, Occupational Health and Safety Administration, state and federal water and air quality regulations and Forest Service regulations (FSM 2008) regarding pesticide use and worker safety.

Chapter 4.
Consultation and Coordination

Preparers and Contributors

The Forest Service consulted the following individuals, federal, state and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment.

Table 25. Forest Service interdisciplinary team (IDT) members participating in compilation of the draft environmental impact statement

Name	Position Title	Agency/ Organization	Function
Martina Keil	Botanist	Bridger-Teton NF	Reviewer
Chad Hayward	Natural Resources Manager	Bridger-Teton NF	Primary IDT, IDT Leader
Rusty Kaiser	Wildlife Biologist	Bridger-Teton NF	Primary IDT
Kate Olsen	Fisheries Biologist	Bridger-Teton NF	Primary IDT
Anita Delong	NEPA specialist	Bridger-Teton NF	Primary IDT
Gary Hayward	Range specialist	Bridger-Teton NF	Primary IDT
John Paul Schubert	Heritage program manager	Bridger-Teton NF	Primary IDT
Steve Markason	Fuels specialist	Bridger-Teton NF	Reviewer
Kelly Owens	Hydrologist	Bridger-Teton NF	Primary IDT
Cindy Stein	Recreation Program Manager	Bridger-Teton NF	Primary IDT
Todd Neel	Regional pesticide specialist and weed scientist	US Forest Service	Reviewer
Mary Cernicek	Public affairs officer	Bridger-Teton NF	IDT Support
Julie Kraft	Weed Supervisor	Sublette County Weed & Pest	IDT Support
Jill Randall	Terrestrial Habitat Biologist	Wyoming Game and Fish Department	IDT Support
Dan Perkins	Soil Scientist	Natural Resources Conservation Service	IDT Support
Kathy Raper	Water Quality Technician	Sublette County Conservation District	IDT Support
Megan Smith	Writer Editor	EcoConnect Consulting LLC	IDT Support

Federal, State and Local Agencies

During scoping, we met with and/or sent letters to the following local, state and federal government agencies, explaining this project and asking for input. They also received copies of the DEIS.

Table 26. Local, state and federal agencies consulted.

Local government agencies	
Sublette County Commissioners	Pinedale, WY
Lincoln County Commissioners	Kemmerer, WY
Teton County Commissioners	Jackson, WY
Sublette County Conservation District	Pinedale, WY
Teton Conservation District	Jackson, WY
Upper Green River Basin Local Sage-Grouse Working Group	Pinedale, WY
Sublette County Weed and Pest District	Pinedale, WY
Teton County Weed and Pest District	Jackson, WY
Lincoln County Weed and Pest	Afton, WY
State entities	
Wyoming Department of Agriculture	Cheyenne, WY
State Lands & Investments	Cheyenne, WY
Wyoming Game and Fish Department	Cheyenne, Pinedale, Jackson, Kemmerer, WY
Wyoming County Commisioners Association	Cheyenne, WY
Wyoming Wildlife and Natural Resource Trust	Cheyenne, WY
Wyoming Department of Environmental Quality	Cheyenne, WY
Wyoming State Forestry	Pinedale, WY
Congressional delegates	
U.S. Senator John Barrasso	
U.S. Senator Mike Enzi	
U.S. Representative Liz Cheney	
Federal agencies	
U.S. Fish and Wildlife	Grand Junction, CO and Cheyenne WY
U.S. Natural Resources Conservation Service	Pinedale, WY
U.S. Environmental Protection Agency	Denver, CO

Tribes

We sent letters to the following tribes, explaining this project and asking for input. No responses were received. Copies of the DEIS were also sent to these tribes.

Tribes consulted:

Eastern Shoshone Tribe, Fort Washakie, WY

Northern Arapaho Tribe, Fort Washakie and Arapaho, WY

Organizations, Businesses, Individuals

The organizations, businesses and individuals listed below commented on the project during scoping.

List of scoping commenters

Jackson Hole Land Trust
Lincoln County Commission
Richard Artley
Sublette County Commissioners
Sublette County Conservation District
Sublette County Weed and Pest
Teton County Weed and Pest
U.S. Environmental Protection Agency
Upper Green River Basin Local Sage-Grouse Working Group
Western Watersheds
Wyoming Coalition of County commissioners
Wyoming Department of Environmental Quality
Wyoming Game and Fish Department

References

Anderson, D.G. 2004. Potentilla rupincola Osterhout (rock cinquefoil): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/potentillarupincola.pdf [1/24/2011].

Anderson, D.G. 2006. Eriogonum exilifolium Reveal (dropleaf buckwheat): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/eriogonumexilifolium.pdf [1/24/2011].

Anderson, D.G. and D. Cariveau 2003. Botrychium campestre W.H. Wagner and Farrar (Iowa moonwort): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/botrychiumcampestre.pdf [1/24/2011].

Baker, W.L., J. Garner, P. Lyon. 2009. Effect of imazapic on cheatgrass and native plants in Wyoming big sagebrush restoration for Gunnison sage-grouse. Natural Areas Journal 29(3):204-209.

Bakke, David, 2002. Analysis of issues surrounding the use of spray adjuvants with herbicides. USDA Forest Service, Pacific Southwest Region.

Barrile, G., A. Chalfoun, and A. Walters. 2018. Boreal toad habitat selection and survival in relation to grazing intensity and disease prevalence. Interim Report to Wyoming Game and Fish Department, Boreal Toad Project (January 2015-December 2017). Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming.

Bartelt, P. E., C. R. Peterson, and R. W. Klaver. 2004. Sexual differences in the post-breeding movements and habitats selected by western toads (bufo boreas) in southeastern Idaho. Herpetologica 60:455–467.

BASF Corporation, 2008. Plateau herbicide technical bulletin. 8 pp.

Bautista, S.L. 2008. Climate change and invasive plants: information for PNW invasive plant NEPA. USDA Forest Service, Region 6. Portland, Oregon.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming, second edition. Wyoming Game and Fish Department, Cheyenne, Wyoming. Available online: http://wyomingnaturalist.com/html/herps/herp_book.html

Belnap, J. and S.L. Phillips. 2001. Soil biota in an ungrazed grassland: response to annual grass (Bromus tectorum) invasion. Ecological Applications 11: 1261-1275.

Blakney, J. R., Loxterman, J. L., & Keeley, E. R. 2014. Range-wide comparisons of northern leatherside chub populations reveal historical and contemporary patterns of genetic variation. *Conservation genetics*, *15*(4), 757-770.

Carey, C. (1993). Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. *Conservation Biology*, *7*(2), 355-362.

Corn, P.S. 1994. What we know and don't know about amphibian declines in the west. Pages 59-67 in W.W. Covington and L.F. DeBano, technical coordinators. Sustainable ecological systems: implementing and ecological approach to land management. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-247.

Dakheel, A. J.; Radosevich, S. R.; Barbour, M. G. 1993. Effect of nitrogen and phosphorus on growth and interference between Bromus tectorum and Taeniatherum asperum. Weed Research. 33(5): 415-422. [43175]

DiTomaso, J.M. 1999. Invasive weeds in rangelands: species, impacts, and management. Weed Science 48(2): 255-265. http://www.bioone.org/bioone/?request=get- document&issn=0043-

1745&volume=048&issue=02&page=0255Wyoming Dept. of Agriculture. 2011 Biocontrol for Weed & Insect Pests. http://www.colordo.gov/cs/Satellite/Agriculture-Main/CDAG/1167928215160.

DiTomaso, J.M., G.B. Kyser, and M.J. Pitcairn. 2006. Yellow starthistle management guide. Cal-IPC Publication 2006-03. California Invasive Plant Council: Berkeley, CA. 78 pp. Available: www.cal-ipc.org.

Dukes, J.S. and H.A. Mooney. 1999. Does global change increase the success of biological invaders? Trends in Ecology & Evolution 14(4): 135-139.

Elseroad A, N. Rudd. 2011. Can imazapic increase native species abundance in cheatgrass (bromus tectorum) invaded native plant communities? Rangeland Ecology & Management. 64(6):641-648.

Goates, M. C., Hatch, K. A., & Eggett, D. L. 2007. The need to ground truth 30.5 m buffers: A case study of the boreal toad (Bufo boreas). *Biological Conservation*, *138*(3-4), 474-483.

Goodwin, K. and R. Sheley. 2003. Revegetation guidelines for western Montana: considering invasive weeds. Prepared for Missoula County Weed District, Montana. http://msuextension.org/publications/AgandNaturalResources/EB0170.pdf

Gryska, A. D. 1996. Development of population monitoring protocols and description of several life history aspects of Kendall Warm Springs dace Rhinichthys osculus thermalis (Doctoral dissertation, University of Wyoming).

Harris, G.A. 1967. Some competitive relationships between Agropyron spicatum and Bromus tectorum. Ecological Monographs 37(2): 89-111. [1093]

Harris, J.L. (comp.) and R2 FHP staff. 2011. Forest health conditions, 2009-2010, in (R2) Rocky Mountain Region. USDA Forest Service. Renewable Resources, Forest Health Protection, R2-11-RO-31. 108 pp.

Hellamann, J.J.; J.E. Byers; B.G. Bierwagen; and J.S. Dukes. 2008. Five potential consequences of climate change for invasive species. Conservation Biology 22(3): 534-543.

Hirsch, C.L., M.R. Dare, and S.E. Albeke. 2013. Range-wide status of Colorado River cutthroat trout (Oncorhynchus clarkii pleuriticus): 2010. Colorado River Cutthroat Trout Conservation Team Report. Colorado Parks and Wildlife, Fort Collins.

Hossack, B.R., W. R. Gould, D. A. Patla, E. Muths, R. Daley, K. Legg, and P.S. Corn. 2015. Trends in Rocky Mountain amphibians and the role of beaver as a keystone species. Biological Conservation 187:260–269.

J.D. Graham. 1991. Weight of the evidence on the human carcinogenicity of 2,4-D. Environ Health Perspect. 96: 213-22.

Joyce, L.A.; G.M. Blate; J.S. Littell; S.G. McNulty; C.I. Millar; S.C. Moser; R.P. Neilson; K. O'Halloran; and D.L. Peterson. 2008. National Forests. Pp. 3-1 to 3-127. In S.H. Julius, and J.M. West (eds.). Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, D.C. 873 pp.

Kimball, S. and P.M. Schiffman. 2003. Differing effects of cattle grazing on native and alien plants. Conservation Biology 17: 1681-1693.

Klaver, R.W., C.R. Peterson, and D. Patla. 2013. Influence of water conductivity on amphibian occupancy in the Greater Yellowstone Ecosystem. Western North American Naturalist 73:184–197.

Kurz, W.A., C.C. Dymond, G. Stinson1, G.J. Rampley, E.T. Neilson, A.L. Carroll, T. Ebata and L.

Safranyik. 2008. Mountain pine beetle and forest carbon feedback to climate change.

Nature 452: 987-90.

Launchbaugh, K., ed. 2006. Targeted grazing: a natural approach to vegetation management and landscape enhancement - a handbook on grazing as a new ecological service. Integrated Pest Management Practitioners Association IVM Technical Bulletin. Cottrell Printing.

Centennial, CO. 199 pages.

Lawrence, P.K.; S. Shanthalingam; R.P. Dassanayake; R. Subramaniam; C.N. Herndon; D.P. Knowles; F.R. Rurangirwa; W.J. Foreyt; G. Wayman; A.M. Marciel; S.K. Highlander: S. Srikumaran. 2010. Transmission of Mannheimia haemolytica from domestic sheep (Ovis aries) to bighorn sheep (Ovis Canadensis): unequivocal demonstration with green fluorescent protein-tagged organisms. J. Wildl. Dis. 46: 706-717.

Liebman, M., C.L. Mohler, C.P. Staver (eds.) 2001. Weed management: a need for ecological approaches. Cambridge University Press, Cambridge, United Kingdom.

Lowe, Petra N.; Lauenroth, William K.; Burke, Ingrid C. 2002. Effects of nitrogen availability on the growth of native grasses exotic weeds. Journal of Range Management 55(1): 94-98. [40093]

Lym, R.G. and R.K. Zollinger. 1995. Integrated management of leafy spurge (revised). North Dakota State University Extension Service W-866. http://www.ag.ndsu.edu/pubs/plantsci/weeds/w866w.htm

Marriott, H. and M.L. Pokorny 2006. Aquilegia laramiensis A. Nelson (Laramie columbine): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/aquilegialaramiensis.pdf. [1/24/2011].

Marshall, M.P. and H.J. Walt. 1984. Rio Abajo: prehistory and history of a Rio Grande province.

May, B.E., and S.E. Albeke. 2005. Range-wide status of Bonneville Cutthroat Trout (Oncorhynchus clarki utah): 2004. Printed agency report. 139pp.

May, B. E., W. Urie, and B. B. Shepard. 2003. Range-wide status of Yellowstone cutthroat trout (Oncorhynchus clarki bouvieri): 2001. USDA Forest Service, Gallatin National Forest, Bozeman, Montana. 201p.

Muths, E. 2003. Home range and movements of boreal toads in undisturbed habitat. *Copeia*, *2003*(1), 160-165.

NatureServe. 2017. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: May 21, 2018)

Santa Fe, New Mexico: Historic Preservation Division. Cited in U.S. Army Corps of Engineers. 1988. Site impacts in the Rio Abajo District Central Rio Grande River Valley, New Mexico. In: Archeological Sites Protection and Preservation Notebook Technical Notes ASPPN I-7. Vicksburg: U.S. Army Engineer Waterways Experimental Station, Environmental Laboratory.

Messersmith, C.G, R.G. Lym, and D.S. Galitz. 1985. Biology of leafy spurge. Reprinted from Leafy spurge, monograph series of the Weed Science Society of America. ed. Alan K. Watson, 1985. Chapter 5 (3):42-56. Weed Science Society of America. http://www.wssa.net/

Meyer, S.E. 2003. How cheatgrass won the west – lessons for Wyoming. Wyoming Cheatgrass Awareness Conference. Feb 24-25, 2003. Casper, WY. 31 pages.

Meyer, Susan E.; D.L. Nelson, S. Clement, and J. Beckstead. 2008. Cheatgrass (Bromus tectorum) biocontrol using indigenous fungal pathogens. In S.G. Kitchen, R.L. Pendleton,

T.A. Monaco, J. Vernon, compilers. Proceedings: Shrublands under fire: disturbance and recovery in a changing world; 2006 June 608; Cedar City, UT. Proc. RMRS-P-52. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Pages 61-67.

Norton, J.B., T.A. Monaco, J.M. Norton, D.A. Johnson, T.A. Jones. 2004. Cheatgrass invasion alters soil morphology and organic matter dynamics in big sagebrush-steppe rangelands. USDA Forest Service Proceedings RMRS-P-31. Pages 57-63.

Ogg, A. Jr., S. Christy, K. Stinson, G. Blincow. 2003. Control of cheatgrass with low rates of plateau in arid rangelands in north central Wyoming. In Proceedings Cheatgrass Awareness Conference. February 24 and 25, 2003. Casper, WY. Page 21.

Olson, B.E. 1999. Impacts of noxious weeds on ecologic and economic systems. In: Sheley, R.L.; Petroff, J.K., eds. Biology and management of noxious rangeland weeds. Corvallis, Oregon: Oregon State Univ. Press. P. 4-18.

Owen, M.D.K. and I.A. Zelaya, 2005. Herbicide-resistant crops and weed resistance to herbicides. Pest Management Science 61(3): 301 - 311.

Panjabi, S.S. and D.G. Anderson. 2006. Penstemon harringtonii Penland (Harrington’s beardtongue): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/penstemonharringtonii.pdf [1/24/2011].

Patla, D.A. 2000. Amphibians of the Bridger-Teton National Forest: species distributions and status. Report prepared for the Bridger-Teton National Forest. Feb. 22, 2000. 24 pp plus appendices.

Patla, D.A. and D. Keinath. 2005. Columbia Spotted Frog (Rana luteiventris formerly R. pretiosa): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/columbiaspottedfrog.pdf

Pearson, D. E., and R. M. Callaway. 2008. Weed-biocontrol insects reduce native-plant recruitment through second-order apparent competition. Ecological Applications 18:1489–1500.

Pellant, M. 1996. Cheatgrass: the invader that won the west. Interior Columbia Basin Ecosystem Management Project. USDI, BLM. Boise, ID. 22 pages. http://www.icbemp.gov/science/pellant.pdf.

Pemberton, R.W. 2000. Predictable risk to native plants in weed biological control. Oecologia 125(4): 489-494. http://www.ent.orst.edu/insect_ecology/PDF/Pemberton%202000.pdf

Pierce, L. J. S. 2006. *Boreal Toad (Bufo boreas boreas) Recovery Plan*. New Mexico Department of Game & Fish.

Pilliod, D. S., Peterson, C. R., & Ritson, P. I. 2002. Seasonal migration of Columbia spotted frogs (Rana luteiventris) among complementary resources in a high mountain basin. *Canadian Journal of Zoology*, *80*(11), 1849-1862.

Prather, T.S., J.M. DiTomaso, and J.S. Holt. 2000. History, mechanisms, and strategies for prevention and management of herbicide resistant weeds. In Proceedings of the California Weed Science Society (Volume 52) p. 155-163.

Rice, P. and S. Sutherland. 2006. Imazapic effects on in-situ non-target plants. PIAP Final Report, Project Number RM8, RMRS Participating Agreement No. 03-Pa-11222048-223, University of Montana & USFS Rocky Mountain Fire Sciences Lab. 15 pages.

Rice, P.M. 1999 Testimony of Peter M. Rice, Senate Agriculture Committee hearing on noxious weeds (http://agriculture.senate.gov/Hearings/Hearings_1999/ric9958.htm)

Roath, R. 2009. Is cheatgrass process driven? Rocky Mountain Cheatgrass Management Project Workshop. December 3, 2009.

Rogers, Kiana. 1995. Wyoming, biological control of weeds - historical data, 1975-1994. Department of

Plant, Soil and Insect Sciences, College of Agriculture, University of Wyoming.

Sabba, R.P., I.M. Ray, N. Lownds, and T.M. Sterling. 2003. Inheritance of resistance to clopyralid and picloram in yellow starthistle (Centaurea solstitialis L.) is controlled by a single nuclear recessive gene. Journal of Heredity 94(6): 523-527

Sattleberg, Mark 2011. Letter to Phil Cruz, Forest Supervisor, Bridger-Teton National Forests, from Mark Sattleberg, Field Supervisor, U.S. Fish and Wildlife Service Wyoming Ecological Services Field Office. On file in the Bridger-Teton supervisor's office. Laramie, Wyoming.

Schommer,T. and M. Woolever. 2001. A process for finding management solutions to the incompatibility between domestic sheep and bighorn sheep. USDA Forest Service Region 2 white paper.

Schoup, K. 2003. Case study: plateau herbicide effect on true mountain mahogany. Page 23. In Proceedings Cheatgrass Awareness Conference. February 24 and 25, 2003, Casper, WY.

Schultz, L. D., Cavalli, P. A., Sexauer, H., & Zafft, D. 2016. Habitat and fish assemblage associations and current status of northern leatherside chub Lepidomeda copei in western Wyoming. *Western North American Naturalist*, *76*(4), 427-440.

Sebastian, J., S. Nissen, G. Beck. 2003. Management strategies for the establishment of warm and cool season grasses in downy brome infested rangeland. Boulder County Parks and Open Space Small Grants Report for 2003 Research Project. 23 pages.

Sebastian et al 2015

Sebastian, D.J, JR Sebastian, SJ Nissen, KG Beck. 2016. A Potential New Herbicide for Invasive Annual Grass Control on Rangeland, Rangeland Ecology & Management 69(3): 195-198 http://dx.doi.org/10.1016/j.rama.2015.11.001

Sheley, R.L., and J.K. Petroff, eds. 1999. Biology and management of noxious rangeland weeds.

Oregon State University Press. Corvallis, OR.

Sheley, R.L., B.E. Olson, C. Hoopes. 2005. Impacts of noxious weeds: what is so dangerous about the impacts of noxious weeds on Montana's ecology and economy? Pulling Together Against Noxious Weeds, Montana's Statewide Noxious Weed Awareness and Education Program. On file in the Bridger-Teton supervisor's office. Laramie, Wyoming.

Sieg, C. H., B. Philips, and L. Moser. 2003. Exotic and noxious plants. Pages 251-267. In P. Frederici, ed. Restoration handbook for southwestern ponderosa pine forests. Island Press. Washington, D.C.

Simberloff, D. 2005. Nonnative species do threaten the natural environment! Journal of Agricultural and Environmental Ethics 18: 595–607.

Sperry, L.J., J. Belnap, and R.D. Evans. 2006. Bromus tectorum invasion alters nitrogen dynamics in an undisturbed arid grassland and ecosystem. Ecology 87(3): 603-615.

Stannard, M. 2004. Basic biology, distribution and vegetative suppression of four knapweed species. Technical Notes Plant Materials #25. USDA Natural Resources Conservation Service. Boise, Idaho and Spokane, Washington. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn5594. pdf

Swearingen, Jill M. 2008. Survey of invasive plants impacting national parks in the United States. WeedUS Database: http://www.invasive.org/weedsus/parks.html.

Tausch, R.J. 2008. Invasive plants and climate change. USDA Forest Service, Climate Change Resource Center. http://www.fs.fed.us/ccrc/topics/invasive-plants.shtml

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed control methods handbook: tools and techniques for use in natural areas. The Nature Conservancy Wildland Invasive Species Team. http://tncweeds.ucdavis.edu/handbook.html

U.S. Congress. 1992. Office of Technology Assessment, Forest Service Planning: Accomodating Uses, Producing Outputs, and Sustaining Ecosystems, OTA-F-505 (Washington, DC: U.S. Government Printing Office, Febuary 1992).

USDA Animal and Plant Health Inspection Service. 2000. Reviewer's manual for the technical advisory group for biological control agents of weeds: guidelines for evaluating the safety of candidate biological control agents.

USDA Forest Service. 1999. Internal Memo regarding Research Natural Area and Special Interest Area Designations.

USDA Forest Service. 2005. Gallatin National Forest weed final environmental impact statement (2005). On file at the Bridger-Teton supervisor's office. Laramie, WY.

USDA Forest Service. 2007. Guidelines for revegetation for the Bridger-Teton National Forests and Thunder Basin National Grassland. On file at the Bridger-Teton supervisor's office. Laramie, WY. 67 pages.

USDA Forest Service. 2009. Forest Service Manual 2600 – wildlife, fish, and sensitive plant habitat management. Chapter 2670 – threatened, endangered and sensitive plants and animals, region 2 supplement No. 2600-2009-1. Denver, CO.

USDA Forest Service. 2016. Intermountain Region (R4) Threatened, Endangered, Proposed, and, Sensitive Species. Available: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5370041.pdf

USDA Forest Service. 2018. Upper Green River Area Rangeland Project Final Environmental Impact Statement. Chapter 3: Wildlife, Amphibians begin page 352; Boreal Toad, page 354; Columbia Spotted Frog, page 362. Available online: https://www.fs.usda.gov/nfs/11558/www/nepa/3077_FSPLT3_4092241.pdf

USDI Bureau of Land Management. 2005. Chlorsulfuron ecological risk assessment final report. Bureau of Land Management contract No. NAD010156. ENSR document number 0909- 020-650. 137 pp. http://www.blm.gov/wo/st/en/prog/more/veg_eis.html

USDI Bureau of Land Management. 2005. Sulfometuron methyl ecological risk assessment final report. Bureau of Land Management contract No. NAD010156. ENSR document number 0909-020-650. 135 pp. http://www.blm.gov/wo/st/en/prog/more/veg_eis.html

USDI Bureau of Land Management. November 2005. Diuron ecological risk assessment final report. Bureau of Land Management contract No. NAD010156. ENSR document number 09090-020-650. 135. pp. http://www.blm.gov/nhp/spotlight/VegEIS/hhra.htm

USDI Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; 90-day finding on a petition to list the Eastern or Southern Rocky Mountain population of the boreal toad as an endangered or threatened distinct population segment. Federal Register 77:21920-21936.

USDI Fish and Wildlife Service. 2015. Recovery Plan for the Kendall Warm Springs Dace (Rhinichthys osculus thermalis). Revision: *Original Approved July 12, 1982. U.S. Fish and Wildlife Service, Cheyenne, Wyoming.*

USDI Fish and Wildlife Service. 2018. Pallid Sturgeon fact sheet. Available: https://www.fws.gov/midwest/endangered/fishes/pallidsturgeon/palld_fc.html

Utah Department of Natural Resources. 2009. Rangewide conservation agreement and strategy for Northern Leatherside. Publication Number 09-11. Available: https://wildlife.utah.gov/habitat/pdf/northern_leatherside.pdf

Vallentine, J.F., and A.R. Stevens. 1994. Use of livestock to control cheatgrass--a review. Pages 202-206 in S.B. Monsen and S.G. Kitchen, editors. Proceedings--ecology and management of annual rangelands. General Technical Report INT-GTR-313. USDA Forest Service, Intermountain Research Station, Ogden, UT.

Van Kirk, R. W., & Benjamin, L. 2001. Status and conservation of salmonids in relation to hydrologic integrity in the Greater Yellowstone Ecosystem. *Western North American Naturalist*, 359-374.

Van Mantgem, P.J. Stephenson, N.L., Byrne, J.C. et al., 2009. Widespread increase of tree mortality rates in the western United States. Science 323, 521-4.

Vollmer, J. G. 2003. Fire suppression and native range release. Pages 27-28. In Proceedings Cheatgrass Awareness Conference. February 24 and 25, 2003, Casper, WY.

Voos, G. and P. M. Groffman. 1997. Relationships between microbial biomass and dissipation of 2,4-D and dicamba in soil. Biol. Fertil. Soils 24:106-110.

Weltje, L., Simpson, P., Gross, M., Crane, M., & Wheeler, J. R. (2013). Comparative acute and chronic sensitivity of fish and amphibians: a critical review of data. *Environmental toxicology and chemistry*, *32*(5), 984-994.

Whitson, T. 1996. Weeds of the West. Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services. 628 pp.

Wilson, R. 2005. Cancer and chemical carcinogenisis. http://phys4.harvard.edu/%7Ewilson/cancer&chemicals/ccar.html

Wyoming Game and Fish Department. 2005. A Comprehensive Wildlife Conservation Strategy for Wyoming. 5400 Bishop Blvd. Cheyenne, Wyoming 82006.

Wyoming Game and Fish Department. 2010. Columbia spotted frog – Rana Luteiventris. Pages IV-4-3 through IV-4-4 in Wyoming State wildlife action plan. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.

Young, J.A. and F.L. Allen. 1997. Cheatgrass and range science: 1930-1950. Journal of Range Management. 50(5): 530-535.

Appendix A
Resource Protection Measures

The resources protection measures for federally-listed species, protection measures by activity included in Appendix A are to be implemented under the proposed action (Alternative 2). Resource protection measures are actions designed to reduce impacts of proposed activities. They are derived from applicable law, regulation, or policy and include such things as best management practices (BMPs), forest plan standards and guidelines and standard operating procedures. Analyses are completed assuming the implementation of all resource protection measures.

Protection Measures for Federally Listed Wildlife Species

- Any actions proposed within the Kendall Warm Spring Special Interest Area will be coordinated with the forest fisheries biologist to ensure that Kendall Warm Springs Dace are not affected.
- Apply herbicides at concentrations that will avoid tree mortality to protect potential habitat for raptors, lynx and other key species.
- Prohibit or modify pesticide use where it would have adverse effects on threatened, endangered, proposed, sensitive species or species of local concern and minimize risk to other non-target species.

Protection measures for federally listed plant species

There are no federally listed plant species on the Bridger-Teton. Potential habitat for Ute ladies' tresses (*Spiranthes diluvialis*) is suspected on the Jackson and Greys River Districts.

General guidance – The following apply to the development of all potential herbicide treatment projects:

- Establishment of site-specific limited activity and no activity buffers identified by a qualified botanist, biologist, ecologist, or range management specialist if areas of occupied habitat within the proposed project area are identified. Activities in these areas would be extremely limited or prohibited to protect occupied habitat.
- Collect baseline information on the existing condition of Threatened, Endangered and Proposed (TEP) plant species and their habitats in the proposed project area.

Treatments near occupied TEP plant habitat – At a minimum, the following restrictions must be applied:

- Given the high risk for damage to TEP plants and their habitat from burning, mechanical treatments (other than hand pulling) and use of domestic animals to contain weeds, none of these treatment methods should be utilized within 300 feet of sensitive TEP plant populations UNLESS the treatments are specifically designed to maintain or improve the existing population. Grazing and mechanical treatments such as haying may be employed in Ute ladies' tresses habitat if weed treatments will also enhance habitat suitability for this species.
- Off-highway use of motorized vehicles associated with treatments should be avoided in occupied habitat.
- Biological control agents that affect target plants in the same genus as TEP plants must not be used to control target species occurring within the dispersal distance of the agent.
- Prior to use of biological control agents that affect target plants in the same family as TEP plants, the specificity of the agent with respect to factors such as physiology and morphology should be evaluated and a determination as to risks to the TEP species made.

- To avoid negative effects to TEP plant species from off-site drift, surface runoff and/or wind erosion, suitable buffer zones should be established between treatment sites and populations of TEP plant species and site-specific precautions should be taken (refer to the guidance provided below). Buffer zone distances will vary by method of treatment, herbicide used and TEP plant habitat type.
- Within buffer zones limited herbicide treatments such as low boom spraying and spot treatment via hand held wands, backpack sprayers, wicking, etc. may be conducted if the threat of weed invasion into occupied TEP plant habitat is thought to be greater than the threat of herbicide use. Treatment in buffer zones must be approved by a qualified botanist or biologist and will only occur if the treatment is not thought to pose risks to TEP plant populations. Precautions such as the construction of physical barriers, treatment during TEP plant dormancy and treatment during favorable climatic conditions will be used to protect TEP plant populations from herbicide drift and other indirect impacts.
- Follow all label instructions, Resource Protection Measures and Forest Service Standards and Guidelines to avoid spill and direct spray scenarios into aquatic habitats that support TEP plant species.
- Follow all Resources Protection Measures for avoiding herbicide treatments during climatic conditions that would increase the likelihood of spray drift or surface runoff.

Manual spot treatment and low boom ground application of undesirable vegetation can occur if it is determined by local botanists, or designated resource specialists, to not pose risks to TEP plant species in the vicinity. Additional precautions during spot treatments of vegetation within habitats where TEP plant species occur should be considered while planning local treatment programs.

Protection measures by activity

<u>Prevention of Weed Introduction and Spread</u>

- Educate all Forest Service field personal so they are aware of and knowledgeable about invasive plant species (FSM 2902).
- On NFS lands, it is prohibited to possess or store any hay, hay cubes, straw, grain, or other forage or mulch product, without original and current documentation from a state certification process which meets or exceeds the North American Invasive Species Management Association (NAISMA)Weed Free Forage and Gravel Program or comparable certification standard (USDA Forest Service, Rocky Mountain Region Weed Free Forage Products Order R2-2005-01) This includes products used for revegetation projects by the U.S. Forest Service.
- Use contract and permit clauses to prevent the introduction or spread of noxious weeds by contractors and permittees (FSM 2904, Amendment No. 2000-95-5). This includes timber sale contract clauses RO-K-G.6.0.2#, RO-K-GT.6.0.2#, RO-C6.602#, RO-CT6.602# and B6.35 and Special Use Permit clauses R2-D-103 (R2 Supplement 2709.11-2006-1).
- All purchased seed should be certified noxious weed free. As a Best Management Practice recommend using certified cheatgrass free seed source (Refer to Bridger-Teton Revegetation Guidelines).
- Where noxious weeds or other harmful invasive plant species are present on a project site or near enough to pose a threat of colonizing disturbed areas, seed the disturbed area with approved plant materials as specified in the Bridger-Teton Revegetation Guidelines.
- Before using any gravel, topsoil or other fill products used on NFS lands be sure the source has been treated; that the pits or stockpiles have been treated and are free of noxious weeds. Sites should be inspected regularly and comply with North American Invasive Species Management Association (NAISMA) certified weed free gravel. All gravel, topsoil or other fill products to

be used on NFS lands will be pre-treated before transporting.

- Prevention measures specific to wildfire:
  - Minimize weed spread in fire camps by incorporating weed prevention and containment practices such as mowing, flagging or fencing weed patches, designating weed-free travel routes and washing equipment.
  - Inspect all vehicles involved in fire suppression regularly to assure that undercarriages and grill works are kept weed seed free.

Coordination

- Where traditional cultural plant gathering areas have been identified, tribal consultation may be done to address any additional mitigation measures needed to minimize effects to various aspects of the activity. These could include, but are not limited to adjusting the timing of the treatment, adjusting the type of treatment, adjusting the priority of the treatment.
- If any treatment is desired within RNA boundaries, concurrence must be obtained from the cooperating USFS Research Station and all other relevant partners prior to treatment implementation.
- In cooperation with federal, state and county agencies, National Forest System lands adjacent to other ownership will be selectively treated to coincide with active invasive plant management projects. Decisions regarding treatment methods and buffer width on land adjacent to privately owned land or land managed by other agencies will be negotiated between the Forest Service and the other owner/agency.
- District or Forest invasive plant coordinators will coordinate a review of invasive plant management projects with the District/Forest resource specialists to identify specific resource conditions that may be affected by control activities, to ensure the protection measures are implemented properly.
- If treatment is desired in Special Interest Areas (SIAs) that have special values, treatment must be planned and executed with concurrence from the appropriate forest program manager for that special value.

Travel Management Compliance

- Treatment activities will follow local motorized travel management plan or applicable public land laws, rules, regulations and orders. Variances to motorized travel plans may be allowed for administrative motorized access to conduct weed treatment activities in areas approved by the authorized officer.

Prescribed Burning

- Any prescribed burning conducted for weed control will be conducted in accordance with Bridger-Teton National Forest fire management policy which requires the site specific preparation of a prescribed burn plan before every burn.
- Avoid burning sites with high risk of weed invasion unless effective post-burn treatment methods and funding are incorporated into project planning.

Sagebrush Habitat

- Restrict or contain fire within normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.
- Limit intentional fires in sagebrush habitats, including prescribed burning of breeding and winter habitats unless it can be demonstrated to be beneficial to local sage-grouse populations.
- Design and implement restoration of burned sagebrush habitats to allow for natural succession

to healthy native sagebrush plant communities.

- Implement monitoring programs for restoration activities. Monitoring must continue until restoration is complete.

Biological Control

- Only biological control agents that have been approved by USDA Animal Plant Health Inspection Service (APHIS) will be released.
- Where biocontrol agents have become successfully established protect those sites from other forms of weed control to promote spread of the biocontrol agents and provide collection locations for release at other sites.
- Non-native biological control will not be utilized near or within designated Wilderness, Wilderness Study Areas, or Research Natural Areas.

Livestock Grazing

- Proposals for domestic goat or sheep grazing for control purposes will be coordinated with the appropriate state wildlife agency biologist to determine potential impacts to bighorn sheep.

Revegetation

- Seeding with native seed will only occur if desirable competitive plants do not re-emerge and dominate the vegetation community after the weed species is treated. For further details, refer to Bridger-Teton Revegetation Guidelines.

Mechanical Treatment

- To limit the potential for equipment to spread invasive plant seeds, mechanical treatments should be completed before seed becomes viable.
- Disposal of plants that are grubbed or manually removed will be as follows: If no flowers or seeds are present, pull the plant to dry it out. If flowers or seeds are present, pull and place plants in a plastic bag or a container to retain seeds. Dispose of plants by burning them or taking them in closed garbage bags to a sanitary landfill.
- Avoid or mitigate mechanical treatment methods that have potential to adversely affect the viability of known sensitive plant species populations.

Ground-based Herbicide Application

- Herbicides will be used in accordance with U.S. Environmental Protection Agency label instructions and restrictions. Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: personal protective equipment, user safety, first aid, environmental hazards, directions for use, storage and disposal, general information, mixing and application methods, approved uses, weeds controlled and application rates. It is a violation of federal law to use an herbicide in a manner inconsistent with its labeling.
- Additional herbicides may be considered for use within the project area in the future. Only EPA registered herbicides having a completed risk assessment will be considered for use.
- Adhere to all guidelines and protection measures in the Forest Service Manual 2150, Pesticide Use Management and Coordination and in the Forest Service Handbook 2109.14, Pesticide Use Management and Coordination Handbook.
- Applicators or operators must wear all protective gear required on the label of the herbicide they are using (FSH 6709.11).
- Application will be conducted or supervised by licensed applicators or trained technicians as

required by law.

- Operators will calibrate spray equipment at regular intervals to ensure proper rates of herbicide applications.
- The local herbicide coordinator will maintain daily records of herbicide use, including: temperature, wind speed and direction; herbicide and formulation uses; quantity of herbicide and diluents applied; location and method of application; acreage and persons applying herbicides.
- Procedures for mixing, loading and disposal of pesticides and a spill plan will be followed (Label and FSH 2109.14, 43). All herbicide storage, mixing and post-application equipment cleaning is completed in such a manner as to prevent the potential contamination of any perennial or intermittent waterway, unprotected ephemeral waterway or wetland. Herbicide applicators shall carry spill containment equipment, be familiar with and carry an Herbicide Emergency Spill Plan.
- In occupied public recreation areas (such as developed campgrounds, trailheads, other areas of concentrated use) post notification of treated area until the beginning of the reentry period (as defined by the product label).
- Apply herbicides at concentrations that will avoid tree mortality to protect potential habitat for raptors, lynx and other key species.
- Prohibit or modify pesticide use where it would have adverse effects on threatened, endangered, proposed, sensitive species or species of local concern and minimize risk to other non-target species.

Water resources

- Use only aquatic-labeled herbicides in the Water Influence Zone (WIZ). The WIZ includes the geomorphic floodplain (valley bottom), riparian ecosystem, and inner gorge. Its minimum horizontal width (from top of each bank) is the greater of 100 feet or the mean height of mature dominant late-seral vegetation. The WIZ protects interacting aquatic, riparian, and upland functions by maintaining natural processes and resilience of soil, water, and vegetation systems (Reid and Ziemer 1994). (Watershed Conservation Practices Handbook FSH 2509.25)
- For aquatic-labeled herbicides application within the Water Influence Zone, some application buffers still apply. Chemical and application type will drive any aquatic restrictions. These restrictions can be found in Environmental Risk Analysis documents and on EPA approved product labels.
- Only aquatically approved herbicides will be used over water (streams, ponds, springs, etc.), including water standing or running in ditches. Weeds overhanging a waterway or growing within the channel should be treated as an aquatic situation (including stock tanks).
- Follow herbicide label restrictions regarding use near functioning potable water sources. Herbicides can have varying setback restrictions near functioning/active potable water intakes. For example, labels of glyphosate products registered for aquatic weed control state: “Do not apply this product in flowing water within 0.5 mile up-stream of active potable water intake”.
- Ground herbicide terrestrial applications will maintain a 50 foot buffer of all water sources/wellheads unless the formulations are approved for “in or near water”.
- Locate vehicle service and fuel areas, chemical storage and use areas and waste dumps and areas on gentle upland sites. Mix, load and clean on gentle upland sites. Dispose of herbicides and containers in State-certified disposal areas. (Watershed Conservation Practices Handbook FSH 2509.25)

- During use periods, inspect herbicide transportation, storage, or application equipment for leaks. If leaks occur, report them and install emergency traps to contain them and clean them up. Refer to FSH 6709.11, Chapter 60 for direction on working with hazardous materials. Report herbicide spills and take appropriate clean-up action in accordance with applicable state and federal laws, rules and regulations. Contaminated soils and other material shall be removed from NFS lands and disposed of in a manner according to state and federal laws, rules and regulations. (Watershed Conservation Practices Handbook FSH 2509.25)
- Apply herbicides using methods that minimize risk of entry to surface and ground water. Apply at lowest effective rates as large droplets or pellets. Follow the label directions. Favor selective treatment. (Watershed Conservation Practices Handbook FSH 2509.25)
- Spray only when heavy rain is not expected, per label directions.
- Carry herbicide only in secure containers.
- Only add surfactants specified on the label to herbicides registered for aquatic use.
- Ester formulations are prohibited where fisheries occur.
- Mix herbicides and rinse equipment away from the waterway.

Wildlife and aquatic organisms

- Herbicides will be used in accordance with U.S. Environmental Protection Agency label instructions and restrictions. Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: personal protective equipment, user safety, first aid, environmental hazards, directions for use, storage and disposal, general information, mixing and application methods, approved uses, weeds controlled and application rates. It is a violation of federal law to use an herbicide in a manner inconsistent with its labeling.
- Herbicide will not be sprayed if amphibians are known to be present and cannot be avoided; hand-pulling or wick application of herbicide will be used instead. If tadpoles or metamorphs are identified, the location will be reported to the local amphibian specialist (fisheries or wildlife biologist) and invasive plant coordinator and application of herbicides will be delayed until metamorphs disperse if necessary.

Sensitive plant species

- Broadcast (boom) applications of chlorsulfuron are prohibited within 1,500 feet of sensitive plant occurrences. Selective hand spot or wick treatment with this herbicide is allowed within this setback.
- When applying herbicides within 50 feet of sensitive plants, spot treat with hand held wands, backpack sprayers, wick, etc. using herbicide that does not persist in the soil (i.e. picloram and imazapic are more persistent in soils) and protect sensitive plants from herbicide drift (e.g. cover plant with plastic when spraying herbicide or use a wick applicator).
- Chlorsulfuron and imazapyr, are prohibited within the 50-foot buffer zone around sensitive plants. The broad-spectrum herbicide, glyphosate, may be applied within the 50 feet buffer, only if the sensitive plant species is dormant.

<u>Aerial application of herbicides</u>

- All aviation activities will be in accordance with FSM 5700 (Aviation Management), FSM 2150 (Pesticide Use Management and Coordination), FSH 5709.16 (Flight Operations Handbook), FSH 2109.14, 50 (Quality Control Monitoring and Post-Treatment Evaluation). A project Aviation Safety Plan will be developed prior to aerial spray applications.

- Any non-selective herbicides that are aerially applied will be used at rates that are low enough to limit injury to desirable species, or used during periods when non-target plants are dormant.
- Aerial applications would be excluded from designated Wilderness and Research Natural Areas unless needed on a site-specific basis to protect the native plant populations for which the area is being managed.
- Aerial application of herbicides will not occur in occupied developed campgrounds or recreation residences. Areas adjacent to campground and recreation residences will be treated outside of high use periods where feasible. Temporary closures of campgrounds may be considered to protect the public during spray operations.
- Signing and on-site layout will be performed prior to actual aerial treatment.
- Temporary area and road/trail closures could be used to ensure public safety during aerial spray operations.
- Constant communications will be maintained between the aircraft and project leader during spraying operations. Ground observers will have communication with the project leader. Observers would be located at various locations adjacent to the treatment area to monitor wind direction and speed as well as to visually monitor drift and deposition of herbicide.

Protection measures to reduce spray drift

- Application will occur per label instruction.
- Aerial spray units would be field-validated, flagged and/or marked using GPS prior to spraying to ensure only appropriate portions of the unit are aerially treated. To ensure that aerial treatments stay within intended treatment areas, units will be GPS'd before and during the flight.
- Drift reduction agents, nozzles that create large droplets and special boom and nozzle placement, would be used to reduce drift during aerial spraying.
- Drift control agents may be used in aerial spraying during low humidity to reduce drift into non- target areas. Products that reduce volatility, have been shown to keep droplet sizes larger and are appropriate adjuvant for the herbicide (as specified by labeling of both the herbicide and the drift agent, in consultation with the herbicide manufacturer) would be used.
- Aerial spraying will be discontinued if herbicide is drifting within the set-back zone and/or wind speed exceeds those recommended on the product's label.
- Weather conditions would be monitored on-site (temperature, humidity, wind speed and direction) and spot forecasts would be reviewed for adverse weather conditions.
- Monitor treatment boundaries next to sensitive areas with spray deposit cards to detect any possible drift.

Water resources

- During contract preparation for aerial application, reassess surface water quality risk with site-specific information. Once the exact treatment areas are delineated in preparation for the contract, determine treatment acres for 6th hydrologic unit code (HUC) watersheds potentially affected by aerial application. If picloram is used, incorporate these acres into the risk assessment to estimate probable herbicide concentrations and allowable treatment acres. If concentrations of picloram exceed the recommended threshold, reduce treatment acres to the allowable amount or use herbicides approved for use near surface water.

Sensitive plant species

- No aerial application of herbicide will occur within 300 feet of any sensitive plant populations.

Buffers around sensitive plants will be generated using the most current species information available, which will include Wyoming state records of plant occurrences (databases maintained by Wyoming Natural Heritage Program and Wyoming Natural Diversity Database), records in the Forest Service Natural Resource Manager database and recent field survey results.

Appendix B
Herbicides, Product Name and Properties

Table B-1. Quick guide to herbicide properties.

Active Ingredient	Restricted[1]	Human Health Findings				Terrestrial Persistence (half-life)[6]	Mobility
		Cancer[2]	Repro[3]	Neuro[4]	Endo[5]		
2,4-D	No	No	No	No	Prob	6.2 Non	Low-Mod
aminocyclopyrachlor	No	Not likely to be carcinogenic	No	No	No	114-433 days Persistent	Low
aminopyralid	No	No	No	Unclear	No	32-533 Mod to Persistent	Relatively Low
chlorsulfuron	No	Evidence of non-carcinogenicity	No	No	No	37-168 Mod to Persistent	High
clopyralid	No	Not likely to be carcinogenic	No	No	No	14-29 Non	V High
glyphosate (aquatic and terrestrial)	No	Evidence of non-carcinogenicity	No	No	No	5.4 Non	E Low
imazapic	No	Evidence of non-carcinogenicity	No	No	No	113 Persistent	High
imazapyr	No	Evidence of non-carcinogenicity	No	Not likely	No	210 Persistent	High
indaziflam	No	No	No	No	No	35 days Mod	Moderate
metsulfuron methyl	No	Not likely to be carcinogenic	No	No	No	120 Persistent	High
picloram	Restricted	Evidence of non-carcinogenicity	No	No	No	18-513 Non to Persistent	V High
rimsulfuron	No	Not likely to be carcinogenic	No	No	No	1.7 – 4.3 Not Persistent	Low
sulfometuron methyl	No	Evidence of non-carcinogenicity	potential	No	No	10-100 Non to persistent	High

Sources used include USFS Human Health and Ecological Risk Assessment documents and the CDMS website (http://www.cdms.net/Label-Database/Advanced-Search). For more information on herbicides, resources are available in the project file.

[1] Restricted. Restricted indicates a restricted use product. No indicates not a restricted use product. A restricted use pesticide is a pesticide that is

available for purchase and use only by certified pesticide applicators or persons under their direct supervision. This designation is assigned to a pesticide product because of its relatively high degree of potential human and/or environmental hazard even when used according to label directions.

[2] Cancer. The EPA evaluates carcinogenicity (cancer), neurotoxicity, reproductive, teratology (birth defects), and mutagenicity (gene mutation) study results of herbicide effects to animals during the herbicide registration and re-registration processes. The study data are used to make inferences relative to human health. “No” designates unlikely or no indication of a carcinogenic effect when used at recommended rates.

Cancer column. When assessing possible cancer risk posed by a pesticide, EPA considers how strongly carcinogenic the herbicide is (its potency) and the potential for human exposure. The pesticides are evaluated not only to determine if they cause cancer in laboratory animals, but also as to their potential to cause human cancer. For any pesticide classified as a potential carcinogen, the risk would depend on the extent to which a person might be exposed (how much time and to what quantity of the pesticide). The factors considered include short-term studies, long-term cancer studies, mutagenicity studies, and structure activity concerns. (The term “weight-of-the-evidence” is used in referring to such a review. This means that the recommendation is not based on the results of one study, but on the results of all studies that are available.). Diuron is a likely or known carcinogen. However, the EPA's 2002 re-registration assessment of the human and environmental scientific data reinforces a number of regulatory decisions and expert reviews that conclude the use of diuron according to product instructions does not present an unacceptable risk to human health or the environment

[3] Reproductive (Repro). “No” designates unlikely or no indication of a fertility impairing effect. EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any reproductive issues.

[4] Neurotoxicity (Neuro). “No” designates unlikely or no indication of a developmental toxic effect at doses that are not toxic to the parental animals. EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any neurotoxicity issues.

[5] Endocrine disruption (Endo). EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any issues except for probable issues for 2,4-D. Based on currently available toxicity data, which demonstrate effects on the thyroid and gonads in test animals following exposure to 2,4-D, there is concern regarding its endocrine disruption potential. There have been no studies on 2,4-D that specifically assess its endocrine disruption potential. The EPA determined that a repeat 2-generation reproduction study is required to address these concerns. However, the EPA's 2005 re- registration assessment of the human and environmental scientific data reinforces a number of regulatory decisions and expert reviews that conclude the use of 2,4-D according to product instructions does not present an unacceptable risk to human health or the environment

[6] Persistence. Persistence assessment is based on the herbicides half-life in soil from the Herbicide Handbook (Shaner, 2014). Pesticides that are considered nonpersistent are those with a half-life of less than 30 days; moderately persistent herbicides are those with a half-life of 30 to 100 days; pesticides with a half-life of more than 100 days are considered persistent.

-

Appendix C
Species-specific Ecology and Proposed Treatments, Including Herbicide Rates

The following table displays species-specific ecology and integrated pest management treatments for invasive plants known to be on the Bridger-Teton NF and for species likely to be invaders in the future. The herbicides listed in the table are the most commonly used and rates are guidelines. In all cases, application rates would be those indicated on herbicide labels. Ongoing testing may result in new instructions on rate and target species.

A surfactant is recommended with most herbicides except some formulations of glyphosate.

Invasive species control from post-emergent herbicides is influenced by plant community tolerance, weed species, weed size and climatic conditions. These factors should be considered in determining the herbicide selection and rate range. The lowest rate of post-emergent herbicides should be effective under favorable growing conditions and when weeds are small and actively growing. Use the higher labeled rates under adverse conditions and for well-established weeds.

Efforts to utilize the most selective herbicide should be considered. A wide variety of herbicides have a wide range of plant selectivity.

- Glyphosate (Roundup) is the least selective, affecting most plant species.
- Clopyralid (Stinger, Transline) is the most selective herbicide, affecting only plants in the sunflower (Asteraceae), buckwheat (Polygonaceae), nightshade (Solanaceae) and pea (Fabaceae) families.
- Picloram (Tordon) and 2,4-D amine are less specific.
- Monocots (grasses, grass-like plants, lilies, orchids and related families) are more tolerant of broadleaf herbicides because of rapid metabolism (Sheley and Petrof 1999).
- Picloram, 2,4-D and clopyralid can cause injury or death to forbs, trees and shrubs but do not harm most grasses.
- Aminopyralid is very effective and more environmentally friendly than picloram for control of perennial and biennial thistles and knapweeds. It can be used in riparian areas up to water's edge but is not to be used in areas of standing water.
- Imazapic (Plateau) may be used around trees and over-the-top of many legumes and wildflowers. Some cool-season grasses may be injured or seedhead production may be inhibited. When permitted by the label, the use of methylated seed oil (MSO) surfactant may provide improved results for control but avoid MSOs when applying to emerged seedling grasses and forbs.
- Glyphosate herbicide will control almost all vegetation sprayed. Glyphosate does not have soil residual.
- Metsulfuron (Escort) can cause injury or death to certain trees, shrubs, forbs and grasses.

Species

<u>Austrian fieldcress (Priority 4)</u>

Austrian fieldcress (*Rorippa austrica*) invades roadsides, moist disturbed, cultivated sites and wet meadows. It can grow in ditches or wet areas within fields, even submerged in water. Perennial with creeping root stalks, forming dense clonal infestations. Extensive roots systems make this plant difficult to control. Reproduces by seed and root fragments. Plants can produce from 1500 to 20,000 seeds.

Biocontrol	non known	
Mechanical and cultural	Do not till. Can be grazed before seedset. Repeated hand pulling can minimize small, new infestations.	
Herbicide	**Rate**	**Timing**
Telar	1 oz. per acre	Actively growing bud to early flower
Plateau	4-12 oz. per acre (can cause grass injury)	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.
Aquatic glyphosate (Rodeo)	1.25-3 qts per acre	active growth

<u>Black henbane (Priority 2)</u>

Black henbane (*Hyoscyamus niger*) is found in disturbed open sites, roadsides, fields, waste places and abandoned gardens. Grows best in sandy or well-drained loam soils with moderate fertility. Does not tolerate waterlogged soils. Poisonous to most mammals. As an annual or biennial, black henbane relies on prolific seed production. A single plant can produce up to half a million seeds.

Biocontrol	None known	
Mechanical and cultural	Hand-pulling, mowing, or digging to prevent seed production is effective. The tap root must be removed to kill the plant. Burning mature plants will kill the seed. Can be controlled with regular cultivation.	
Herbicide	**Rate**	**Timing**
Tordon	1 to 2 pints per acre	Actively growing, prior to seed set
Telar	1 oz. per acre	
Escort	1 oz. per acre	

Bull thistle (Priority 2)

Bull thistle (*Cirsium vulgare*) occurs in dry to moist habitats, fields, pastures, grasslands, roadways, forest clearings, rock outcrops and along waterways. It is not shade tolerant. A biennial, bull thistle relies on short-lived seed (viable for 3 years or less) for regeneration.

<table>
<tr><td>Biocontrol</td><td colspan="2">Gall fly (Urophora stylata) and Cheilosia grossa</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Hand-pulling, mowing, burning, digging will kill if above ground portions of the plant are completely removed or consumed because it does not sprout from the root crown or root. If 8 inches or more of the stem remains alive, it may sprout from remaining portions of the stem.
The presence of tall herbs reduces bull thistle seedling survival, so revegetation with desirable species is an important part of control.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1 pint Tordon</td><td rowspan="2">Before seed set or during fall regrowth</td></tr>
<tr><td>Milestone</td><td>5-7 oz. per acre</td></tr>
</table>

Canada thistle (Priority 3)

Canada thistle (*Cirsium arvense*) prefers and is invasive in, prairies and other grasslands and riparian areas with deep, well aerated, mesic soils, but also occurs in almost every upland herbaceous community, especially roadsides, abandoned fields and pastures. Perennial and rhizomatous. Reproduction by seeds and shoots from lateral roots. Dormant, buried seeds can remain viable for up to 26 years. It readily roots from fragments less than an inch in length. Canada thistle differs from other species of the true thistle in that there are male and female flower heads on separate plants. By asexual reproduction, it is possible that a colony of male plants would produce no fruits, but still maintain itself. A Canada thistle shoot can produce as many as 100 heads in a season, with each head containing as many as 100 seeds. Horizontal root growth can extend more than 19 feet in one season and may eventually penetrate into the soil as deep as 22 feet. A one-year growth study showed a root segment had grown 1,700 feet of roots and turned into a 142-plant colony. The thistle root averaged 2.5 feet of root growth per day.

Biocontrol	Stem-boring beetle (*Centorhyncus litura*), gall fly (*Urophora cardui*), shoot fungus (*Sclerotinia sclerotiorum*), seed head weevil (*Larinus planus*). Overall, this method provides little or no control, although some agents weaken and kill individuals. Most bio-controls are not adequately synchronized with its life cycle in North America. Management that delays flowering, such as mowing or burning, may help to synchronize a more susceptible stage with bio-control agent's life cycle. At least three agents may be needed for effective control.	
Mechanical and cultural	Removing flowers to prevent seed production may reduce spread by seed but the species reproduces primarily by vegetative means. Cultivation is not recommended. Mowing may only be effective in rare cases where it can be repeated at monthly intervals. This intensity is not recommended in natural areas, where it would likely damage native vegetation, but may be practical along roadsides. When mowing, cut high enough to leave >9 leaves per stem, or > 20 centimeters of bare stem tissue, as mature Canada thistle leaves and stems independently inhibit development of shoots from rootbuds. Smothering Canada thistle with boards, sheet metal or tar paper can kill plants. Above ground parts will be killed by fire, but below ground parts will survive even severe fires. There is abundant evidence that post-fire establishment of Canada thistle is common where seed source is available. Results are mixed on the use of prescribed fire as a management tool. Prescribed burns may be effective at stimulating growth of native species and thereby discouraging the growth of this invasive. It may be best if timed to emulate the natural fire regime of a site. Late spring burns may discourage the species, yet early spring burns may encourage it.	
Herbicide	**Rate**	**Timing**
Tordon	1 quart per acre	Before seed set or during fall regrowth
Rodeo (in wetlands)	1 quart per acre	
Telar	1.5 oz. per acre	
Milestone	5-7 oz. per acre	
Transline	⅔ - 1 ⅓ pint per acre	

<u>Cheatgrass and Japanese brome (Priority 2)</u>

Cheatgrass (*Bromus tectorum*) and Japanese brome (*Bromus arvensis*): Although annual bromes can be found in both disturbed and undisturbed shrub-steppe and grasslands, the largest infestations are usually found in south facing slopes in shrub-steppe areas, overgrazed rangeland, abandoned fields, eroded areas, sand dunes, road verges and waste places. Annual bromes are winter annuals; as such they are dependent on seed production for reproduction. They are prolific seed producers, able to produce enough seed to perpetuate themselves even under unfavorable growing conditions.

Biocontrol	None currently available. Several rhizobacteria, *Pseudomonas fluorescens* (strain D7) are being studied.	
Mechanical and cultural	Hand pulling or grubbing small population can be effective. Disking and other mechanical control methods applied alone are often ineffective. A combination of methods is needed: deep disking several times at intervals to bury seeds 4 to 6 inches then overseeding or shallow disking to initiate seed germination, then either disking again or spraying with glyphosate, followed by broadcast or drill seeding. Sites must be revegetated with perennial grasses with an established groundcover of 15-25%. Burning is an ineffective method for controlling cheatgrass due to its prolific seed production. Livestock grazing can be purposely manipulated to control cheatgrass. Plants must be grazed before they turn purple in color. At least two defoliations are needed in the spring of each year for at least two consecutive years and there must be an existing stand of native perennial grasses.	
Herbicide	**Rate**	**Timing**
Glyphosate	2 to 4 oz. per acre	Early to pre-root development. Apply in early spring when the plants are growing vigorously.
Plateau	2 oz./ac to 12 oz./acre 2 to 6 oz./ac of Plateau are recommended for bare soil, with light infestations. In areas of thick vegetation and leaf litter, higher rates of 6 to 12 oz./ac may be needed.	Fall, pre-emergent to germination.
Rimsulfuron Matrix SG Laramie 25DF	*<u>labelled grazing restriction apply</u>* 3 oz. per acre, 3-4 oz. per acre	fall prior to ground freeze
Esplanade 200SC	5-7 oz. per acre labelled grazing restrictions apply	Pre-emergence, Recommended mid-summer to get required 0.25 inch precipitation for activation.

Common burdock (Priority 3)

Common burdock (*Arctium minus*) is commonly found growing along roadsides, ditch banks, in pastures and waste areas. The burs can become entangled in the hair of animals allowing seed to be distributed to new areas. A biennial, common burdock reproduces by seed only. Seed is generally considered to be viable for two years (although it was been reported to be viable up to ten years).

Biocontrol	None known	
Mechanical and cultural	Because common burdock is a biennial that reproduces from seed only, any method which removes the seed source can be effective; including mowing, grazing, hand treatment and tilling.	
Herbicide	**Rate**	**Timing**
Milestone	4-6 oz./acre	Apply from the late rosette to the late bolting stage.

Common mullein (Priority 3)

Common mullein (*Verbascum thapsus*) is found in natural meadows and forest openings, where it adapts easily to a wide variety of site conditions. Prefers, but is not limited to, dry sandy soils. It is intolerant of shade. Primarily a weed of pastures, hay fields, roadsides, rights-of-way and abandoned areas. Biennial or short-lived perennial. One plant can produce 100,000-180,000 seeds with viability up to 100 years.

Biocontrol	Mullein seedhead weevil (*Gymnetron tetrum*) and mullein moth (*Cucullia verbasci*)	
Mechanical and cultural	Easy to pull in loose soils because of shallow taproot (before flowering). Hand-hoeing or digging also effective. Mow or scythe just before flowering.	
Herbicide	**Rate**	**Timing**
Escort	1 to 1.5 oz. per acre	Rosette, before seed sets
Tordon	2 pints Tordon	
Telar	1-1.5	

Common tansy (Priority 2)

Common tansy (*Tanacetum vulgare*) is a perennial herb in the sunflower family. This species, native to Europe, has a long history of medicinal use. It was first introduced to North America for use in folk remedies and as an ornamental plant. Common tansy is an invader of disturbed sites and is commonly found on roadsides, fence rows, pastures, stream banks and waste areas throughout North America.

Common tansy spreads mainly by seeds and less commonly from creeping rhizomes, to form dense clumps of stems.

Biocontrol	None currently available.	
Mechanical and cultural	Hand-pulling not recommended (stimulates sprouting from rhizomes) and must remove all roots. Constant cultivation, otherwise the infestation can increase by chopping roots that sprout. Mowing to reduce seed production. Grazing by sheep and goats. Revegetation for shade.	
Herbicide	**Rate**	**Timing**
Tordon	2 pints per acre For a 3-gallon backpack: 2 oz. per 3 gallons water	Before flowering
Milestone	3-7 oz. per acre	
Escort	1 oz. per acre	

Common teasel (Priority 4)

Common teasel (*Dipsacus fullonum*) invades roadsides, waste areas, disturbed sites, riparian areas, fields and pastures. Biennial and occasionally a short lived perennial. Erect flower stems with spiny flower heads. Thick tap-root, but spreads by seeds that can last 6 years under field conditions. Dense stands can become impenetrable to humans and grazers.

Biocontrol	none known	
Mechanical and cultural	Manual removal of plant including root crown can be successful on small infestations. Moving to prevent seed set can help reduce infestations.	
Herbicide	**Rate**	**Timing**
Milestone	5-7 oz. per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or rosettes.

Dalmatian toadflax (Priority 1)

Dalmatian toadflax (*Linaria dalmatica)* is an introduced ornamental that is quick to colonize open sites and is capable of adapting growth to a wide variety of environmental conditions. Because of its deep, extensive root system, waxy leaf and heavy seed production, this plant is difficult to manage.

It is a tap-rooted perennial (taproot may be as long as 3 feet) with horizontal roots that may grow 25 inches per year. Adventitious root buds may form independent plants. Once established this species can suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years. A single Dalmatian plant can produce up to 500,000 seeds. Seed production can begin on lower portions of the stems while upper portions are still in various stages of bloom. Dried floral stalks can remain standing for two years, retaining some seeds but dispersing most during the first year. Some Dalmatian toadflax seed germination occurs in the fall, but most occurs the following spring.

Germination rates are as high as 75% and seeds can remain dormant at least 10 years. These dormant seeds can rapidly re-infest a site following control applications, even when pre- emergent herbicides are used, because only a portion of the seeds will germinate in any given year.

<table>
<tr><td>Biocontrol</td><td colspan="2">Effective: toadflax moth (Calophasia lunula), root-boring moths (Eteobalia intermediella and E. serratella) stem-boring weevil (Mecinus janthiniformis) has shown dramatic impact on Dalmatian toadflax at some locations.
Not highly effective: ovary-feeding beetle (Brachypterolus pulicarius) flea beetle (Longitarsus jacobaeae) seed capsule-feeding weevils (Gymnetron antirrhini and G. linariae)</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Toadflax seedlings are initially very vulnerable to competition from established, vigorous vegetation. Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate).
Regular cultivation. Restricting spring cattle grazing on sites with toadflax can help maintain vigorous competition from native species. Mowing and fire are not effective.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1-2 quarts per acre + surfactant *
For a 3-gallon backpack: 4.5 oz per 3 gallons water + surfactant</td><td rowspan="2">Spring bloom & late fall post bloom</td></tr>
<tr><td>Telar</td><td>1.5 to 2.0 oz. per acre + surfactant For a 3-gallon backpack: 0.5 oz per 3 gallons water + surfactant</td></tr>
<tr><td>Escort</td><td>2 oz. per acre + silicone surfactant</td><td>Best if used in the fall.</td></tr>
<tr><td>Plateau</td><td>8 to 12 oz per/acre and MSO and silicone surfactant</td><td>Fall prior to frost</td></tr>
</table>

* Toadflax has a waxy leaf surface; silicone surfactant is the most important additive to any of the herbicide mixture to ensure results. Wet entire plant.

Diffuse knapweed (Priority 1)

Diffuse knapweed (*Centaurea diffusa)* is a biennial or short-lived perennial with abundant seed production. A single plant can produce up to 18,000 seeds. Seeds germinate in both early spring (primarily) and fall. In the fall, diffuse knapweed breaks off at ground level and disperses widely as a tumble-weed. The allelopathic chemical may reduce recovery potential as its presence in the soil may hinder the resurgence of natives. Dormant seeds may germinate and re-infest an area.

<table>
<tr><td>Biocontrol</td><td colspan="2">Knapweed flower weevil (Larinus minutus) and bronze knapweed root borer (Sphenoptera jugoslavica) are more effective biocontrol agents than the following agents: seed head gall fly (Urophora affinis); seed head gall fly (U. quadrifasciata); peacock fly (Chaetorellia acrolophi); seed head weevil (Bangasternus fausti); root weevil (Cyphocleonus achates). None of these, alone or in combination effectively control populations. They may prove useful as part of an integrated program to weaken plants therefore making them more susceptible to other treatments.</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Hand-pulling of small infestations usually must be repeated for 7 to 10 years. Dig rosettes in the spring. Pull mature and immature plants in early summer before seeds form. Pull and bag (to remove seed from area) remaining plants in mid to late summer. All of the infestation must be pulled. All of the taproot must be removed.
Mowing could increase populations of this species. Grazing is not an effective control method. It is generally unpalatable and the spines can injure livestock. Fire may be effective in controlling this species. Low-severity fire may only top-kill diffuse knapweed. Dry soil conditions associated with burns may discourage re- infestation as moisture is the limiting factor for seed germination. Re-seeding of desirable species may be necessary. The fuel model developed for spotted knapweed may be useful to managers planning to burn infestation of diffuse knapweed.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1 pint per acre + surfactant
For a 3-gallon backpack: 1.5 to 2 oz per 3 gallons water</td><td rowspan="2">Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth</td></tr>
<tr><td>Milestone</td><td>5-7 oz. per acre</td></tr>
</table>

Dyer's woad (Priority 4)

Dyer's woad (*Isatis tinctoria*) can be a winter annual, biennial, or short-lived perennial. Reproduction is by seed. Dyer's woad taproots can reach 3 to 6 feet in depth and branch laterally within the first 12 to 20 inches of soil.

Biocontrol	Weevil under petition, expected approval 2019	
Mechanical and cultural	Hand-pulling, cultivation, or digging below the crown before seed production is very effective. The crown must be removed to prevent re-sprouting. Sheep grazing may also provide limited control of Dyer's woad. Sheep readily consume top growth of woad until the flowering stage. Recent studies suggest that properly timed grazing, repeated several times per season may increase mortality and reduce reproductive performance when at least 60 percent of the plant is removed.	
Herbicide	**Rate**	**Timing**
Escort	1⁄2 oz. per acre + NIS surfactant To minimize seed production on large infestations for about 2 seasons of control.	Best in pre-bloom or early bloom. Can minimize seed production with late application after fruits have begun to form.
Telar	1 oz. per acre Registered for use on right-of-ways and in crops; not in rangelands.	Pre- or early post emergent to young plants

Field bindweed (Priority 3)

Field bindweed (*Convolvulus arvensis*) is a perennial and one of the most persistent and difficult-to-control weeds. It has a vigorous root and rhizome system that makes it almost impossible to control with cultivation. Its seed has a long dormancy and may last in soil for up to 60 years. It has a climbing habit that allows the plant to grow through mulches. Field bindweed is also very drought tolerant and once established is almost impossible to control with herbicides. Seeds (viable up to 50 years) and creeping deep roots.

Biocontrol	Leaf-galling mites (Aceria malherbae / A. convolvuli)	
Mechanical and cultural	Hand-pulling (and cultivating) must be done for 3 to 5 years every 2 weeks to be effective. Grazing or mowing is not an effective control. Cultivation and herbicide treatment can be used. If herbicides are to be used, treat the bindweed plants before they are drought stressed. Re-treatments will be necessary to control both established plants and seedlings. If possible, grow a competitive planting of other plants to reduce field bindweed growth. Establish and maintain healthy native vegetation, especially perennial grasses.	
Herbicide	**Rate**	**Timing**
Tordon	2-4 pints per acre	active growth

Field Scabious (Priority 4)

Field Scabious (*Knautia arvensis*) invades roadsides, fields and pastures, prefers nutrient rich soil but can establish in many soil types. In many areas has become an ornamental invader. Reproduces by seed and a plant can produce up to 2000 seeds that remain viable for many years.

Perennial with deep tap root, opposite leaves and bright purple flowers

Biocontrol	No known agents.	
Mechanical and cultural	Considered unpalatable so grazing is not a viable option. Tillage and diligent pulling can reduce seed set and help to reduce plant numbers. Repeated mowing can also help reduce seed set.	
Herbicide	**Rate**	**Timing**
Milestone	5-7 oz. per acre	Actively growing (early rosette stage) in the spring, bolt to early bud.

Hoary alyssum (Priority 4)

Hoary alyssum (*Berteroa incana*) winter annual that produces dense stands. The species is a prolific seed producer. Small white 4 petaled mustard flowers. Develops a deep tap root. Forms a rosette in the fall and bolts the next spring. Invades disturbed area, open lots, gravel bars and roadsides. Can be toxic to horses.

Biocontrol	none	
Mechanical and cultural	Moving can be used early to prevent seed set or part of an integrated program. Tillage can minimize plants but also causes disturbance that promotes this type of winter annual species, use as part of an integrated approach. Competition planting are also a tool. Irrigation typically minimizes the infestation as Berteroa likes dry conditions.	
Herbicide	**Rate**	**Timing**
Telar	1 oz per acre	rosette to full bloom
Escort	1 oz per acre	
Glyphosate	1-2 qts per acre	rosette to bud

Hoary cress, whitetop (Priority 2)

Hoary cress, whitetop (*Cardaria draba*) is found in non-shaded, disturbed conditions, including roadsides, waste places, fields, gardens, watercourses, open grasslands and along irrigation ditches. Not particular about soil type, even saline soils, except for highly acidic soils. Most aggressive, rapid expansion occurs in irrigated conditions or during moist years. Whitetop is one of the earliest perennial weeds to emerge in the spring. If conditions remain suitable, they will flower and produce a second crop of seeds late in the summer. A single plant can produce from 1,200 to 4,800 seeds each year. Buried seeds remain viable for about three years. Whitetop is a deep-rooted perennial, with roots going 12 to 30 feet deep. One plant can spread 12 feet in its first year.

<table>
<tr><td>Biocontrol</td><td colspan="2">2 agents under petition and awaiting approval</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Manual, mechanical and cultural control practices have provided little success. Mowing or grazing with sheep or goats during bud stage and again during re-bud (follow by herbicide). Hand-pulling or digging must remove all roots and continue for 2 to 5 years to eradicate. Presence of competing vegetation, particularly shrubs, vetch, lupine and other nitrogen-fixing legumes will help suppress whitetop.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Escort</td><td>0.5 to 1 oz per acre + blended surfactant</td><td rowspan="2">Treat prior to or at early flowering and fall regrowth</td></tr>
<tr><td>Telar</td><td>3⁄4 to 1 oz per acre + blended surfactant</td></tr>
</table>

Houndstongue (Priority 3)

Houndstongue (*Cynoglossum officinale*) is a biennial or short-lived perennial species which forms rosettes in the first year and flowers in the second. It has a thick branching taproot, extending to depths >40 inches. It often occurs in dense stands. Seedlings are usually clustered around parent plants in densities of up to 405 seedlings per square foot. Estimates of total seed number per plant range from 50 to more than 2,000. Its spiny husk and protruding barbs enable long distance dispersal to occur. Seeds attach to fur and clothing. Seed viability in the soil is relatively short compared to other invasive plants. Seed can remain viable above ground on plants for up to two years. Houndstongue is most abundant in areas with more than 10 percent bare ground. It is toxic to livestock and wildlife. It contains pyrrolizidine alkaloids which cause liver cells to stop reproducing.

Biocontrol	Biological controls are being screened for possible use. One is approved in Canada. A native bacterium is being tested at Montana State University as an effective biological control as well. Spraying the plant with these bacteria interferes with its production of chlorophyll, weakening it so it will not re-sprout the following year.	
Mechanical and cultural	Surface cultivation, digging and hand-pulling are considered ineffective means of control because plants are capable of regenerating from the root crown. Hand pulling can reduce the size of populations up to 85%, though, if roots are completely removed hand-pulling occurs before flowering. Severing the root crown 1 to 2 inches below the soil surface with a spade and removing top growth can be effective in controlling small infestations when done before flowering. Mowing at ground level can reduce re-growth by 60% as well as seed production in some cases. Plowing is said to control houndstongue, but may not be appropriate in most areas. A vigorous vegetative cover will help prevent infestations of houndstongue. Houndstongue seedlings have a comparatively low growth rate and are not strongly competitive. Interspecific competition can severely reduce the dry weight of first and second year plants. Therefore, revegetation can effectively control houndstongue re-introduction, although more research is needed.	
Herbicide	**Rate**	**Timing**
Escort	0.5 to 1 oz per acre	Rosette to bolt.
Telar	1 oz per acre	active growth

Leafy spurge (Priority 1)

Leafy spurge (*Euphorbia esula*) occurs on untilled, non-cropland habitats, including both disturbed and undisturbed sites, especially abandoned cropland, pastures, rangelands, woodlands, roadsides and waste places. Tolerant of a wide range of soils from rich, moist soils of riparian zones to nutrient-poor, dry soils of western rangelands. It is most aggressive in semi-arid situations where competition from associated species is less intense.

Perennial and rhizomatous. Reproduces by seed (viable up to 8 years, usually germinate within 2 years) and spreading roots. Each flowering stem produces an average of 140 seeds. When the plant matures, the seed capsule explodes and launches the seeds up to 15 feet. Seed production ranges from 25 to 4,000 pounds per acre depending on plant density and site productivity. Seedlings have capacity for vegetative reproduction and can develop root buds with 7 to 10 days of emergence. Roots as long as 35 feet have been found. Root systems of well-established older plants can regenerate from fragments even if roots are removed to a depth of three feet.

Leafy spurge can cause blistering and hair loss around horses' hooves and can be irritating to the skin, eyes and digestive tracts of humans and other animals.
(http://plants.usda.gov/plantguide/pdf/pg_eues.pdf)

Biocontrol	Flea beetle (*Aphthona abdominalis*), flea beetle (*A. nigriscutis*), flea beetle (*A. lacertosa*), flea beetle (*A. czwalinae*), flea beetle (*A. cyparissiae*), flea beetle (*A. flava*), hawk moth (*Hyles euphorbiae*), long horned beetle (*Oberea erythrocephala*), gall midge (*Spurgia esulae*) Some success has been found with the flea beetle combined with fall herbicide treatments.	
Mechanical and cultural	No mechanical methods have been found to work effectively alone. Hand- pulling, digging and tilling are only successful if the entire root system can be excavated and may increase the number of plants if any remnants remain in the soil. Repeated mowing/cutting before flowering in conjunction with use of herbicides may be adequate control of stand expansion. Mowing is ineffective when used alone. However, it does reduce seed production and dispersal and disrupts root vigor, making the plants more susceptible to pathogens. Mowing increases the effectiveness of herbicides by making the stand of leafy spurge more uniform improving the coverage of the herbicide treatment. Grazing by sheep or goats can be a very effective tool for controlling leafy spurge populations. Leafy spurge is not toxic, and in fact is very nutritious, providing good forage. Light, periodic cultivation stimulates additional plants from the roots resulting in a denser stand. Initial reseeding with grasses followed by eventual revegetation with forbs and shrubs may contribute to long-term suppression of leafy spurge. Burning, alone, is ineffective for reducing leafy spurge infestations and it stimulates sprouting of established plants, increasing plant density. Spring or fall burns are best when trying to control seed production and is more effective when used in conjunction with herbicides or grazing.	
Herbicide	**Rate**	**Timing**
Tordon	1 to 3 quarts per acre + surfactant For 3-gallon backpack: 4.5 to 6.5 oz per 3 gallons water	Before seed set or during fall regrowth
2,4-D amine	8 oz - 1 qt per acre	before flower - to stop flower and seed production and burn plant down

Plateau	8-12 oz per acre +surfactant	Late fall before leafy spurge loses its milky sap after a killing frost

Meadow knapweed (Priority 4)

Meadow knapweed (*Centaurea pratensis*) invades roadsides, waste area, fields and pastures. In many areas has become an ornamental invader.

Perennial with many branched stems per plant. Lower leaves are lobed, reducing leaf size as you go up the stem. Considered as a hybrid between brown and black knapweeds.

Biocontrol	None known.	
Mechanical and cultural	Tillage and pulling are not recommended for perennial knapweed species.	
Herbicide	**Rate**	**Timing**
Tordon	1 pint per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.
Milestone	5-7 oz. per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.

Medusahead (Priority 4)

Medusahead (*Taeniatherum caput-medusae*) is an annual grass native to the Mediterranean region. Flowering occurs in late spring. The seed heads are what distinguish this plant from other annual grasses. Awns twist as they dry, hence the common name "medusahead". The longer of the two awns in each spikelet is barbed. These barbs catch on fur or clothing and spread seed. Plants invade dry, open lands with frequent disturbance.

Biocontrol	None	
Mechanical and cultural	Although a few reports indicate that medusahead is palatable in early spring before maturity, most grazing animals rarely eat it. Heavy spring grazing by sheep during the green stage of medusahead has been reported to assist in its control. Maintaining good stands of perennial vegetation helps to prevent medusahead invasion, but restoration of most native vegetation without first removing this weed have not been successful. Tillage will control existing medusahead plants and can be used to breakup deep thatch layers. But, it can increase potential for soil erosion and loss of soil moisture. Mowing is not an effective control strategy for medusahead.	
Herbicide	**Rate**	**Timing**
Plateau	2 oz/ac to 12 oz/acre 2 to 6 oz/ac of Plateau are recommended for bare soil, with light infestations. In areas of thick vegetation and leaf litter, higher rates of 6 to 12 oz/ac may be needed.	
Rimsulfuron Matrix SG Laramie 25DF	*labelled grazing restriction apply* 3 oz per acre, 3-4 oz per acre	fall prior to ground freeze
Esplanade 200SC	5-7 oz per acre labelled grazing restrictions apply	Pre-emergence, Recommended mid summer to get required 0.25 inch precipitation for activation.

Musk thistle (Priority 2)

Musk thistle (*Carduus nutans*) does best in disturbed areas, such as along roadsides, grazed pastures, burned areas and old fields, but also can invade deferred pastures and native grasslands. It can occur in almost all habitats except dense forests, high mountains, deserts and frequently cultivated farmlands. It is a biennial or winter annual, reproducing by seed. It is a very prolific seed producer, producing a few thousand to 100,000 seeds per plant. Most seeds fall close to the plant, resulting in thousands of new seedlings in the immediate area. Musk thistle seeds may remain viable for more than 10 years in the soil.

<table>
<tr><td>Biocontrol</td><td colspan="2">Rosette weevil (Trichosirocalus horridus), flea beetle (Psyliodes chalcomera), syrphid fly (Cheilosia corydon).</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Mechanical control is effective on musk thistle. Tilling, hoeing and hand-pulling must be completed either in the rosette stage or early after the flower stalk blots, but before the plant flowers and produces seed. To be effective, a successful revegetation program must follow tilling. If this is not done, re-infestation of musk thistle is inevitable.
Mowing is an option, but it can allow some musk thistle plants to recover and possibly sow seeds. Mowing does reduce seed production, but should not be the single means of control in a management program. It is most effective at the flower bud stage. Mowing combined with an herbicide is more effective.
Good forage management practices that establish competitive desirable forage, maintain soil fertility and prevent erosion will help combat musk thistle.
Research shows that musk thistle has declined over the years when perennial grasses are present.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1 pint Tordon</td><td rowspan="3">Before seed set or during fall regrowth</td></tr>
<tr><td>Transline</td><td>16 oz per acre per year</td></tr>
<tr><td>Milestone</td><td>3-5 oz. per acre</td></tr>
</table>

North Africa Grass (Priority 4)

North Africa Grass (*Ventanta dubia*) is a winter annual grass. Flowering occurs in late spring, producing 15-35 seeds per plant. The entire plant is cover in tiny hairs, which gives the plant a shiny appearance. The plant has a band at the node that is dark red to black. The ligule is long and membranous. The inflorescence is an open panicle in a pyramid shape. The plants seed head awns are bent and twisted much like those of wild oat. This plant is high is silica content making it a very low quality forage. Plants invade dry, open lands with frequent disturbance.

Biocontrol	None	
Mechanical and cultural	Maintaining good stands of perennial vegetation helps to prevent invasion, but restoration of most native vegetation without first removing this weed have not been successful. Tillage will control existing plants and can be used to breakup deep thatch layers. But, it can increase potential for soil erosion and loss of soil moisture. Mowing is not an effective control strategy. Repeated pulling can reduce plants and seed production in small infestations. Can be grazed in early spring but forage value is minimal.	
Herbicide	**Rate**	**Timing**
Plateau	2 oz/ac to 12 oz/acre 2 to 6 oz/ac of Plateau are recommended for bare soil, with light infestations. In areas of thick vegetation and leaf litter, higher rates of 6 to 12 oz/ac may be needed.	fall prior to ground freeze
Rimsulfuron Matrix SG Laramie 25DF	*labelled grazing restriction apply* 3 oz per acre, 3-4 oz per acre	
Esplanade 200SC	5-7 oz per acre labelled grazing restrictions apply	Pre-emergence, Recommended mid-summer to get required 0.25 inch precipitation for activation.

Oxeye daisy (Priority 3)

Oxeye daisy (*Leucanthemum vulgare*) is a shallow-rooted rhizomatous perennial. The plant is a prolific seed producer; a single, healthy, robust plant produces up to 26,000 seeds. Reproduction occurs primarily through seed dispersal and germination, although spreading rootstalks contribute to its propagation. Seeds may be viable ten days after the flower blossoms and are dispersed close to the parent plant. Germination occurs throughout the growing season, but most new seedlings emerge in spring. Seeds that do not germinate in the spring may remain viable for many years.

Biocontrol	No biological controls have been discovered for oxeye daisy.	
Mechanical and cultural	Oxeye daisy should be mowed as soon as flowers appear to reduce seed production. Mowing may have to be repeated during a long growing season because mowing may stimulate shoot production and subsequent flowering. Root systems are shallow and the plant can be dug up and removed. Be sure to remove the entire root system, though, as remaining roots may produce new shoots. Hand removal will have to be continued for several years because seeds may remain viable in the soil for a long time. Where oxeye daisy is already a major member of the plant community, it will increase with continuous cattle grazing. However, oxeye daisy density may be reduced by intensive cattle grazing.	
Herbicide	**Rate**	**Timing**
Escort	1 oz per acre	Before seed set
Tordon	1 to 2 quarts per acre	
Milestone	4-7 oz. per acre	

Perennial pepperweed (Priority 4)

Perennial pepperweed (*Lepidium latifolium*) produces dense stands with stems reaching up to 3 feet in height, but even up to 8 feet in wet areas. Its dense cover blocks sunlight from reaching the soil, thus suppressing the growth of other plants. Roots are enlarged at the soil surface in a woody crown and can extend at times into the water table. The species is a prolific seed producer, capable of producing more than six billion seeds per acre. Seeds lack a hard cover, though, therefore viability may be short. In addition to seeds, the species can spread by rhizomes which may grow to a length of ten feet.

Biocontrol	None approved	
Mechanical and cultural	With the exception of continual flooding, no non-herbicide treatments have been found to effectively control this species.	
Herbicide	**Rate**	**Timing**
Telar	1 oz /ac	bud to full bloom

Perennial sowthistle (Priority 4)

Perennial sowthistle (*Sonchus arvense)* is a perennial with thickened rhizomes. Reproducing by rhizomes and by seed (2-5 year viability).

Biocontrol	Cyst-forming nematode (*Heterodera sonchophila*). Seedhead fly (*Tephritis dilacerata dilacerata*) waiting for final approval	
Mechanical and cultural	Cutting, grazing and mowing can be effective at depleting root stores, if done selectively and frequently. Repeated hoeing and cultivating can be effective if done at 6-leaf rosette stage. Establish and maintain healthy native vegetation	
Herbicide	**Rate**	**Timing**
Milestone	3-7 oz. per acre	active growth

Plumeless thistle (Priority 4)

Plumeless thistle (*Carduus acanthoides*) prefers temperate regions and is frequently found on grasslands. Typically, plumeless thistle inhabits pastures, stream valleys, fields, roadsides and disturbed areas. A winter annual or biennial herb that has a stout fleshy taproot, plumeless thistle reproduces solely through seed production. During the first growing season, plumeless thistle produces a rosette of leaves and a fleshy taproot. The plant bolts early in the second growing season and flowers from May to August. Seeds are dispersed one to three weeks after flowering, with each flower capable of producing approximately 50 to 80 seeds. Seeds can remain viable for a period of ten years or more.

Biocontrol	Rosette weevil (*Trichosirocalus horridus*), flea beetle (*Psyliodes chalcomera*), syrphid fly (*Cheilosia corydon*).	
Mechanical and cultural	Hand pulling small infestations of plumeless thistle can be an effective control method. This method should be conducted before the reproductive growth stages of the plant to prevent seed production. Mowing prior to seed dispersal may limit the amount of seed available for germination.	
Herbicide	**Rate**	**Timing**
Tordon	1 pint per acre	Before seed set or during fall regrowth
Milestone	3-7 oz. per acre	

<u>Purple loosestrife (Priority 4)</u>

Purple loosestrife (*Lythrum salicaria*) is a stout, erect perennial that is usually associated with wetland, marshy, or riparian areas. A mature plant may have as many as thirty flowering stems capable of producing an estimated two to three million seed per year. It also readily reproduces vegetatively at a rate of about 1 foot per year, with root or stem segments forming new flowering stems. The seeds can remain viable even after 20 months of submergence in water. A strong rootstock serves as a storage organ, providing resources for growth in spring and regrowth if the aboveground shoots are cut, burned, or killed by application of foliar herbicides.

Biocontrol	Weevil (*Hylobius transversovittatus*), black-margined and golden leaf eating beetles (*Galerucella calmariensis* and *G. pusilla*), flower weevil (*Nanophyes marmoratus*). The most promising control measure for purple loosestrife is the application of biological agents. Beetle species have been screened as potential control agents and are being studied.	
Mechanical and cultural	Areas of individual younger plants and clusters of up to 100 younger plants can be hand-pulled, if done before flowering. Older plants, especially those in bogs or in deep organic soils, can be dug out. Follow-up treatments are recommended for three years after the plants are removed. Generally, mowing or cutting is not recommended. Where feasible, the flower heads can be cut, bagged and removed from the site to prevent seed set. Revegetation can be effective.	
Herbicide	**Rate**	**Timing**
Aquatic glyphosate	1 to 1.5% concentrate/ac (1 to 1.5 gal/100 gal water or 1.3 to 1.9 fl. oz. / gal) Spot application to individual is recommended treatment where hand pulling is not feasible. Since purple loosestrife is usually taller than the surrounding vegetation, application to the tops of the plants alone can be very effective and limit exposure of non-target species.	When plants begin to flower
Garlon 3A	1 to 9 lbs. ai/ac (1 to 3 gal/100 gal water)	

Rush skeletonweed (Priority 4)

Rush skeletonweed (*Chondrilla juncea*) invades roadsides, waste areas, disturbed sites, pastures. It inhabits well drained, light textured soils. Perennial that grows between 1-4 feet. At base of stem has rust colored stiff hairs. Extensive roots systems make this plant difficult to control. Reproduces by seed and root fragments. Plants can produce from 1500 to 20,000 seeds.

Biocontrol	Four biological control agents have been released for control of Rush Skeletonweed in North America: a mite, a midge and a rust	
Mechanical and cultural	Do not till. Not palatable to livestock. Repeated hand pulling can minimize small infestations.	
Herbicide	**Rate**	**Timing**
Milestone	5-7 oz. per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or rosettes.
Tordon	1 pint per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.

Russian knapweed (Priority 1)

Russian knapweed (*Acroptilon repens*) prefers heavy, often saline soils of bottomlands and sub-irrigated slopes and plains. Commonly found along roadsides, riverbanks, irrigation ditches, pastures, waste places, clearcuts, croplands and hayfields. Does not readily establish in healthy native vegetation, requires disturbance. The healthier the native vegetation, the less susceptible it will be to Russian knapweed invasion. Once established, it emits allelopathic compounds to inhibit other plants. Long-lived perennial (75 years). A single plant may produce 1,200 seeds, which remain viable two to three years. Although Russian knapweed produces seeds, it does not reproduce extensively from seed. Infestations increase primarily vegetatively through adventitious buds on a creeping root system. Roots, which are both vertical and horizontal in the soil, may or may not be black with a scaly appearance. Roots grow 6 to 8 feet deep the first season and 16 to 23 feet deep in the second season.

Biocontrol	Gall-forming nematode (*Subanguina picridis*), seed head gall fly (*Urophora quadrifasciata*), seed head gall fly (*U. affinis*), *Ailacidea acroptilonica*, *Jaapiella ivannikova*	
Mechanical and cultural	Cultivation, cutting/mowing and/or hand- pulling not recommended unless done three times per year (spring, summer, fall) to force the plants to use nutrient reserve stored in roots, followed by herbicide treatment. This protocol must be followed for at least 3 years otherwise it will stimulate sprouting from rhizomes. It is difficult to remove all roots with a one-time effort. Severed root pieces as small as 2.5 cm can generate new shoots from depths to 15 cm. Whichever control combination is chosen, it is imperative to continually stress the plant because it does not do well under stressful conditions. The most preferred method of control is to mow the area of Russian knapweed once a month during the spring and summer months, then follow up with an application of Tordon or 2,4-D in the fall. Herbicides are not always necessary if the plant is stressed by mechanical methods and proper cultural techniques are applied. Long-term reductions must include planting competitive plant species to occupy bare ground once infested by the weed, due to Russian knapweed's allelopathic qualities.	
Herbicide	**Rate**	**Timing**
Tordon	2 quarts per acre For 3-gallon backpack: 4.5 oz per 3 gallons water	Before full flower or during fall re- growth
Telar	1 1/3 pints per acre For 3-gallon backpack: 0.5 oz. per 3 gallons water	
Milestone	5-7 oz. per acre	

Russian olive (Priority 2)

Russian olive (*Elaeagnus angustifolium*) *is* a native of southern Europe and western Asia. It was introduced into the United States in the early 1900s as an ornamental and specimen for wind-row plantings. It is a perennial deciduous tree (or shrub) that grows to heights of 10 to 25 feet. The seeds are ingested by birds or gathered by small mammals, who then deposit them elsewhere. The seeds can remain viable for up to three years and can germinate over a broad range of soil types. The tree itself tolerates a wide range of soil and moisture conditions, from sand to heavy clay and can withstand flooding, silting and drought. Russian olives are deep-rooted and have well-developed lateral root systems. Although the tree reproduces primarily by seed production, it can establish vegetatively by sprouting from buds on the root crown and sending up root suckers. It has a medium to rapid growth rate and can grow up to six feet per year.

Biocontrol	There are no registered biocontrol agents for Russian olive. Mite currently under petition.	
Mechanical and cultural	Cutting alone is not enough to control this tree. Russian olive is a vigorous resprouter from the root crown and will rapidly regrow following cutting or any type of top growth damage. Small seedlings may also be hand pulled in the spring and early summer, but this is extremely difficult when stems are greater than one-half inch in diameter. Resprouts from older root crowns cannot be hand pulled at all. In addition to the sprouts, control efforts will need to continue until the seed source within the soil is exhausted, which may take several years.	
Herbicide	**Rate**	**Timing**
Glyphosate	2 cc (ml) per inch of trunk diameter or 5% solution applied to foliage	Apply undiluted to frill cuts or apply to foliage after the tree fully leafs out.
Arsenal	2 cc (ml) per inch of trunk diameter or 0.75% solution of the 2 lb. ai/gal applied to foliage	

Saltcedar (Priority 1)

Saltcedar (*Tamarisk complex*) is a deciduous shrub that can grow up to 15 feet in height. It is found in many riparian areas throughout the West. It was introduced as an ornamental and for erosion control. It out-competes native riparian trees by forming deep root systems that can remove underground water not available to native species. It invades streambanks, sandbars, lake margins, wetlands, moist rangelands and saline environments. It can crowd out native riparian species, diminish early succession and reduce water tables, thus interfering with hydrological processes. It reproduces by seed (can produce over 500,000 seeds); and from stems, crown and roots.

Biocontrol	Mealy bug (*Trabutina mannipara*)	
Mechanical and cultural	New growth occurs readily when young plants are grazed or mowed, or the trunk or shoots are removed or killed by fire or severe drought. Establish and maintain native vegetation to prevent infestation or re-infestation.	
Herbicide	**Rate**	**Timing**
Aquatic glyphosate	Per acre rate: 71/2 pts./ac plus 1/2%v/v nonionic surfactant Spot treatment: 11/2% v/v solution plus 1/2% v/v nonionic surfactant Cut stump treatment: 100% v/v solution (full strength)	August through September
Glyphosate	Per acre rate 5 qts/ac Spot treatment: 2% v/v solution Cut stump treatment: 100% v/v solution (full strength)	
Arsenal	Per acre rate: 1.5 to 2 qt/ac w/ MSO adjuvant Spot treatment: 1 gal per 100 gal water + 0.25% surfactant Cut stump treatment: 12 oz per gallon of water Thoroughly wet foliage. Do not cut down and remove for at least 3 years or re-growth will occur.	

Scentless chamomile (Priority 2)

Scentless chamomile (*Tripleurospermum perforatum*) is an annual, biennial or short-lived perennial that reproduces by seed. This weed is found in roadsides, drainage ditches, fence lines, various croplands, hay lands, pastures, farmyards and wastelands. It is more prevalent on disturbed sites. Scentless chamomile reproduces only by seed. Abundant seed production and variable dispersal methods are key to success. A single plant can produce as many as a million seeds. Most scentless chamomile seedlings establish in the spring or fall. The seed does not have a dormancy period. New seed requires light to germinate and will not germinate if buried in the soil. With time, scentless chamomile seed loses its requirement for light and will germinate in the dark. Buried seed can remain viable up to 15 years.

Biocontrol	None approved in USA	
Mechanical and cultural	Frequent, shallow tillage can help exhaust the seed bank in non-native areas. Mowing is not an effective long-term control method due to the fact the plant will prostate, in the short-term mowing will assist with limiting seed production. Hand pulling can prevent spread into new areas and is effective on small infestations.	
Herbicide	**Rate**	**Timing**
Milestone	4-7 oz product per acre	Apply when plant is in rosette to bolting growth stage

Scotch thistle (Priority 2)

Scotch thistle (*Onopordum acanthium*): Scotch thistle is a biennial, relying on seed production for proliferation. Requiring adequate moisture for establishment, Scotch thistle is often associated with waterways in the western United States, but it can also occupy dry sites.

Biocontrol	thistle crown-weevil (*Trichosirocalus horridus*)	
Mechanical and cultural	Digging must cut plant off below soil level, leaving no above-ground biomass. Establishing and maintaining dense, vigorous native vegetation is especially important to reduce seed germination (particularly in the fall). Grazing regimes should be adjusted to avoid late summer/fall rotations.	
Herbicide	**Rate**	**Timing**
Tordon	1 pint Tordon	Before seed set or during fall regrowth
Milestone	5 -7 oz. per acre	

Spotted knapweed (Priority 1)

Spotted knapweed (*Centaurea maculosa*) is best adapted to well-drained, light-textured soils in areas that receive some summer rainfall. Once established, it emits allelopathic compounds to inhibit other plants. The roots give off a chemical reaction that kills other plants surrounding it. This then leaves bare ground for new knapweed plants to sprout and grow thus, increasing size and density of an infestation. This eventually results in a monoculture of knapweed.

Biennial or short-lived perennial. Each plant can produce 400 or more seeds per flower stalk and up to 40,000 seeds per plant. Most seeds fall within a 3- 4 foot radius of the parent plant. Seeds are viable for 7 to 20 years and germinate throughout the growing season. Typically, the species bolts during its second growing season but plants may stay in the rosette stage for multiple years before bolting

<table>
<tr><td>Biocontrol</td><td colspan="2">Seed head gall fly (Urophora affinis and U. quadrifasciata), seed head fly (Chaetorellia acrolophi), seed head moth (Metzneria paucipunctella), seed head weevil (Bangasternus fausti), seed head weevil (Larinus minutus and Larinus obtusus), black leaf blight fungus (Alternaria alternata), root moth (Agapeta zoegana), verdant seed fly (Terellia virens), root weevil (Cyphocleonus achates), fungus (Sclerotinia).
The most promising bio-agents are the two seed head attacking flies Urophora affinis and U. quadrifasciata.</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Hand-pulling of small infestations (usually takes 7 to 10 years). The entire root crown must be completely removed.
In stands with little other vegetation, it may be possible to mow if mowing occurs just after most flowering has ended, but before seeds have matured. Mowing combined with mulching may increase effectiveness. Mowing may cause low growing forms. It is considered moderately effective.
Long term grazing by sheep and goats has been found to control spotted knapweed. Sheep, goats and cattle will consume spotted knapweed without any adverse effects. Generally this can be an effective method if it coincides with cultural practices and proper grazing management practices are used.
Prescribed burning alone is probably not effective for controlling spotted knapweed and may cause increases. Studies have shown that moderate increases occur after fire. Established stands may be reduced by hot, prescribed burns. Fire may be useful in conjunction with herbicides under the right conditions by reducing old stem densities. A fuel model has been developed for this species. The fire severity depends on the amount of dry knapweed stems and the amount of fine grass fuels.
Plowing soils under to 7 inches, allowing 4-6 weeks for re-germination and then repeating for one growing season has been successful. Herbicide application may make cultivation more effective for large infestations. For cultural controls, desired grasses should be planted during the fall to maximize establishment success.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1 quart per acre
For a 3-gallon backpack: 1.5 to 2 oz per 3 gallons water</td><td rowspan="3">Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.</td></tr>
<tr><td>Transline</td><td>⅔ - 1 ⅓ pint per acre</td></tr>
<tr><td>Milestone</td><td>5-7 oz. per acre</td></tr>
</table>

Squarrose knapweed (Priority 1)

Squarrose knapweed (*Centaurea virgata ssp squarrosa*) prefers dry, open rangeland with shallow soils. It readily invades and becomes established on rangelands with little herbaceous understory and particularly after fire. It can survive harsh climates and is tolerant of fire and drought. This weed is rarely found on croplands or irrigated pasture because it cannot survive cultivation or excessive moisture from irrigation.

Biocontrol	Knapweed flower weevil (*Larinus minutus*) and bronze knapweed root borer (*Sphenoptera jugoslavica*) are more effective biocontrol agents than the following agents: seed head gall fly (*Urophora affinis*); seed head gall fly (*U. quadrifasciata*); peacock fly (*Chaetorellia acrolophi*); seed head weevil (*Bangasternus fausti*); root weevil (*Cyphocleonus achates*) None of these, alone or in combination effectively control populations. They may prove useful as part of an integrated program to weaken plants therefore making them more susceptible to other treatments.	
Mechanical and cultural	Hand pulling squarrose knapweed is ineffective because stout taproots resprout when broken off. Grubbing or digging the roots of individual plants or small infestations of squarrose knapweed with a shovel may be effective if most of the taproot is removed. The root should be cut at least eight inches below the soil surface in order to prevent the formation of new shoots.	
Herbicide	**Rate**	**Timing**
Tordon	1 pint per acre + surfactant	Apply to actively growing plants in the bud stage
Milestone	5-7 oz. per acre	Late spring before or during flower stem elongation

St. Johnswort (Priority 2)

St. Johnswort (*Hypericum perforatum*) is a taprooted perennial weed which reproduces by seeds and short runners. The taproot may reach depths of 4 to 5 feet. Lateral roots grow 2 to 3 inches beneath the soil surface but may reach depths of 3 feet. Flowering begins in May and continues through September. Developing capsules become very sticky and contain 400 to 500 seeds. Seeds may remain viable in soil for up to 10 years.

Biocontrol	Beetle (*Agrilus hyperici*), moth (*Aplocera plagiata*), beetle (*Chrysolina hyperici*), beetle (*C. quadrigemina*), Klamath weed midge (*Zeuxidiplosis giardi*). The Klamath weed beetle has had good success and another beetle (*C. hyperici*) is better adapted to wetter sites.	
Mechanical and cultural	Hand-pulling or digging of young, isolated plants. Repeated treatments will be necessary because lateral roots can give rise to new plants. Pulled or dug plants must be removed from the area to a refuse site or burned to prevent vegetative regrowth. Cutting and mowing not recommended - may reduce seed but promotes sprouting from rhizomes. Burning may increase the density and vigor of this species. Livestock avoid this species which can make them sensitive to sunlight, so grazing would select for the increase of this species. Regular cultivation. Maintain a competitive, closed-canopy plant community. This species is not shade tolerant	
Herbicide	**Rate**	**Timing**
Tordon	1 pint per acre	Pre-bloom
Milestone	5-7 oz per acre	Seedling/pre-bloom

Sulfur cinquefoil (Priority 2)

Sulfur cinquefoil (*Potentilla recta*) is a long-lived, taprooted perennial herb that typically flowers from late May to mid-July. It reproduces primarily through seed; a single plant can produce thousands of seeds annually and it can be spread by roots if they are moved by tillage or on soil-moving equipment. Seeds are dispersed primarily by wind from late summer through fall. Seeds appear to remain viable in the soil for more than four years, though studies specifically addressing seedbank persistence are lacking. In western North America, sulfur cinquefoil invades native forest, shrub and grassland plant communities as well as disturbed habitats that typically harbor weeds. It can dominate a site within 2 to 3 years. New shoots can develop annually from the outer portion of the main root allowing a plant to live for extended periods as long as 20 years

<table>
<tr><td>Biocontrol</td><td colspan="2">Root moth (Tinthia myrmosae-formis), flower-head weevil (Anthonomus rubripes)
Sulfur cinquefoil is closely related to the desirable northern cinquefoil, the wild strawberry and tame strawberry. Therefore, plant-specific insects for biocontrol are very difficult to find.</td></tr>
<tr><td>Mechanical and cultural</td><td colspan="2">Hand-pulling of small infestations (must remove root crown). Regular cultivation. Mowing not recommended. Burning used alone does not appear to be effective and may in fact increase sulfur cinquefoil recruitment.
If populations are reduced (i.e. by herbicide, hand-digging), native plants are usually able to rapidly recolonize sites if sufficient native seed is still viable in the soil. Seeding of native species under adequate environmental conditions, reducing grazing pressure and continued spot herbicide re-treatments, will result in a more rapid and stable restored native plant community.</td></tr>
<tr><td>Herbicide</td><td>Rate</td><td>Timing</td></tr>
<tr><td>Tordon</td><td>1 pint Tordon</td><td rowspan="3">Before seed set and during fall regrowth</td></tr>
<tr><td>Escort</td><td>0.5 to 1 oz per acre</td></tr>
<tr><td>Milestone</td><td>4 to 6 oz per acre</td></tr>
</table>

Yellow starthistle (Priority 4)

Yellow starthistle (*Centaurea solstitialis*) invades roadsides, waste areas, disturbed sites, pastures and all soil types. Winter annual that grows between 2-3 feet. Reproduces by seed, a large plant can produce 75,000 seeds that can live up to 10 years in field conditions. Bright yellow flowers with long sharp spines. Plants are highly competitive and can form large impenetrable stands to humans and grazers. Causes chewing disease in horses, in forces to eat it. Considered one of the most serious rangelands weeds in the West.

Biocontrol	Bangasternus orientalis, Eustenopus villosus, Larinus curtus, Urophora sirunaseva and Chaertorellia australis	
Mechanical and cultural	Repeated hand pulling can minimize small infestations. Tillage, moving, grazing can help reduce seed productions, when used long-term. Burning to prevent seed and reduce biomass can be effective.	
Herbicide	**Rate**	**Timing**
Milestone	5-7 oz. per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or rosettes.
Tordon	1 pint per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.

Yellow toadflax (Priority 1)

Yellow toadflax (*Linaria vulgaris*), like Dalmatian toadflax, is an introduced ornamental that is quick to colonize open sites and is capable of adapting growth to a wide variety of environmental conditions. It is a perennial. Flowers produce capsules containing 10 to 40 seeds each. The fruit is round, about 1⁄4 inch in diameter and brown. A single plant may produce 15,000 to 30,000 seeds. Seed germination rates are usually low, often below 10%. It is a tap-rooted perennial (taproot may be as long as 3 feet) with horizontal roots that may grow 25 inches per year. Adventitious root buds may form independent plants. Once established, this species can suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years.

Biocontrol	None of these are considered highly effective: toadflax moth (*Calophasia lunula*), root-boring moths (*Eteobalia intermediella* and *E. serratella*), seed capsule-feeding weevils (*Gymnetron antirrhini* and *G. linariae*), stem-boring weevil (*Mecinus janthinus*), ovary-feeding beetle (*Brachypterolus pulicarius*), flea beetle (*Longitarsus jacobaeae*).	
Mechanical and cultural	Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate). Regular cultivation (every 7 to 10, for 2 years). Do not mow. Fire is not effective. Intense competition with native vegetation. Because established infestations of yellow toadflax spread mainly by roots, physical removal (especially around perimeters) can limit spread.	
Herbicide	**Rate**	**Timing**
Tordon	4 pints Tordon per acre+ a silicone surfactant For 3-gallon backpack: 4.5 oz per 3 gallons water; Use a silicone surfactant.	Before seed set.
Telar	1-105 oz per acre	late summer

[1] Washington State University Cooperative Extension. 1995. http://cru.cahe.wsu.edu/CEPublications/eb1551/eb1551.html

Montana state University Fact Sheets. 2017. msuextension.org/publications/AgandNaturalResources/EB0194.pdf

Weeds of California and other Western States.2007. Publication 3488, University of California

Biological Control Agent Guide

plants.usda.gov/plantguide/pdf/pg_vedu.pdf

Weeds of the West. 2000. Western Society for Weed Science