National Park Service
U.S. Department of the Interior

Yellowstone National Park

Invasive Vegetation Management Plan

Environmental Assessment

February 21, 2013

Executive Summary

Yellowstone National Park (YNP) has developed a plan to address terrestrial invasive nonnative plants parkwide. (As used here, the term "invasive nonnative plant" has a similar meaning as alien, exotic, or noxious plant or weed.) This Invasive Vegetation Management Plan and Environmental Assessment (EA) provides a comprehensive approach toward invasive vegetation management to preserve, protect, and restore the diversity, ecological integrity, and processes associated with native plant communities in the park. The purpose of the plan is to expand current invasive plant management efforts and implement a parkwide strategy to prevent the establishment and spread of invasive nonnative plant species and to restore, as needed, native plant communities in the park.

The plan proposes to achieve these goals by accomplishing the following objectives:

1. **Prevent** the entry and establishment of new invasive plants
2. **Control** existing populations of invasive plants by eradicating them, reducing their abundance and density, and containing their spread
3. **Restore** native plant communities when they have been disrupted or replaced by invasive nonnative plant populations.

This environmental assessment evaluates a No-Action Alternative and one action alternative:

- **Alternative A** – The No-Action Alternative represents no change from the current direction as established under the 1986 Exotic Vegetation Management Plan (NPS 1986).
- **Alternative B** – The Preferred Alternative proposes the implementation of an Integrated Weed Management (IWM) approach to invasive vegetation management in Yellowstone National Park. An IWM approach would incorporate a balanced strategy to successfully manage invasive plant populations and would include the following processes: a) prevention, b) identification, c) a combination of control methods based on best information, and d) evaluation toward effective adaptive management.

This EA includes a review of the affected environment, methods to be used to manage invasive vegetation, and information on potential impacts on park resources from implementing the plan. Resources evaluated in detail in the EA include: soils; geothermal resources; wetlands and water resources; vegetation, especially rare plants; fish and wildlife, especially threatened, endangered, and special status species; archeological resources; cultural landscapes; health and human safety; visitor use and experience; and park operations. All other impact topics were dismissed because the potential effects of the alternatives under consideration to those resources would be negligible or minor. None of the alternatives under consideration are expected to result in major adverse impacts.

Development of this plan included review of past efforts and public comments received during the public scoping process. Public scoping was conducted in March 2011 to assist with the development of this proposal. No major issues were raised related to the proposal. Comments received were mostly in support of the proposed plan.

This EA has been prepared in compliance with the National Environmental Policy Act and other associated laws and regulations to provide the decision-making framework that (1) analyzes a reasonable range of alternatives to meet objectives of the proposal, (2) evaluates potential issues and impacts on the environment associated with the alternatives under consideration, and (3) identifies mitigation measures to lessen the degree or extent of these impacts.

Public Comment

Comments on this EA may be submitted through the NPS Planning, Environment and Public Comment (PEPC) website (http: //parkplanning.nps.gov/YELLInvVeg) or by mailing them to the following address: Invasive Vegetation Plan/EA, P.O. Box 168, Yellowstone National Park, WY, 82190. Comments may also be hand-delivered during normal business hours to the mailroom in the park's administration building in Mammoth Hot Springs, Wyoming. Comments will not be accepted by fax, e-mail, or in any other way than those specified above. Bulk comments in any format (hard copy or electronic) submitted on behalf of others will not be accepted.

Please be aware that all of the information provided in your entire comment—including your address, phone number, e-mail address, or other personal identifying information—may be made publicly available at any time. Although you can request to have your personal identifying information withheld from public review, the provisions of the Freedom of Information Act prevent us from guaranteeing that this will be possible. Comments will not be accepted by fax, e-mail, or in any other way than those specified above. Bulk comments in any format (hard copy or electronic) submitted on behalf of others will not be accepted.

This EA will be on public review for 30 days. Comments must be received by midnight, March 22, 2013.

Table of Contents

Purpose and Need 1
Introduction 1
Background 1
Purpose and Need 3
Relationship to Other Plans and Policies 4
Scoping 5
Impact Topics Dismissed and Retained for Further Analysis 7

Alternatives 13
Alternative A: No Action—Current Management Practices 13
Alternative B: Integrated Weed Management Practices 18
Mitigation Measures Applicable to Both Alternatives 29
Alternatives Considered and Dismissed 31
Environmentally Preferred Alternative 31
Alternative Summaries 32

Affected Environment 37
Soil Resources 37
Geothermal Resources 37
Wetlands and Water Resources 38
Water Quality 39
Vegetation including Rare Plant Species 40
Fish and Wildlife Species 43
Threatened, Endangered, and Special Status Wildlife 45
Archeological Resources 49
Cultural Landscapes 49
Health and Human Safety 50
Visitor Use and Experience 50
Park Operations 51

Environmental Consequences 53
Soil Resources 55
Geothermal Resources 60
Wetlands and Water Resources 64
Water Quality 70
Vegetation including Rare Plants 74
Fish and Wildlife Species 79
Threatened, Endangered, and Special Status Wildlife 83
Archeological Resources 90
Cultural Landscapes 95
Health and Human Safety 100
Visitor Use and Experience 104
Park Operations 109

Consultation and Coordination 113
Internal Scoping 113
External Scoping 113
Agency Consultation 113

Native American Consultation 114
Environmental Assessment Review and List of Recipients.....114
List of Preparers 114

References 116

Appendices

Appendix 1: Invasive Vegetation Authority and Policy 122
Appendix 2: Invasive Plant Species Priority List.....125
Appendix 3: Exotic Plant Data Collection Form 132
Appendix 4: Seven-Step Decision Flow Charts.....134
Appendix 5: Sand and Gravel Pit Inspection Form.....142
Appendix 6: Safety 143
Appendix 7: Herbicides Used in Yellowstone National Park.....144
Appendix 8: Potential Use of Biological Control in Yellowstone 154
Appendix 9: Monitoring Plan for Invasive Plant Control Effectiveness.....165
Appendix 10: Vegetation Restoration in the Gardiner Basin.....169

Purpose and Need

Introduction

The National Park Service (NPS) proposes to implement a parkwide plan in Yellowstone National Park to prevent the establishment and spread of terrestrial invasive plant species and to restore, as needed, native plant communities. (As used here, the term "invasive nonnative plant" has a similar meaning as alien, exotic, or noxious plant or weed.) During the last 25 years, the number of nonnative plant species documented in Yellowstone National Park (YNP) has increased from 85 in 1986 (Whipple 2001) to 217 species today (J. Whipple pers. comm.). Control of invasive nonnative plants is one of the most significant issues facing national parks (NPS 2009).

The purpose of this environmental assessment (EA) is to expand current invasive plant management efforts to implement a more integrated approach. The actions proposed would preserve, protect, and restore the biodiversity, ecological integrity, and processes associated with native plant communities in the park. This EA was prepared in accordance with the National Environmental Policy Act of 1969, regulations of the Council on Environmental Quality (40 CFR §1508.9), and the NPS Director's Order, *Conservation Planning, Environmental Impact Analysis, and Decision-Making* (DO-12).

Background

Yellowstone National Park encompasses 2.2 million acres and is located in the northwest portion of Wyoming, with portions of the park extending into southwest Montana and southeast Idaho (Figure 1). The park is the core of the Greater Yellowstone Area (GYA), an approximately 18-million-acre area that includes Grand Teton National Park and John D. Rockefeller Jr. Memorial Parkway to the south, seven national forests, three national wildlife refuges, three American Indian reservations, state lands, towns, and private property. By an Act of Congress on March 1, 1872, Yellowstone was designated as the first national park in the world, and as a United Nations Biosphere Reserve and a World Heritage Site nearly 100 years later. Through subsequent legislation and administrative guidelines, including the 2006 NPS Management Policies, Yellowstone's fundamental goal continues to be the preservation of its cultural and natural resources and their interactions while minimizing human influence on these resources. Resource managers consider invasive plant establishment and proliferation to be the largest threat to the integrity of native plant communities and associated processes affecting ecosystem structure and function in the park.

Plant communities in the park include species typical of the Rocky Mountains as well as of the Great Plains to the east and the Great Basin to the west. Most of the park is a volcanic caldera in which the plant communities reflect the underlying geology and disturbances created by fires, floods, humans, wildlife, and the presence of invasive plants. Yellowstone's geothermal systems are highly diverse and range in acidity and alkalinity, creating unique assemblages of plant species. Within the park three endemic rare plants occur, two of which rely on the habitat created by the thermal areas.

Invasive nonnative plants now infest approximately 2.6 million acres in the National Park System, reducing the natural diversity of these places. In addition to nearly 1,350 native vascular plant species, 217 nonnative plant species have been documented in the park (Whipple 2001; J. Whipple pers. comm.). Although not all of these nonnative plants endanger the park's native species, many are highly invasive and can alter native plant communities and the wildlife that depends on them.

The full extent of invasive plants in Yellowstone in acres has not been determined, but the areas most vulnerable to invasion are those most frequently used by the 3 million annual visitations to the park—467 miles of paved roads, 900 miles of backcountry trails, 2,650 miles of rivers, 12 frontcountry developed areas, and 302 backcountry campsites. Yellowstone National Park also has 291 miles of backcountry boundary shared with other public and private entities that pose a special management concern, in that invasive plants easily move across jurisdictional boundaries.

Invasive plants can have substantial impacts on the park's natural and cultural resources (Olliff et al. 2001). They impact biological diversity and ecosystem integrity by altering hydrologic conditions, soil properties, and fire regimes. This results in the displacement of rare plant species, the transformation of complex plant communities into simple ones, and alterations in the visitor's experience. These changes in native plant communities may have adverse effects on wildlife species that depend on them for forage, breeding, and nesting habitat. Invasive plants spread to adjacent areas, affecting both public and private lands.

Since the mid1880s, the park's vegetation communities have been increasingly subject to both purposeful and unintended alterations by humans. Nonnative plants were introduced and became established in the park beginning with western expansion, which brought many new activities and types of use to the area. Changes to plant communities were subtle initially, and escalated as more use and development occurred and travel increased (Whipple 2001). Potential sources for current invasive plant introductions include contaminated sand and gravel used in park operations; construction activities and equipment to build and maintain roads and trails; agricultural and timber harvesting practices on adjacent federal and private lands; seeds brought into the area by vehicles (automobiles, over-snow vehicles, maintenance equipment and railroads); ornamental plants, topsoil, seed, and sod used for landscaping; and seeds transported by wind, animals, and people.

Most invasive plants in Yellowstone have a strong association with disturbed ground such as roadsides, trails, and developed areas (Allen and Hansen 1999; Rew et al. 2005). Removal of topsoil and vegetative cover creates favorable microhabitats for invasive plant colonization. Spread beyond the center of colonization occurs by transport of seeds on construction equipment, vehicles, people, animals, wind, and water.

Invasive plant species in Yellowstone exhibit a wide range of invasive and competitive abilities (Stohlgren et al. 1999). Some invasive species are widely established in native plant communities, while the invasive potential of others seems relatively low. Many exotic plants, particularly the more invasive species, do very well in open, sunny habitats but are much less competitive in shaded, forested areas.

Once established, invasive plants are frequently difficult to eradicate. Ecological invaders generally have the ability to proliferate through high seed production, vegetative reproduction, and/or extensive underground root systems. This can result in exotic plants having a competitive advantage over native vegetation. Invasive plants are often less palatable and less nutritious for wildlife, which reduces grazing pressure and aids in their successful competition with native grassland species.

Park staff began managing invasive plants in the late 1960s under the guidance of the park botanist, with assistance from park forestry crews. These early identification and control efforts were directed toward a few invasive species, involved limited staff, and were not supported with special funding. One of the first management programs began in 1968 with the attempted control of Dalmatian toadflax (*Linaria dalmatica*) in the Mammoth area. This early effort used various mechanical, chemical, and biological techniques including the release of the experimental biological control insect *Calophasia lunula*. Due to questionable success, inconclusive results, and loss of program funds, the program was terminated after a few years (Olliff et al. 2001). During the next

15 years, sporadic, minimally funded control efforts continued on spotted knapweed (*Centaurea maculosa*), musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), ox-eye daisy (*Chrysanthemum leucanthemum*) and field bindweed (*Convolvulus arvensis*) as well as Dalmatian toadflax.

In 1982, the YNP Resource Management Plan identified invasive plant management as priority 10 out of 35 parkwide concerns. However, it was not until the completion of the YNP Exotic Vegetation Management Plan (EVMP) in 1986 (NPS 1986) that a comprehensive approach to exotic plant management began in the park. The EVMP was supported by the NPS Natural Resources Management Guidelines: NPS-77 (NPS 1991). In 1986, the 85 species of invasive plants known to be present in the park were prioritized into four groups to guide staff in subsequent survey and control efforts. The integrated pest management approach continued with the use of mechanical removal and several NPS sanctioned herbicides, but without the use of biological control agents.

In recent years, the scope and complexity of invasive plant management has continued to change as the number of invading species grew, and infested acreages increased without regard to political boundaries. With increasing legislation and policies developed toward invasive species management (Appendix 1), and development of "Guidelines for the Coordinated Management of Noxious Weeds in the Greater Yellowstone Area" (1990), park staff have increased their involvement in weed management activities with local, state, and federal entities in the tri-state area. Resource Management staff have gradually become more involved in seven cooperative weed management areas within the GYA, and are active participants on the Greater Yellowstone Coordinating Committee's Terrestrial Invasive Species Subcommittee. YNP also hosts the Northern Rocky Mountain Exotic Plant Management Team, an ongoing NPS effort to control invasive weeds in 15 national park units within the northern Rocky Mountain region.

As awareness of the problem has grown, more staff from all divisions have assisted in the park's invasive plant program. Additional steps were taken to prevent invasive plant populations from becoming established in the park through better control of construction materials entering the park, equipment inspections at park entrances, and the availability of weed mitigation funding for road construction projects. Still, program emphasis has largely been on control efforts, where staff have increasingly relied on use of herbicides and manual control. By 2010, approximately 70 park staff and over 100 volunteers were involved in invasive plant control and surveyed a total of 20,291 acres in the park. Of the 4,600 acres that were found to have nonnative vegetation, 105 acres were treated, including 9 acres that were treated twice. By 2011, permanent and seasonal resource management operations staff were spending 36% of their work hours on nonnative plant management, with most of that time used to pull or spray weeds. Of the 118-plus acres treated in 2011, more than 115 were treated with chemicals.

Purpose and Need

The purpose of this Invasive Vegetation Management Plan/EA is to provide a parkwide strategy to prevent the establishment, and control the spread, of terrestrial nonnative plant species. The plan would also provide a strategy to restore, as needed, native plant communities. The plan is needed because the park currently lacks an up-to-date, comprehensive plan to preserve, protect, and restore the biodiversity, ecological integrity, and processes associated with the park's native plant communities.

The plan has three fundamental objectives:

1. **Prevent** the entry and establishment of new invasive plants as well as further infestations of invasive plants already present in the park.
2. **Control** existing populations of invasive plants, either by by eradicating them, reducing their size and density or containing their spread.
3. **Restore** native plant communities disrupted or replaced by nonnative plant populations.

Other objectives of the plan include:

- **Identify best management practices** that include an array of techniques to prevent further spread of existing invasive plants and introductions of new invasive plant species.
- **Identify mechanisms for cooperation among neighboring agencies and landowners** to prevent the spread of existing invasive plants and introductions of new invasive plant species.
- **Establish decision-making tools** to guide integrated vegetation management activities.
- **Establish restoration treatments** in disturbed areas and restoration measures that could be incorporated into future actions.
- **Ensure visitor and employee safet**y during project implementation.
- **Improve visitor experience and appreciation** for native plant communities in the park through awareness of invasive plant species.

Relationship to Other Plans and Policies

The National Park Service (NPS) is mandated to prevent exotic plant introduction and to control established exotic plants by law, executive order, and management policy (NPS 2006). Legislation and policies that guide the management of exotic plants in Yellowstone National Park are listed in Appendix 1. The following plans and policies related to the management of invasive vegetation were taken into consideration in the development of this plan:

- **Exotic Vegetation Management Plan,** Yellowstone National Park (NPS 1986) considered alternatives to deal with exotic plants. The recommended course of action was an Integrated Pest Management (IPM) program. This included mapping and identifying sources of infestations and evaluating the impact of each species on the environment as well as the probable impact of various control actions on invasive plants. It was understood that invasive plants would never be entirely eliminated, but existing populations would be reduced and further invasions would be curtailed. This plan delineated staff responsibilities, information needs, and general guidelines for management efforts, provided a system for categorizing exotic species for management action, and listed the top problem species and the IPM plans for those top species.
- **Vegetation Management Guidelines for Construction Disturbance** in Yellowstone National Park (NPS 2002) provided guidelines for measures to minimize disturbance to vegetation and soils prior to construction and to enhance revegetation efforts following construction.
- **2006 NPS Management Policies** (4.4.4—Management of Exotic Species) requires national parks to prevent the displacement of native species by exotic species.
- **Executive Order 13112** states that a federal agency cannot "authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with

the actions." This Executive Order requires federal agencies to identify invasive species and develop a plan to prevent their introduction and reduce the risk of their spreading.
- **Yellowstone's Resource Management Plan** (NPS 1998) identified conservation of native plant communities and controlling invasive plant species as a high priority.

Scoping

Scoping is a process undertaken to identify the resources that may be affected by a project proposal, and to explore possible alternative ways of achieving the proposal while minimizing adverse impacts. Yellowstone National Park conducted internal scoping with appropriate National Park Service staff, as described in more detail in the Consultation and Coordination chapter. The park also conducted external scoping with the public and interested/affected groups and conducted Native American consultations.

External scoping was initiated with the distribution of a scoping letter to inform the public of the proposal to develop an invasive vegetation management plan and to generate input on the preparation of this environmental assessment. A 30-day scoping period began on March 31, 2011, with a media release, a posting on the NPS's Planning, Environment, and Public Comment (PEPC) website, and distribution of a scoping newsletter mailed to 265 interested individuals, organizations, state and federal agencies, and affiliated Native American tribes.

During the 30-day scoping period, 11 public responses were received, including comments from the invasive plant managers at Park County and Teton County (Wyoming) and Gallatin National Forest. The comments, which fell into seven general categories listed below, were incorporated into the alternatives, related issues, and potential impacts sections of this EA. Scoping comments are discussed further in later sections of the Purpose and Need chapter. More information regarding external scoping and Native American consultation can be found in the Consultation and Coordination chapter.

Commenters brought up the following concerns, issues, and suggestions during scoping:
- Adopt an Integrated Weed Management or Ecologically Based Integrated Plant Management Plan approach using the best management practices from areas surrounding the park, e.g., requiring loads of gravel and dirt to be covered, ensuring that any fill or hay brought into the park is free of invasive plants, and cleaning tires and vehicles before entering the park.
- Use herbicide, mechanical control, cultural control, biocontrol agents, and/or restoration planting to reduce new infestations of invasive plants.
- Address all activities necessary to implement prevention activities.
- Adopt an expedient Early Detection/Rapid Response process.
- Foster cooperation and relationships with local partners, agencies, and adjacent landowners beyond those provided through the established Greater Yellowstone Area nonnative plant management groups.
- Educate visitors about the importance of native plants as well as the damaging aspects of nonnative species.
- Adopt a prioritization system for nonnative vegetation management based on level of risk and environmental impact.

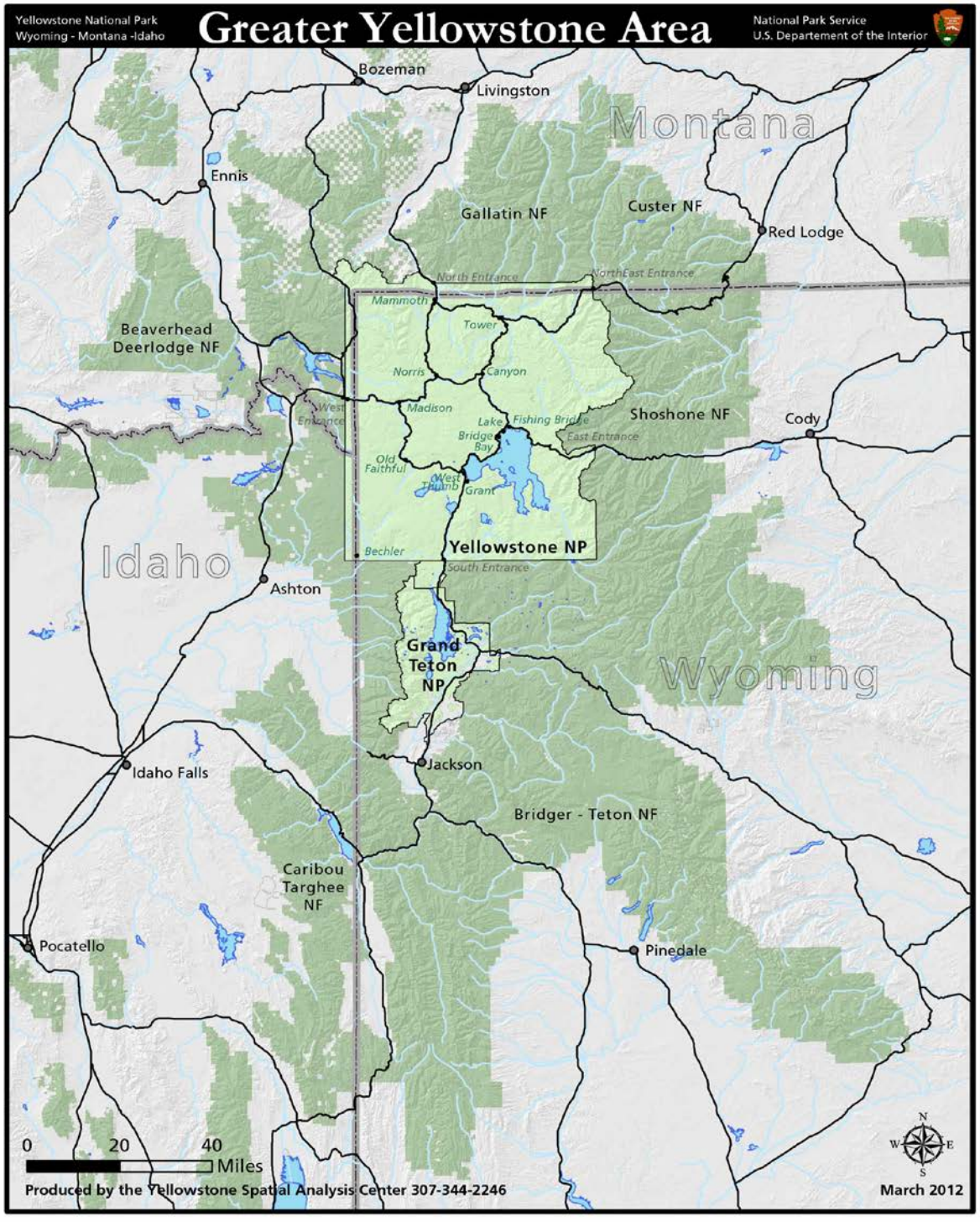

Figure 1. Project location, Yellowstone National Park, within the Greater Yellowstone Area.

- Build larger paved turnouts and curtail off-pavement parking to reduce vehicle-related spread of nonnative plant seeds.
- Conduct inventory of areas infested with invasive plants and monitor areas post-treatment.

Impact Topics Dismissed and Retained for Further Analysis

Impact topics for this project were identified on the basis of federal laws, regulations, and executive orders; the 2006 NPS Management Policies; and input from the public and NPS staff. The impact topics that were carried forward for analysis in this EA are:

- Soil Resources
- Geothermal Resources
- Wetlands and Water Resources
- Water Quality
- Vegetation, including Rare Plant Species
- Fish and Wildlife Species
- Threatened, Endangered and Special Status Species
- Archeological Resources
- Cultural Landscapes
- Health and Human Safety
- Visitor Use and Experience
- Park Operations

In this section, NPS takes a "hard look" at all potential impacts by considering the direct, indirect, and cumulative effects of the proposed action on the environment, along with connected and cumulative actions. Impacts are described in terms of context and duration. The context or extent of the impact is described as localized or widespread. The duration of impacts is described as short-term, ranging from days to three years in duration, or long-term, extending up to 20 years or longer. The intensity and type of impact is described as negligible, minor, moderate, or major, and as beneficial or adverse. The NPS equates "major" effects as "significant" effects. The identification of "major" effects would trigger the need for an EIS. Where the intensity of an impact could be described quantitatively, the numerical data is presented; however, most impact analyses are qualitative and use best professional judgment as the standard for making the assessment.

The NPS defines "measurable" impacts as moderate or greater effects. It equates "no measurable effects" as minor or less effects. "No measurable effect" is used by NPS in determining if a categorical exclusion applies or if impact topics may be dismissed from further evaluation in an EA or EIS. The use of "no measurable effects" in this EA pertains to whether NPS dismisses an impact topic from further detailed evaluation in the EA. The reason NPS uses "no measurable effects" to determine whether impact topics are dismissed from further evaluation is to concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail. This process of analysis is undertaken in accordance with CEQ regulations at 1500.1(b).

In this section of the EA, NPS provides a limited evaluation and explanation as to why some impact topics are not evaluated in more detail. Impact topics are dismissed from further evaluation in this EA if:

- they do not exist in the analysis area, or
- they would not be affected by the proposal, or the likelihood of impacts are not reasonably expected, or
- through the application of mitigation measures, there would be minor or less effects (i.e. no measurable effects) from the proposal, and there is little controversy on the subject or reasons to otherwise include the topic.

Due to there being no effect or no measurable effects, either there would be no contribution towards cumulative effects or the contribution would be low. For each issue or topic presented below, if the resource is found in the analysis area or the issue is applicable to the proposal, then a limited analysis of direct and indirect effects and cumulative effects is presented.

Impact Topics Dismissed from Further Analysis

Land Use Conflicts

The *2006 NPS Management Policies* state that "the Service will cooperate with federal agencies; tribal, state, and local governments; nonprofit organizations; and property owners to provide appropriate protection measures. Cooperation with these entities will also be pursued, and other available land protection tools will be employed when threats to resources originate outside boundaries." The proposed alternatives would not directly or indirectly affect the park's boundaries, zoning and/or land use outside park boundaries. Although the alternatives may have negligible effects on land use, overall land use would not change as a result of their implementation. Because the impacts on land use would be none or negligible, this topic has been dismissed from further analysis.

Energy Requirements and Conservation Potential

Implementation of the proposed actions would not cause measurable increases or decreases in the overall consumption of electricity, propane, wood, fuel oil, gas, or diesel associated with visitation or for park operations or maintenance. As a result, this topic has been dismissed from additional analysis.

Ecologically Critical Areas (Wild and Scenic Rivers)

As part of the Omnibus Public Land Management Act of 2009, Congress designated a portion of the Snake River headwaters as protected under the Wild and Scenic Rivers Act (WSRA). Waters designated under the WSRA have the same anti-degradation requirements in terms of water quality and flow as all other Class 1 waters. Yellowstone has two rivers designated under the WSRA. The Snake River is designated as Wild, the segment of the Lewis River above Lewis Falls is designated as Wild, and the segment below Lewis Falls is designated as Scenic. While management of invasive vegetation would occur near these areas, there will be no construction or infrastructure development and thus no more than minor expected impacts on wetlands, floodplains, free-flowing condition, or surface water quantity and quality, and implementation would not adversely affect the Outstandingly Remarkable Values of any waterways protected under the WSRA. In addition, no proposed activity would affect the eligibility or designation of a Wild and Scenic River. None of the actions proposed in the alternatives would affect ecologically critical areas. As a result, this topic has been eliminated from further analysis.

Floodplains

Executive Order 11988 (Floodplain Management), requires all federal agencies to avoid construction within the 100-year floodplain unless there is no other practicable alternative. The 2006 NPS Management Policies and Director's Order 77-2, Floodplain Management, strive to

preserve floodplain values and minimize hazardous floodplain conditions. According to Director's Order 77-2, certain construction within a 100-year floodplain requires preparation of a statement of findings. There will be no net loss of floodplains and no construction in these areas as a result of implementing the actions proposed in this EA. None of the proposed actions has the potential to affect floodplain values or contribute to hazardous floodplain conditions. Therefore, this topic has been dismissed from further analysis.

Geology

According to the 2006 NPS Management Policies, the National Park Service is required to protect geologic resources and features from the adverse effects of human activities while allowing natural processes to continue. The 2006 NPS Management Policies call for analysis of geology and geologic hazards if relevant. The proposed mechanical, manual, and chemical control techniques are highly unlikely to impact geologic or paleontological resources. Potential impacts that result from spot herbicide spraying or manual control of invasive plants would be localized and minor or less; therefore, this topic was dismissed from further analysis.

Museum Collections

The NPS Director's Order 24, Museum Collections, requires the National Park Service to consider impacts on museum collections (historical artifacts, natural specimens, and archival and manuscript materials), and provides policy guidance, standards, and requirements for preserving, protecting, documenting, and providing access to and use of NPS museum collections. Many of the park's museum collections are stored in the Heritage and Research Center in Gardiner, Montana, or in the park's visitor centers. The proposed actions would have no impacts on museum collections. As a result, this topic has been dismissed from further analysis.

Soundscape Management

In accordance with the 2006 NPS Management Policies and Director's Order 47 (Sound Preservation and Noise Management), an important component of the NPS mission is to preserve the natural soundscapes associated with national park units. The natural ambient soundscape is the aggregate of all the natural sounds that occur in the park together with the physical capacity for transmitting natural sounds. The frequencies, magnitudes, and durations of human-caused sound considered acceptable varies among NPS units and within each park unit, being generally greater in developed than in undeveloped areas. The proposed activities would occur in areas of Yellowstone where development and high concentrations of people are already present and existing sounds are most often generated from vehicular traffic, people, wildlife, thermal features and, wind. The activities proposed in this EA could result in the generation of noise from utility terrain vehicles and sprayers. However, because the impacts of these activities on the soundscape would be short-term and minor or less, this topic has been dismissed from further analysis.

Natural Lightscapes

In accordance with the 2006 NPS Management Policies, the National Park Service strives to preserve the natural ambient lightscapes that exist in the absence of human-produced light. No artificial lighting is proposed in any alternative. Therefore, the topic of natural lightscapes has been dismissed from further analysis.

Prime and Unique Farmlands

The Farmland Protection Policy Act of 1981, as amended, requires federal agencies to consider adverse effects on prime and unique farmlands that would result in the conversion of these lands to non-agricultural uses. Prime and unique farmlands are designated by the U.S. Department of Agriculture's Natural Resources Conservation Service and defined as soil that produces general crops such as common foods, forage, fiber, and oil seed; unique farmland produces specialty crops such as fruits, vegetables, and nuts. Prime and unique farmlands do not occur within Yellowstone National Park. The actions described in this Invasive Vegetation Management Plan would not occur in these areas. Therefore, none of the alternatives under consideration has the potential to affect prime and unique farmlands, and this topic has been dismissed from further analysis.

Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts on Indian trust resources from a proposed project or action by Department of Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes. The park's lands and resources related to this project are not held in trust by the Secretary of the Interior for the benefit of Native Americans. Because there are no Indian trust resources potentially affected by this project, this topic has been dismissed from further analysis.

Historic Structures

The National Historic Preservation Act, as amended in 1992 (16 USC 470 *et seq*.), the National Environmental Policy Act, NPS Director's Order 28, *Cultural Resource Management Guideline* (NPS 1997), *Management Policies* (NPS 2006), and NPS Director's Order 12, *Conservation Planning, Environmental Impact Analysis and Decision-making* (NPS 2001), all require the consideration of impacts on cultural resources listed in, or eligible for listing in, the National Register of Historic Places (National Register). Historic properties are the buildings, structures, objects, cultural landscapes and districts listed on or eligible for listing on the National Register of Historic Places. There are seven nominated historic districts. Seven individual properties, which include multiple buildings, have been designated as National Historic Landmarks. Cultural landscapes were retained as an impact topic in this plan. Historic structures were not included for analysis because the potential impacts of the actions proposed in this plan would not have more than a minor effect on them.

Ethnographic Resources

The NPS Director's Order 28, Cultural Resource Management, defines ethnographic resources as any site, structure, object, landscape or natural feature assigned traditional, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it (NPS 1997). Discussions with the 26 Native American tribes associated with the park to identify park resources significant to tribes have been ongoing for over 12 years. Although no specific area has been identified, many tribes have identified the general importance of thermal water and geyser features, and the various minerals found in the thermal areas, as important resources to be preserved and protected. A variety of common plants found throughout the park have been

identified as having been used for food, medicinal and other purposes, many of which are still used today. Some of the plants are potentially located in areas proposed for management activities. All of the plants identified are common and are plentiful in many locations within and outside the park. The proposed invasive vegetation management plan would avoid removal of native plant materials. Because there are no ethnographic resources potentially affected by this project, this topic has been dismissed from further analysis.

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed activities would not take place in areas where minorities and low-income populations and communities could realize disproportionate health or environmental effects. Therefore, this topic has been dismissed from further analysis.

Climate Change and Sustainability

Although climatologists cannot be certain of the specific long-term consequences, it is clear that the planet is experiencing global climate changes that affect ocean currents, sea levels, polar sea ice, and global weather patterns. Although this is likely affecting precipitation patterns and amounts in Yellowstone, it would be speculative to predict localized changes in temperature, precipitation, or other weather facets, in part because many of the variables are not fully understood.

The actions proposed in this EA would not affect or contribute to overall greenhouse gas emissions. Although changing weather patterns are likely to affect the distribution of both nonnative and native plant populations, analysis of the degree to which effects would occur over the timeframe of this plan would be speculative and would not change the process and parameters with which invasive vegetation are managed in the park. Therefore, the possible effects of climate change on native and nonnative plant populations are dismissed from further analysis.

Wilderness

The 1964 Wilderness Act defined wilderness as "an area where the earth and its community of life are untrammeled by man." In 1972, a total of 2,032,721 acres (91 percent) of the park was proposed to be designated as wilderness. While not yet legislatively designated, this recommended wilderness is managed as wilderness in accordance with the 2006 NPS Management Policies. Invasive vegetation management activities would occur in the park's recommended wilderness. Invasive plant treatments proposed in this EA would involve manual removal or spot-spraying with backpack sprayers with approved herbicides for individual invasive plants. Mechanized equipment or large broadcast spraying would not be used in Yellowstone recommended wilderness. Because any proposed treatments would (1) not use mechanized access or equipment without undertaking a Minimum Requirement Analysis review and approval, and (2) be considered local in scale, these effects would be minor or less. Therefore, this topic has been dismissed from further analysis.

Visual Quality, including Viewsheds

Yellowstone abounds with impressive viewsheds of the highest quality. Most of the park's landscape appears untouched by humans and retains its wild characteristics. Less than 2 percent of the park is developed, and visitor use facilities are predominantly grouped along the road system and in a handful of small communities, leaving substantial acreage in its natural condition. Park visual quality would be affected in a small scale by observations of staff treating weeds and the temporary presence of blue dye where localized spot spraying would occur. As a result of an invasive vegetation management program, viewsheds would improve with more native flora and fewer invasive plants. These effects would remain local in scale. Because the actions under consideration in this plan would not affect visual quality within the park, including viewsheds, and would be minor or less, this topic has been dismissed from further analysis.

Socioeconomics

Yellowstone National Park plays a prominent role in social and economic life in the GYA. Commercial enterprises and gateway communities have developed both within and outside the park's five entrances. These communities provide food, lodging, medical services, groceries, gasoline, gifts, and other goods and services to the public. The economic well-being of developed areas in the park and gateway communities depends on the recreation activity and tourism generated by the park and other recreation destinations. Proposed actions in this EA, including invasive vegetation management, would occur within park developments and entrance stations. These activities would affect visitors that visit the park and the surrounding lands. However, there would not be anticipated effects on park and gateway economic and social activities. Therefore, this topic has been dismissed from further analysis.

Alternatives

This chapter describes the alternatives considered and analyzed in this EA. Alternatives were developed from collaborative interdisciplinary analyses, internal and external scoping, and use of Integrated Weed Management techniques adopted from Integrated Pest Management (IPM) practices (NPS 2006). One action alternative and the no-action alternative are presented for evaluation in this EA. A table comparing the alternatives is presented at the end of this chapter.

Alternative A: No Action—Continuation of Current Management Practices

The no-action alternative would continue current vegetation management programs and practices to control invasive plant species in the park. This would include maintaining existing levels of prevention, survey, treatment; recordkeeping and monitoring of invasive vegetation; and restoration of native plants.

Compliance with Regulatory Measures

Under Alternative A, the park would continue to manage invasive plants using current treatments. This would mean that invasive vegetation management activities would continue on a limited basis. Park resource managers would be limited to treatment options that qualify as a Categorical Exclusion (CE) or treatments whose impacts have been previously addressed in other NEPA documents. Under DO-12, the only exotic plant management activities that are covered under a CE are:

> *"Removal of individual members of a non-threatened/endangered species or populations of pests and exotic plants that pose an imminent danger to park visitors or an immediate threat to park resources."*

In addition to meeting this criterion, to qualify as a CE the proposed treatment must have no measurable impacts. Measurable impacts are those that the interdisciplinary team determines to be greater than minor by the analysis process described in DO-12. For effects to be minor, only a relatively small number of individuals/resources may be affected. Minor impacts typically require considerable scientific effort to measure, are limited to relatively few individuals of the populations, are much localized in area, and have barely perceptible consequences. Any proposed treatments that are not covered under a CE or another existing NEPA document would require preparation of additional NEPA documents, such as an EA or Environmental Impact Statement (EIS).

A summary of other policies and plans that provide guidance on exotic plant management, including the park's most recent Resource Management Plan (1998), is provided in Chapter 1.

Primary Components

Under the no-action alternative, existing efforts to control invasive plant species would continue in Yellowstone National Park. Based on the known extent of these species in the park, their ability to outcompete native vegetation, and the cost-effectiveness of control, the following categories would continue to be used to prioritize their treatment:

- **Watch list**—Invasive species that have not been found in Yellowstone National Park but are known to exist nearby.

- **Priority I**—Invasive species that have produced seed in the park, but known populations are small and limited in number.
- **Priority II**—Aggressive invaders for which effective control methods are known; some of these species are well established, but only in relatively small areas at specific locations.
- **Priority III** – Aggressive invasive plants that are dispersed over large areas of Yellowstone.
- **Priority IV** – Nonnative plants for which there are no known effective control techniques or which are likely to have only small harmful effects on the native ecosystem.

A prioritized list of Yellowstone's invasive and nonnative plant species can be found in Appendix 2. Given this prioritization, control efforts would continue to be directed toward the following high-risk areas:

- 454 miles of roadway, including shoulders, pullouts, picnic areas, trailheads, and parking lots.
- Maintenance facilities, campgrounds, residential areas, lodging facilities, restaurants, marinas, horse corals, entrance stations, stores, and gas stations.
- Earth moving equipment and material storage sites that could spread weeds to new sites.
- Active and post-construction disturbance sites.
- Rare and sensitive native plant sites.
- Geothermal areas.
- Historic districts and cultural landscapes.
- Trailheads and backcountry areas that receive heavy visitor and stock animal use.
- Visitor-created social trails leading to popular fishing sites, viewing areas, and geyser basins.

Management efforts to control prioritized invasive plants during recent years are shown in Figure 2 and are summarized below.

Table 1. Invasive vegetation program yearly comparison, 2009–2011.

	2009	2010	2011
Total hours	7,108	7,210	9,170
Acres surveyed	17,091	20,291	20,429
Gross infested acres	3,679	4,600	4,642
Treated acres—total	137	105	118
Treated acres—repeat	23	9	4
Percentage of road/development area	76%	75%	77%
Percentage of backcountry area	24%	25%	23%
Percentage of chemical acres	95%	95%	97%
Percentage of mechanical acres	5%	5%	3%
Number of species treated	42	44	40
Total initial treatments	1,354	1,542	1,652
Number of data entries	1,726	1,780	1,717
Number of entries incidental plants	635	738	840
Number of entries patches	1,091	1,042	877
Ounces of herbicide concentrate used	2,514	1,398	1,320
Gallons of mixed herbicide	4,287	2,887	3,722
Number of NPS staff	25	26	24

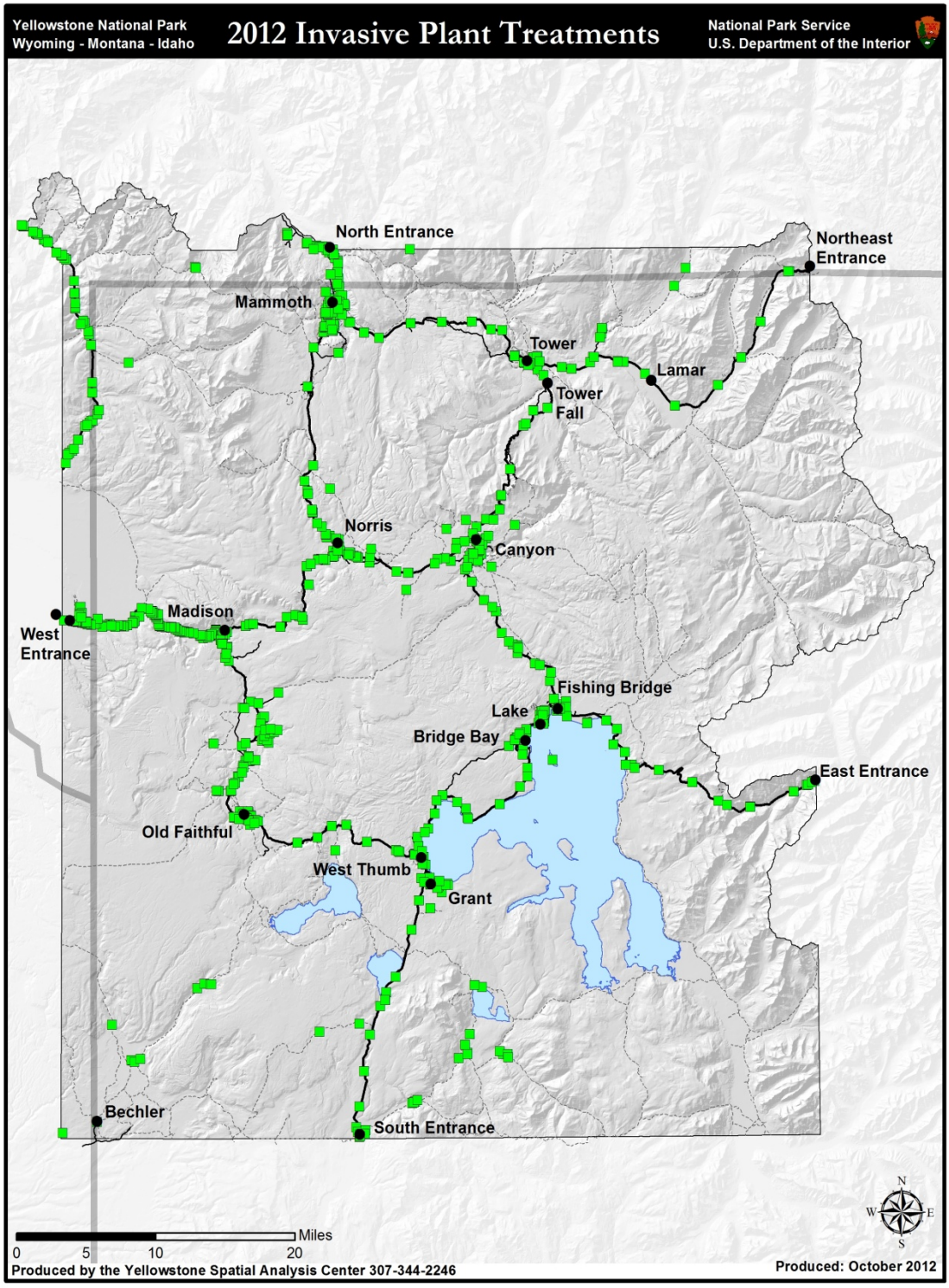

Figure 2. A map of invasive plant treatments conducted in 2012.

The invasive vegetation management program at Yellowstone would continue to be based primarily on the guidance provided by the park's 1986 Exotic Vegetation Management Plan (NPS 1986) and consists of the following components:

- **Education and Prevention.** Education to park staff would continue on a limited basis. YNP would continue to comply with existing weed management laws and policies to identify and prevent the spread of invasive plants. Stock coming into the park would continue to be required to use certified weed-free hay, weed-free sand and gravel source material pits would be identified for use in the park, and, when possible, construction equipment would be inspected to ensure that they are free of source materials or soils that may contain noxious seeds. Park staff would continue to watch for new invader plants and respond as quickly as possible to remove them before they establish and spread.
- **Collaboration**. YNP would continue current collaborative efforts throughout the GYA. This would include participation in the Greater Yellowstone Coordinating Committee's Terrestrial Invasive Species Committee, which coordinates invasive plant management activities on public lands. Park collaboration with adjoining weed and pest control districts and state and federal agencies and private neighboring landowners would continue on a limited basis.
- **Survey and Treatment.** Park staff would continue to identify invasive plant populations and treat infestations using the current array of control methods, which does not include use of biological control agents or aerial spraying. Targeted species would typically be those listed on federal, state and county noxious weed lists or the park's nonnative plant priority lists (Appendix 2). Targeted areas would be primarily associated with park roads and developments, with limited work on known backcountry patches. Control treatments would rely on use of NPS-approved herbicides applied as spot treatments employing backpack sprayers or UTV wand or boom sprayer applications.
- **Recordkeeping and Monitoring.** Since 1993, invasive plant conditions and associated management actions have been recorded in an established database. Park resource management staff would continue to maintain records of invasive plant surveys and control efforts (Appendix 3). These records include data such as species, locations, patch sizes, control types, and type and amount of herbicide used. Monitoring efforts other than survey and control records would not be developed.
- **Restoration.** Native vegetation restoration would continue to occur when possible at select locations associated with park construction and ground disturbance activities. The primary plant restoration technique is to remove and store the top soil prior to the disturbance and then place it back following completion of construction. When possible, native seed, shrubs, and seedling trees would be collected, propagated, and replanted to augment top soil replacement. Rangeland restoration of the historical agricultural lands in the Gardiner Basin along the park's north boundary would continue into the foreseeable future.

Invasive Plant Treatment Methods

Efforts to eliminate or control invasive species would continue the use of mechanical, cultural, and chemical treatments. All herbicides agents used would be approved by IPM specialists from Yellowstone and other NPS staff. Chemical control agents would undergo an internal evaluation and compliance process to determine their efficacy in treating target species and

risks to native species. Biological control agents would not be employed under this alternative. Specific treatments would include the following methods:

- **Mechanical Treatments.** Mechanical or manual control pulling, grubbing, mowing, or cutting weeds would be the first choice for small weed infestations and in sensitive areas near wetlands, waterways and geothermal features. These methods are effective in reducing seed production as well as reducing the possibility of seed transport from roadsides, trailheads, campgrounds and developed areas.

- **Cultural Treatments.** Methods of cultural treatment would include revegetation, topsoil conservation, limited fire, shading, and the use of competition from native plants. Cultural techniques may also manipulate the plant community through cultivating (cutting through and turning over the soil), re-seeding, mulching, and irrigating. Cultural control methods are most useful for large restoration projects.

- **Chemical Treatments.** Herbicides would be used under this alternative to eradicate and contain aggressive, high-priority invasive plant species that do not respond well to other treatments. Approved herbicides would be applied that would minimize effects toward wildlife, soil, and water, and its health risks for those applying it and the general public. Staff would adhere to product label guidelines that have been developed to ensure human safety and minimal environmental impact. Herbicides would be applied by spot spraying individual plants using backpack sprayers or boom sprayers mounted to UTV tanks.

Table 2. Herbicides currently used in Yellowstone National Park

Active Ingredient	Trade Names	Target Plants
Aminopyralid	Milestone	Broadleaf plants
Clopyralid	Transline	Broadleaf plants
Metsulfuron methyl	Escort	Broadleaf plants
Imazameth	Plateau	Broadleaf plants
Chlorsulfuron	Telar	Broadleaf plants
Glyphosate	Round Up Pro Max, Rodeo	Broadleaf plants, some grasses

Alternative B: (Preferred) Full Application of Integrated Weed Management Practices

Alternative B proposes to formalize the park's current management practices described in Alternative A and enhance some practices using an Integrated Weed Management (IWM) approach that would include (1) prevention, (2) identification, (3) a combination of control methods based on best information, and (4) evaluation to enable effective and adaptive management. This alternative would retain the invasive plant prioritization and emphasis on park areas described in the no-action alternative.

This approach varies from Alternative A in that Alternative B would include these components:

1. **Use of a comprehensive decision-making process** to guide park staff in prioritizing invasive species for management and considering all treatment options.
2. **Strengthened prevention programs** through increased education and interpretation, increased enforcement of weed-free hay restrictions, better preventive practices in park operations such as the mitigation of weeds during construction and other ground disturbance activities, compliance of weed-free equipment and other vehicles entering the park, and strengthened detection surveys.
3. **Establishment of monitoring protocols** to assess the effectiveness of prevention measures and treatments.
4. **Use of approved biological control agents would be considered** as a treatment option after an appropriate review process is completed.

Compliance with Regulatory Measures

The preferred alternative would include a broad analysis of potential impacts of various treatments on environmental resources. Management actions for invasive plant issues would be addressed through the decision process described in Appendix 4. Specific actions that are consistent with those evaluated in this EA would be implemented. Actions involving plant management treatments that could have impacts that have not been considered in this EA would require additional compliance with NEPA. The preferred alternative would help resource managers confirm compliance with regulatory measures. Applicable NPS policies and guidelines have been built into this tool. By using this process and through collaboration with NPS Regional IPM and NEPA Coordinators, resource managers would be able to confirm that their proposed treatments meet the necessary NPS and NEPA environmental compliance requirements.

Integrated Weed Management

Yellowstone National Park would use a comprehensive decision-making process referred to as an integrated weed management (IWM) approach to manage invasive terrestrial vegetation. An IWM program would coordinate knowledge of pest biology, the environment, and available technology to reduce damage, using environmentally sound, cost-effective strategies that pose the least possible risk to people, park resources and the environment (NPS 2006). The overall goal IWM would be to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. This integrated approach would conform to adaptive management principles through ongoing assessment of the program's effectiveness, using annual monitoring data and making modifications as necessary and as better techniques become available.

An IWM approach is "predicated on ecological principles and integrates multidisciplinary methodologies in developing ecosystem management strategies that are practical, economical, and protective of public and environmental health" (Piper 1992). The IWM approach would emphasize cooperative efforts throughout the GYA, and the park would continue to participate in Cooperative Weed Management Areas and other regional control efforts that benefit both the park and surrounding land.

The IWM program would provide guidance in determining the ecological impacts of invasive plants and direction in implementing science-based processes for selecting and developing control methods. Most fundamental to IWM is a thorough understanding of an area and the short- and long-term objectives and priorities for land management. Invasive species described and classified by priority levels that are determined largely by each species' degree of impact and whether effective control methods are available to treat it. Impacts would be considered on native plant communities and ecological processes, and to specific resource values (i.e., wetlands, rare native plants, geothermal areas, etc. and their communities).

Under this alternative, IWM procedures would be used to determine the most effective strategies for identifying invasive plant populations and controlling them through an array of treatments including mechanical, chemical, biological and/or cultural methods. Restoration treatments of disturbed areas would be established along with conservation and restoration measures to be incorporated into future projects.

An IWM strategy would be a flexible and adaptive process. Assessment through monitoring would be ongoing as managers define objectives or benchmarks for achieving success. Modifications could involve changes in control methods, the type and amount of herbicide used, and the timing of its application. The results of these changes would be monitored and evaluated, and recommendations would be made where changes would improve invasive plant management outcomes.

Education and Prevention

Park managers would strengthen prevention programs through increased education and interpretation, increased enforcement of weed-free hay restrictions, better preventive practices in park operations An IWM approach would begin with a strong education program for park staff and the public in order to obtain their assistance in recognizing and reporting invasive plants, as well as preventing their entry into the park. Under Alternative B, prevention programs would be strengthened through increased education and public involvement; increased participation of NPS employees, concessionaires, researchers and contractors; improved preventive practices in park operations; and strengthened detection surveys.

Education and Public Involvement. YNP's Division of Resource Education and Youth Programs, in cooperation with the Public Affairs Office, Concessions Management Office, Division of Resource and Visitor Protection, Maintenance Divisions, and Yellowstone Center for Resources, would be responsible for educating the public and park employees about invasive plant prevention.

Educational elements would include:

- increasing employee and public appreciation of native plant communities and their associated wildlife.
- improving employee and public understanding of the issues and problems caused by invasive plants in YNP and the GYA.

- increasing employee and public support for the regulations and actions associated with invasive plant species prevention.
- providing information and training to targeted groups and public audiences on invasive plant identification and the control activities occurring in the park.

Park staff would conduct periodic meetings to provide employees, the general public, and/or neighboring landowners with an opportunity to:

- learn about current and proposed invasive plant management activities and issues in the park.
- express concerns regarding current and proposed invasive vegetation management activities.
- learn how they can help prevent the introduction and spread of invasive vegetation in the park.
- encourage involvement in controlling invasive plants on public and privately owned land.

Prevention Strategies. The invasive nature of many nonnative plants makes it important that personnel working throughout the park become more familiar with the highest priority invasive species, the threat they pose, and the steps needed to prevent their spread. Under Alternative B, NPS resource management employees performing control work would be required to attend training on species identification and control methods. Park staff with weed management responsibility would be required to attend continuing education courses necessary to maintain state certifications as commercial pesticide applicators. Wildlife biologists, physical scientists and technicians, cultural resource staff, maintenance staff, researchers, rangers, and others interested in invasive plant species prevention represent an opportunity for more eyes in the field. NPS seasonal employees would be given invasive plant program information at orientation sessions.

Under this alternative, the most important management action would be to prevent them from becoming established. Certain fundamental characteristics of invasive plants determine where they become established:

- Many invasive plants specialize in colonizing highly disturbed ground. They possess physical traits that enable them to arrive at disturbed sites sooner and grow faster than other species.
- Invasive plant species tend to invade plant communities that have been degraded by prior land management practices.

Under this alternative, YNP would minimize the introduction and spread of invasive plants through weed- free practices in its daily operations. To prevent the establishment of invasive plant populations, disturbance or destruction of native vegetation would be avoided whenever possible. If disturbance cannot be avoided, the top soil conservation would be salvaged and replaced as a source of native seed bank, and/or native species would be re-seeded or re-planted in the disturbed area as soon as possible. This revegetation would enable disturbed areas to be quickly populated by native plant species.

Any materials used in the park for construction, maintenance, restoration, or landscaping (e.g., sand, gravel, fill, mulch, and wood chips) would be inspected as weed-free before entering the park to the extent practicable. Materials to be moved between locations within the park would be evaluated by park staff to the extent practicable to minimize the spread of invasive plant seeds. Outside sand and gravel pits that provide material for park use would be required to have a weed control plan approved by the respective county and to pass an annual inspection by NPS personnel (see Appendix 5 for Certification of Sand and Gravel Inspection form). These steps would be

implemented through the park's Standard Operating Procedures and concession and utility operating plans, and stated in park and concessions permits and contracts.

All construction equipment owned by the government, concessions, utilities, and contractors would be required by contract or operation plans to be pressure-washed prior to entering the park. Any equipment that operates off-road in a project area known to contain invasive plants would be pressure-washed prior to leaving the work site. These steps would be implemented through the park's Standard Operation Procedures, concession and utility operating plans

Only state and county certified weed-free forage would be permitted in the park, with no hay of any kind permitted in the backcountry (36 CFR 1.6(2) and 2.16(G)). NPS and concession stock operations, licensed guides, researchers, contractors, park employees and any other entity under an NPS permit would have to use hay that certified weed-free and, to the extent possible, from NPS approved weed-free sources, and they would be encouraged to hold their stock in a weed-free environment prior to entering the park. Only manure trucks and state and county certified weed-free hay that is covered or enclosed could be transported within the park.

Collaboration

Establishment of management partnerships are encouraged under the preferred alternative to foster relationships among the public, private landowners, conservation groups, and county invasive vegetation managers. Collaboration would be an ongoing consensus-building process involving:

- conservation groups, landowners, and the general public,
- park resource managers and exotic plant management experts,
- local, state, and federal officials involved in invasive vegetation management in the GYA.

Collaboration with invasive vegetation experts within and outside the NPS would be conducted on a regular basis to help NPS resource managers keep informed on the latest invasive vegetation management technologies available. Such collaboration would also be an opportunity for individuals to share and learn from their invasive vegetation management successes and challenges.

Under the preferred alternative, park staff would also include:

- continue to participate in the GYCC's Terrestrial Invasive Species Committee, which coordinates invasive plant management activities on public lands in the GYA;
- work with universities, state and federal agencies, and private organizations to develop education programs and courses for resource managers;
- work with interested agencies and the concerned public to incorporate invasive vegetation management techniques into herbicide applicator training courses;
- participate in seminars or workshops on invasive vegetation management;
- encourage NPS staff to participate in professional organizations or societies concerned with invasive vegetation management issues;
- cooperate with other agencies to develop and disseminate educational materials (publications, posters, videos, and intranet) to the public, interested organizations, and agency employees;
- develop collaborative groups that include interested agencies and the public to assist with invasive vegetation management and to ensure that planning incorporates the concerns of land managers and landowners with similar invasive vegetation management issues.

Survey and Treatment

An IWM approach would apply best management practices in selecting an invasive species and location of infestations to treat. Survey, containment and/or control of invasive plant species or groups of species would use an array of treatment methods including physical or mechanical control, herbicide treatments, cultural methods, and biological control agents. This approach would be multidisciplinary, using ecological considerations to manage invasive plant species.

An IWM approach to invasive plant surveys and treatment can be summarized in these steps:

1. Identify nonnative plant species.
2. Determine whether nonnative plant meets the action threshold.
3. Identify management priorities for invasive plants.
4. Identify management strategy and select treatment method.
5. Confirm compliance with laws and regulations and obtain required approvals for proposed action.
6. Implement selected treatment.
7. Monitor the site to evaluate the efficacy of treatments.

This decision-making process is presented below and illustrated as a schematic drawing in Appendix 4. For more information about safety precautions in field work and herbicide handling, see Appendix 6.

Step 1: Survey and identify invasive plant species.

Only plants defined as nonnative and invasive are considered target species under this plan. Except for their use in plant community restoration, this plan does not include management of native plants, even those that are considered pests or problems in natural or cultural landscapes or in recreation areas.

Native plants and nonnative, invasive or exotic species are defined in the 2006 NPS Management Policies (Section 4.4.1.3):

> *Native species are defined as all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system. Native species in a place are evolving in concert with each other*.
>
> *Exotic species are those that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as nonnative, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place. Genetically modified organisms exist solely due to human activities and therefore are managed as exotic species in parks.*

Resources to determine whether the plant meets the definition of a nonnative invasive plant include:

- Federal, state, and county noxious weed lists of species that are a management priority because their treatment is mandated by executive order, regulation, or law.
- The USDA Natural Resources Conservation Service Plant Database (http://plants.usda.gov) contains a searchable component for native status. Plants may be searched via scientific or common name. The database also contains maps of states and counties that include presence and absence data.

Step 2: Determine whether nonnative plant meets the invasive plant action threshold.

An invasive plant is "a nonnative plant whose introduction does or is likely to cause economic or environmental harm or harm to human health."(Executive Order No. 13,112, 64 Fed. Reg. 6,183, Feb. 3, 1999). Invasive plants are marked by their ability to spread rapidly in native ecosystems; they have been identified as a primary threat to federally managed lands. They "increase fire hazard, degrade fish and wildlife habitat, eliminate rare and endangered plants, impair water quality and watershed health, and adversely affect a wide variety of other resource values such as scenic beauty and recreational opportunities." (Administrative Record 22622–22623).

A plant species that meets the definition of "nonnative" in Step 1 is managed under this plan if it also meets any of the criteria for invasive plant species set forth in the 2006 NPS Management Policies (Section 4.4.4.2):

- The species poses a significant risk or nuisance to native plant populations or other ecological aspects of the park or surrounding area. Invasive plants that are on noxious weed lists or that have demonstrated the ability to move into a native landscape and to occupy habitat within it pose a risk to native plant populations.
- The species interferes with natural processes and the perpetuation of natural features, native species or natural habitats.
- The species disrupts the genetic integrity of native species.
- The species disrupts the accurate presentation of a cultural landscape or damages cultural resources.
- The species significantly hampers the management of park or adjacent lands
- The species poses a public health hazard as advised by the U. S. Public Health Service, which includes the Centers for Disease Control and the NPS public health program.
- The species creates a hazard to public safety.

Step 2a: Monitor to determine whether the nonnative species is invasive.

If a nonnative plant is documented in the park for which a determination as to whether it is invasive has not been made by cooperative weed management partners, the county, the state, or NPS staff, its effects on the surrounding vegetation and ecosystem will need to be assessed. Some plants species are considered inherently invasive but, depending on local conditions, a nonnative species that is having a large impact in one plant community may have a much lower impact in another plant community. If displacement of native species or spread of the nonnative species is not occurring, park managers will likely focus nonnative plant management efforts elsewhere to use limited staffing and funding more effectively.

Step 3: Identify management priorities for invasive plants.

Invasive plants are grouped in priority classes based on criteria that include the degree of threat within the particular weed management zone, the sensitivity of the habitat in which the nonnative plants are growing, and the likelihood that actions taken would achieve any meaningful degree of success within a reasonable time and amount of effort. The list of priority groups would be periodically updated using the current list of nonnative species provided by the park botanist (Appendix 2).

As stated in the NPS Management Policies (NPS 2006):

> *High priority will be given to managing exotic species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controlled. Lower priority will be given to exotic species that have almost no impact on park resources or that probably cannot be successfully controlled. Where an exotic species cannot be successfully eliminated, managers will seek to contain the exotic species to prevent further spread or resource damage (Section 4.4.4.2).*

Although the list of invasive plants is grouped by priority, the actual species treated in any given year may vary depending on factors such as treatment success in the previous year, the phenology of the plant at the time of treatment, and variations in weather conditions (e.g., wet vs. dry years). The decision to treat a particular species may also depend on the ability to complete the work due to the species composition and number of other nonnative plant populations to be treated that year.

Step 4: Identify management strategy and select treatment method.

Existing invasive plant infestations would be managed for eradication, containment, or suppression, depending upon the species and the size of the infestation.

Management Strategy: Management strategy is based on the characteristics of the species, the extent of its presence in the park, and its response to available treatments. Although the overall goal is always eradication, because of the patch size, distribution of the plant, effectiveness of treatment methods, or cost, an initial goal may be containment or suppression of a specific plant population. If eradication is not cost effective or feasible, the management strategy moves to containment; if containment is not cost effective, a more extreme method is later determined to be cost effective and feasible, and the initially selected method may change.

Treatment Methods: Treatment methods would be systematically analyzed over time to determine which will work best in each case based on the management strategy for that species, growth stage, site, and patch size with minimal risk to native organisms, their habitats, and humans.

Efforts to eliminate or control invasive species would include mechanical, cultural, chemical, and, when appropriate, biological treatments. All herbicides and biological control agents used would be approved by IPM specialists from Yellowstone and other NPS staff. Chemical and biological control agents would undergo a rigorous internal evaluation and compliance process to determine their efficacy in treating target species and risks to native species.

Management Strategy Definitions

Eradication
Reducing to zero the reproductive success of a invasive plant population in largely uninfested regions and permanently eliminating the species or populations within a specified period of time. Once all specified weed populations are eliminated or prevented from reproducing, intensive efforts continue until the existing seed bank is exhausted.

Containment
Maintaining an intensively managed buffer zone that separates infested regions, where suppression activities prevail, from largely uninfested regions, where eradication activities prevail; does not usually mean reducing the current infestation.

Suppression
Reducing the vigor of invasive plant populations within an infested region, decreasing the propensity of noxious weeds to spread to surrounding lands, and mitigating the negative effects of noxious weeds on infested lands. Suppression efforts may employ a wide variety of integrated management techniques; the reduction of abundance of a targeted species is typically measured or estimated in terms of canopy cover or plant density.

Mechanical Treatments: Mechanical or manual control pulling, grubbing, mowing, or cutting weeds) is the first choice for small infestations of species whose biology makes it the most practical and effective method and in sensitive areas near wetlands, waterways and geothermal features. These methods are effective in reducing seed production as well as reducing the possibility of seed transport from roadsides, trailheads, campgrounds and developed areas. The success of mechanical control on individual plant mortality depends on the species. The drawbacks of manual/mechanical methods include the increased susceptibility to invasion by other nonnative plant species as a result of the ground disturbance and the potential for residual nonnative plant material to re-sprout or for residual seed in the soil to germinate.

Chemical Treatments: Chemical control generates controversy regarding its appropriateness in a national park, its effects on wildlife, soil, and water, and its health risks for those applying it and the general public. One drawback of chemical control is that the ground disturbance created by use of an herbicide can increase susceptibility to invasion by other nonnative plant species or the possibility that residual seed in the soil will germinate. Park staff attempt to balance these concerns with our management objectives through conservative use of herbicides proven to be effective for the target species. Staff would adhere to product label guidelines that have been developed to ensure human safety and minimal environmental impact. Without the use of herbicides ecosystem structure and function would be compromised with potential environmental and economic impact to individuals and agencies outside park boundaries.

Herbicides would be used to eradicate and contain aggressive, high-priority invasive plant species that do not respond well to mechanical control or cultural treatment or when available staff is insufficient to use those methods. Only the most selective, environmentally compatible herbicide for the target species that would be safe for the applicator, park visitors, and wildlife would be used, with spot spraying of individual plants rather than broadcast spraying of scattered plants.

For a list of the currently approved herbicides and surfactants used in the park and their risk assessment, see Appendix 7. This information is also available at www.fs.fed.us/foresthealth/pesticide/risk/. All herbicides considered for use in the park must be approved at NPS regional and national levels.

Herbicides would be applied by spot spraying individual plants using backpack sprayers or boom sprayers mounted to UTV tanks. Aerial spraying would not be used in the park. Human health and safety issues would be of paramount consideration. Staff would adhere to product label guidelines that have been developed to ensure human safety and minimal environmental impacts. Park staff would employ safety practices developed through approved Job Safety Analysis and Green-Amber-Red safety analysis.

Cultural Treatments: Methods of cultural treatment would include revegetation, top soil conservation, fire, shading, and the use of competition from native plants. Cultural techniques may also manipulate the plant community through cultivating (cutting through and turning over the soil), re-seeding, mulching, and irrigating. Cultivating for a year prior to reseeding can kill weeds that have sprouted since the last cultivation and reduces the bank of seeds. Cultural control methods are most useful for large restoration projects. Cultivating is often necessary to reduce the number of nonnative plant seeds in the soil before restoring native species.

Cultivation is generally not appropriate for natural areas because it disrupts established plant communities and renders them susceptible to infestation by nonnative plants. Fire is also likely to result in invasive plant infestations. Cultural control is useful in re-establishing native plant communities on disturbed or depleted areas so that the native plants can prevent or reduce weed infestation. Disturbances such as pipelines, temporary roads, and construction sites need to be

revegetated through top soil conservation and/or re-seeded immediately after the work is completed.

The use of fire for invasive plant control would be employed in certain circumstances where an invasive plant populations and its seed source can be effectively burned off so that native seed or plants can be established. The goal would be to give native vegetation an advantage in gaining access to soil nutrients, water, and sunlight before nonnative plant populations can become established. Burns would be considered for larger-scale restoration efforts such as the Gardiner Basin revegetation project or for control of invasive plant species that would be conducive to the use of fire as an effective weed treatment strategy.

Biological Treatments. Use of approved biological control agents would be considered under Alternative B: Biological control (bio-control) is the use of living organisms to limit the abundance of a target nonnative species. It is a long-term management tool that, when used in conjunction with other methods, can contribute to infestation containment. Biocontrol has been used in invasive plant management in the GYA and is included in NPS management policies (NPS 2006).While biocontrol can occasionally be accomplished with native pathogens or from nonnative agents migrating from adjacent lands, typically one or more insect or pathogen species from the indigenous range of the target nonnative species is released into the target population to reduce its numbers and vigor.

Biocontrol is not necessarily appropriate or preferable to chemical or other control methods if it involves introducing one nonnative species to control another, especially if the biocontrol organism has low efficacy in controlling the target species. Introducing a nonnative biological agent to control invasive plant species has many associated risks (Lockwood et al. 2001). Some introduced biocontrol agents have been found to attack native plants more than expected from the initial testing (Louda and O'Brien 2002), and some introduced biocontrols have affected other native organisms (Pearson and Callaway 2005). Some biocontrols have adapted more rapidly than anticipated (Butler and Wacker 2010), which may damage non-target organisms, including native insect and pathogen populations.

Biocontrol agents may not be capable of completely eradicating an invasive plant population because as the number of host plants declines, so does the population of biocontrol agents. However, biological control could be a useful tool in reducing the size or density of a wide-spread invasive plant infestation, making other treatments more effective. Biocontrol is best suited to large, dense, aggressive nonnative plant infestations where eradication is impractical.

Before approving release of a biocontrol agent, the USDA Animal and Plant Health Inspection Service requires extensive research and testing to make sure that it will not affect native plant species. However, little research is required into the effect of the new biocontrol agent on native insect or pathogen populations.

A scientific review of existing biocontrol methods is presented in Appendix 8. Under Alternative B, park managers would annually review the list of host-specific predators or pathogens approved for use in controlling invasive vegetation and the scientific literature to weigh the benefits and potential negative impacts of using such a method.

To minimize the possibility of negative impacts on park resources from the use of biological control agents, under Alternative B such releases would occur only if all the following conditions are met:

- Other treatment options have proven ineffective or demonstrate unacceptable potential impacts.

- The threat to the park of continued spread of the targeted invasive plants outweighs the risk of introducing a nonnative biocontrol species into the park.
- Peer-reviewed published literature demonstrates a quantifiable measure of agent success under field conditions on the targeted weed species in similar habitats (e.g., Butler et al. 2006), resulting in the proliferation of native plant species.
- Host specificity has been demonstrated under field conditions to the targeted species in similar habitats (e.g., Wacker and Butler, 2006; Breiter and Seastedt, 2007).
- Research indicates that the introduced biological control would not harm other native `organisms, including populations of species similar to it.
- YNP staff has consulted with federal, state, and local weed managers outside the park, especially land managers adjacent to potential release sites.
- Additional NEPA compliance for the use of biological controls would be required beyond this Environmental Assessment if impacts would be determined to be more than short-term, minor and adverse.

For more information about the potential use of biological controls in the park, see Appendix 8.

Step 5: Confirm compliance with laws and regulations and obtain required approvals for the proposed treatment.

Park resources managers would ensure that the proposed treatment complies with all applicable laws, regulations and NPS policy (see Appendix 1, Invasive Vegetation Authority and Policy).

Compliance for Chemical or Biological Methods

Use of pesticides must meet the label requirements and be in compliance with other requirements, such as application or supervision by a certified pesticide applicator. NPS policy and guidance also requires annual review and approval by the regional and national IPM coordinators prior to the application of pesticides in the parks.

In determining whether to approve a pesticide for use in a park, the NPS regional and national IPM specialists routinely refer to the directory of herbicide risk assessments that have been prepared by the EPA and the USFS, and take into account normal uses by land management agencies and the effects on pesticide applicators, visitors, threatened and endangered species. The assessments for herbicides currently used in YNP are provided in Appendix 7 and can be found at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml. Although the National Park Service intends to become a partner in the risk assessment process, the park managers will continue to rely on risk assessment information provided by partner agencies until that occurs.

Any release of a biocontrol agent would have to be approved by the national coordinators of the NPS Invasive Species Program and Integrated Pest Management Program.

Compliance with NEPA, NHPA, and Other Regulations

Park resource managers must ensure that proposed invasive plant management actions comply with the provisions of applicable legislation regarding protection of the park's natural and cultural resources. Actions that are not specifically permitted under this plan or the impact of which may exceed that anticipated by the Invasive Vegetation Plan Environmental Assessment may require additional environmental analysis.

To determine whether the proposed action complies with Section 106 of the NHPA, the park Section 106 coordinator would review the Programmatic Agreement Among the National Park Service (U.S. Department of the Interior), the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers for Compliance with Section 106 of the National Historic Preservation Act.

Step 6: Implement the selected treatment.

During the appropriate time of year, and as time and staffing permit, the selected treatment methods to reduce invasive species are implemented by park staff, the Northern Rocky Mountains Exotic Plant Management Team, and/or permitted volunteers, park partners or cooperators (agencies, organizations and neighbors), and contractors. Additional permits to implement the project would be obtained if needed. Implementation actions may change over time to respond to reductions or increases in the invasive plant population.

Step 7: Monitor the treatment to assess its efficacy.

Weed managers have emphasized the need for inventory and monitoring to quantify problems and evaluate program effectiveness (NPS 1986, Johnson 1999). Monitoring is the repeated collection and analysis of information to evaluate progress and effectiveness in meeting resource management objectives and is an essential part of an integrated weed program. Based on inventory and ranking criteria, a good monitoring program saves time and money by telling managers which control techniques are working and which are not. Monitoring programs can range from simple, such as taking photo points, to more complex plot and transect data collection, but all are ongoing processes that may detect useful tends over time. Without monitoring, there is no way of knowing whether control efforts are contributing to fulfillment of desired management objectives, nor is it possible to use adaptive management.

Recordkeeping and Monitoring

Under Alternative B, a comprehensive monitoring system would be developed to gain a more thorough assessment of nonnative plant populations, the efficacy of control measures, and the potential impacts on native vegetation communities.

- Walking surveys would be undertaken each year from May to September on about 3,000 acres to look for infestations of nonnative plants in the early stages of establishment.
- Early detection efforts would be directed at the 47 species that are Priority 1 or 2 or are on the Watch List (Appendix 2). Some high priority areas would be surveyed multiple times each summer through a combination of walking and driving surveys.
- Backcountry survey efforts would be more opportunistic and focused, and depend on infestation history and available time and personnel.
- Selected infestations would be monitored to determine the response of weed species and populations that have been treated.

For details about monitoring invasive vegetation, see Appendix 9.

Under Alternative B, park resource management staff would continue to maintain records of invasive plant surveys and control efforts. The data recorded on field forms by district resource managers and technicians (Appendix 4) are transferred to a relational database and district information is pooled to represent park-wide weed management activities and conditions observed

within a given year. These records are annually incorporated into a regional GYA weed distribution database supported by the GYCC.

Under Alternative B, park managers would develop a system to standardize and consolidate data on invasive plants that would include:

- Data from consistent annual surveys that emphasize roads, developed areas, and other high probability pathways in key park locations.
- Data on species, locations, patch sizes, control types, and types and amounts of herbicide used.
- GIS spatial dataset that can be used to map species and the size and density of infestations to determine total acres and show changes over time.
- Monitoring protocols to evaluate the status of targeted species and the response of native plant species.
- An annual report that assesses the status of invasive plants in the park and the efficacy of the year's treatments, survey and control efforts by weed management districts.

Restoration

Land restoration and revegetation would be a component of all construction or maintenance projects that cause measurable ground disturbance. The restoration methods used would depend on the location, size, and type of disturbance. For excavation projects, top soil would be conserved and placed at the surface to act as a native seed source in bolstering the recovery of a site when filling trenches or other human-caused ground disturbance.

Another form of restoration under this alternative would be the reestablishment of native soil and vegetation on land altered by previous management practices. A good example is the Gardiner Basin along the park's north boundary, where roughly 700 acres that had been planted with nonnative crested wheatgrass was acquired by the National Park Service in the 1930s and has since been invaded by other nonnative annual plants. Phased, multi-year remedial actions recommended by a panel of reclamation specialists are underway in a pilot effort on 50 acres. In addition to weed control, remedial actions include fenced exclosures, planting of barley or a winter wheat cover crop, collection and growing of native seed, a native seeding trial, and possibly burning to eliminate surficial nonnative seed banks. No-till drilling of native seed is planned for 25 to 30 acres in the fall of 2012, with the remaining 20-25 acres to be seeded in 2014-2015. The results of this pilot effort will guide future, larger-scale restoration in the Gardiner Basin as well as in other areas in need of reclamation. This project is described in detail in Appendix 10.

Under Alternative B, the park would inventory disturbed sites in the park to assess the degree of disturbance and classify them by type and priority, implement an expanded program of ecological restoration in them, and monitor the results and the need for follow-up treatments.

Mitigation Measures Applicable to Both Alternatives

The following mitigation measures, which were developed to minimize the degree and severity of adverse effects, would be implemented during invasive vegetation management activities as needed.

- The park would have a certified applicator on site during projects involving herbicides. State certification, including herbicide training and safety, would be renewed every three years,

with annual training as required. All project participants would receive herbicide training from a certified project leader.

- Project participants would abide by the personal protective equipment (PPE) requirements and rules outlined on the product label. Rubber gloves, long-sleeved shirts, and eye protection may be required PPE for application of herbicides. Job hazard analyses for herbicide application would be reviewed with all project participants annually and when a new project begins.
- All instructions on the herbicide label would be strictly followed. Herbicide containers would be properly labeled. Application equipment and chemicals would be stored in appropriate storage facilities separate from food and personal items. Current labels and Material Safety Data Sheets (MSDS) would be maintained for all chemicals at every site where they are kept. The MSDS contains fire and explosive hazard data, environmental and disposal information, health hazard data, handling precautions, and first aid information. All participants would review the MSDS with the project leader and understand first aid instructions described on the MSDS and label.
- If the label instructions for the herbicide and application method recommend limiting exposure to humans and pets, the area would be closed during and after treatment for the recommended time. Treatments that pose no risk to humans may be done at any time.
- All herbicide mixing and loading of sprayer tanks would occur in designated staging areas where there would be no impacts on native plant communities. Herbicide sprayer calibration and training would be employed to minimize sprayer drift. Staff would follow established protocols, safety plans, and spill response plans. Use of UTVs, equipment, and materials would comply with applicable safety plans and guidelines.
- Treatments would occur when the least number of visitors would be impacted by the closure. Signage informing visitors about the impacts of invasive vegetation and the importance and need for the activities would be placed to help mitigate visitor experience impacts.
- In wetland and aquatic areas, use of herbicides to control invasive plants would be minimized and park staff would employ more manual invasive plant removal.
- In geothermal areas, access would be minimized for employee safety and resource protection. Park staff would employ more manual invasive plant removal than herbicide use and would not use mechanized equipment off-road.
- There would be annual training for park staff on native and nonnative plant identification and treatment strategies for target species.
- Monitoring of invasive plant control treatments would enable park staff to adjust treatment types to maximize control efforts with minimum impacts on native plant and animal species.
- Removal of nonnative vegetation that has high value as forage would occur in consultation with the park's wildlife management staff.
- Prior to major nonnative control treatments and vegetation restoration activities at historical sites, a cultural resource specialist would be notified to help identify potential impacts on archeological sites or cultural landscapes and identify measures to avoid and minimize impacts on cultural resources. Treatments in known areas of high archeological or historic sensitivity would not employ mechanized equipment off-road.

- Invasive plant control within park recommended wilderness would not use mechanized access or equipment unless it is supported by completion of a Minimum Requirement Analysis.

- Access for invasive vegetation treatments would not occur in park designated Bear Management Areas unless under consultation with the park's Bear Management Biologist.

Alternatives Considered and Dismissed

Alternatives that could not be implemented if they were chosen, that cannot be implemented for technical or logistical reasons, that do not meet park mandates, that are inconsistent with management goals, or that may have severe environmental impacts are to be eliminated before the impact analysis begins. The following alternatives were considered for project implementation but dismissed from further analysis:

1. **Use of integrated weed management practices without chemical or biological control treatments.** This alternative would apply Integrated Weed Management except that chemical and biological controls would not be considered as treatment options. This would remove the potential risks associated with herbicides and introducing nonnative biological agents into the park, but developing a fully integrated weed management program would not be possible without chemical or biological controls. This alternative was dismissed because it would not meet the goals of an invasive vegetation management plan stated in chapter 1 of this EA, nor would it meet the requirements of NPS policies or of other federal, state, and county policies pertaining to invasive plant management.
2. **No control of nonnative plants.** Without active management or control, loss of natural abundance and diversity of native vegetation and the spread of invasive species would continue to cause irrevocable damage to park resources and severely degrade visitor use and enjoyment of natural vegetation and cultural landscapes as well as the uses and values of land surrounding the park. This alternative was rejected because it would not meet the requirements of the park's enabling legislation to protect natural resources, the NPS Organic Act, NPS policies, or other federal, state, and county policies pertaining to invasive plant management.

Environmentally Preferred Alternative

According to the NPS regulations for implementing National Environmental Policy Act (NEPA; 43 CFR 46.30), the environmentally preferred alternative is the alternative "that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources. The environmentally preferable alternative is identified upon consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources. In some situations, such as when different alternatives impact different resources to different degrees, there may be more than one environmentally preferable alternative." Based on these criteria, Alternative B is the environmentally preferable alternative for this project.

Alternative B is the environmentally preferred alternative because it surpasses the current management practices in realizing national environmental policy goals, as stated in Section 101 of NEPA. Prevention and restoration efforts would be strengthened, reducing exposure to new infestations. More effective monitoring would provide information needed for adaptive

management and improvement of treatments. The comprehensive decision-making process under this alternative would allow continuation of best practices by any resource manager rather than relying on the current expertise of park staff. Alternative B would provide the widest range of management options in controlling invasive plants in the park.

Alternative Summaries

Table 3 compares the ability of the two alternatives to meet the project goals and objectives identified in the Purpose and Need section. Alternative B meets each of the objectives identified for this project, while Alternative A does not address all of the project objectives.

Table 4 summarizes the anticipated environmental impacts of each alternative. The Environmental Consequences chapter provides a more detailed explanation of these impacts.

Table 3. Summary of fulfillment of Invasive Vegetation Management Plan objectives.

Objectives	Alternative A: No Action	Alternative B: Integrated Weed Management
Prevent the entry and establishment of additional nonnative plant species as well as further infestations of invasive species already in the park.	Ongoing practices to prevent the introduction and spread of invasive plants consist of inspection of weed-free hay certificates, sand and gravel pits, and construction equipment. Informal education program outside of training for seasonal NPS resource management employees with direct responsibilities for invasive vegetation management.	Strengthen prevention program with increased visitor and employee education in detecting and preventing the introduction and spread of invasive plant species and additional protective practices. Consistently apply prevention practices and enforcement and inspection of weed-free hay certificates, sand and gravel pits, and construction equipment. Information and educational programs provided to the public, park employees, concessionaires, researchers and contractors on the impacts, identification, spread, and control of invasive vegetation and the value of native plant communities.
Control new and existing populations of invasive plants by eradicating them, reducing their size and density, or containing their spread.	Watch for new nonnative plant species and respond as quickly as possible to prevent establishment. Treatments primarily in frontcountry areas (roads and developments); backcountry control limited to known invasive plant infestations.	Strengthen detection surveys and implement an inventory and monitoring approach to surveys and control of new invasive plants. Strengthen partnerships with park neighbors. Emphasis along park roads and development, but include more backcountry surveys as feasible.
Restore native plant communities when they have been disrupted or replaced by nonnative plant populations.	Limited restoration when ground disturbance occurs; top soil conservation; collection of native seed, shrubs and seedling trees for replanting when possible. Rangeland restoration in the Gardiner Basin would continue on a limited basis.	Implement a more comprehensive native plant restoration program. When ground disturbance occurs, undertake top soil conservation and collection of native seed, shrubs, and seedling trees for replanting. Rangeland restoration in the Gardiner Basin would continue and expand for the entire area.
Prevent further spread of invasive plant species present in the park, as well as new species introductions by implementation of best management practices that include an array of control and preventive actions.	Alternative A would only partly meet this objective. New invasive plants or populations would be prevented or slowed. Current practices would not provide all tools necessary to accomplish this adequately. No formal procedures are in place to direct restoration or other preventive measures that would deter introduction of invasive species.	Alternative B would best meet this objective. Native plant communities would be preserved, protected, and restored over the long-term through the implementation of a comprehensive invasive vegetation management plan. Early detection and rapid response protocols would be established. Partnerships with neighbors would be strengthened.

Objectives	Alternative A: No Action	Alternative B: Integrated Weed Management
Control existing populations of invasive plants by eradicating them, reducing their size and density or containing their spread.	Alternative A would only partly meet this objective. Native plant communities would be protected to some degree and expansion of some existing invasive plant populations may be slowed, but the continuation of current practices would not provide all of the tools needed to reduce the size, density, or contain the spread of nonnative plants. No comprehensive decision-making process is in place to guide staff in considering all treatment options or identify treatment priorities.	Alternative B would best meet this objective. A comprehensive decision-making process would guide staff in considering all treatment options. Treatment priorities would be identified. Alternative B would employ all appropriate tools needed to reduce the size, density, or contain the spread of nonnative plants over the long-term through the implementation of a comprehensive nonnative vegetation management plan. Park would implement a step-process to identify, prioritize, survey, and control invasive vegetation along roads, developed areas, and more backcountry areas.
Establish decision-making tools to guide integrated vegetation management activities.	Treatment priorities are not fully addressed. No comprehensive decision-making process guides staff in considering all treatment options. Less than full range of IWM techniques would be used; primarily mechanical and herbicide application, limited cultural treatments. Site restoration performed when construction activities occur. No aerial spraying.	Treatment priorities would be addressed in detail and a comprehensive decision-making process implemented to guide staff in considering treatments of priority species and all treatment options. Full range of IWM techniques would be used; primarily mechanical and herbicide application; limited biocontrol after thorough review and analysis. Cultural treatments would include revegetation, fire, and shading. Restoration applied in larger context and with major revegetation objectives. No aerial spraying.
Ensure visitor and employee safety during project implementation.	Control activities would have short-term risks for visitors and short- and long-term risks for park staff directly engaged in them. Use of UTVs, equipment, and materials would comply with applicable safety plans and guidelines. Appropriate personal protective equipment would be used during control treatments. Appropriate signage and closures would be used when applying herbicides in public areas.	Control activities would have short-term risks for visitors and short- and long-term risks for park staff directly engaged in them. Use of UTVs, equipment, and materials would comply with applicable safety plans and guidelines. Appropriate personal protective equipment would be used during control treatments. All federal regulations regarding herbicide use would be followed at all times. Herbicide use would be approved annually in consultation with NPS regional and national IPM specialists. Herbicides would be applied by or under the supervision of a certified pesticide applicator. Appropriate signage and closures would be used when applying herbicides in public areas.
Improve the visitor experience and appreciation for native plant communities in the park through awareness of invasive plant species.	Experience of some visitors would be affected during use of control methods, including the presence of crews wearing full-body suits and blue marker dye on the ground. Beneficial effects would include lessening the impacts of invasive vegetation on recreational activities such as photography and viewing native wildflowers and other scenery.	Experience of some visitors would be affected during use of control methods, including the presence of crews wearing full-body suits and blue marker dye on the ground. Beneficial effects would include lessening the impacts of invasive vegetation on recreational activities such as photography, scenic viewing, viewing annual wildflower blooms.

Table 4. Summary of environmental impacts of each alternative.

Impact Topic	Alternative A: No Action	Alternative B: Integrated Weed Management
Soil Resources	Short- and long-term, negligible to minor adverse impacts due to manual disturbance from hand tools, and mechanized equipment, and chemical residue from herbicide application, and beneficial effects from native plant revegetation and top soil conservation.	Short- and long-term, negligible to minor adverse impacts due to manual disturbance from hand tools, and mechanized equipment, and chemical residue from herbicide application, and beneficial effects from native plant restoration and top soil conservation.
Geothermal Resources	Short- and long-term, minor adverse impacts due to manual disturbance from hand tools and mechanized equipment, and chemical residue from approved herbicide application. Access would occur with consultation of park geologist.	Short- and long-term, minor adverse impacts due to manual disturbance from hand tools and mechanized equipment, and chemical residue from approved herbicide application. Access would occur with consultation of park geologist.
Wetlands and Water Resources	Short-term, minor adverse impacts due to manual disturbance from hand tools and herbicide application and drift Use of approved herbicides would be minimized and manual plant removal would be used.	Short-term, minor adverse impacts due to manual disturbance from hand tools and herbicide application and drift, Use of approved herbicides would be minimized and manual plant removal would be used. Beneficial effects would occur from native plant restoration and top soil conservation.
Water Quality	Short-term, minor adverse impacts due to manual disturbance from hand tools and mechanized equipment, and chemical residue from approved herbicide application, Use of herbicides would be minimized near park waters and manual plant removal would be used.	Short-term, minor adverse impacts due to manual disturbance from hand tools and mechanized equipment, and chemical residue from approved herbicide application, Use of herbicides would be minimized near park waters and manual plant removal would be used. Beneficial effects would occur from native plant restoration.
Vegetation, including Rare Plants	Short- and long-term, negligible to minor adverse impacts due to manual disturbance and herbicide application and drift, and long-term minor beneficial effects from native and rare plant protection and revegetation . Mitigation would include training for staff on plant identification and treatment strategies for target weed species and herbicide sprayer calibration to minimize sprayer drift.	Short- and long-term, negligible to minor adverse impacts due to manual disturbance and herbicide application and drift, Biological control after appropriate assessment and compliance. Long-term minor to moderate beneficial effects from native plant protection, revegetation and restoration. Mitigation would include training for staff on plant identification and treatment strategies for target weed species and herbicide sprayer calibration to minimize sprayer drift.
Fish and Wildlife Species	Short- and long-term, negligible adverse impacts due to access, disturbance, and herbicide application, and beneficial effects from native plant revegetation and increase native plant forage.	Short- and long-term, negligible to minor adverse impacts due to access, disturbance, and herbicide application, and minor beneficial effects from native plant revegetation, restoration, and increase native plant forage.

Impact Topic	Alternative A: No Action	Alternative B: Integrated Weed Management
Threatened, Endangered, and Special Status Wildlife	Short-term, negligible to minor adverse impacts, and long-term, negligible beneficial impacts due to access, disturbance and herbicide application, and revegetation on threatened wildlife species and critical habitat (grizzly bears, Canada lynx, and lynx critical habitat), proposed threatened species (wolverine) and their habitats, and special status species. Actions proposed under this alternative would lead to "may affect, not likely to adversely affect" for listed species.	Short-term, negligible to minor adverse impacts, and long-term, negligible beneficial impacts due to access, disturbance and herbicide application, and effects from native plant revegetation and restoration on threatened wildlife species and critical habitat (grizzly bears, Canada lynx, and lynx critical habitat), proposed threatened species (wolverine) and their habitats, and special status species. Actions proposed under this alternative would lead to "may affect, not likely to adversely affect" for listed species.
Archeological Resources	Short-term, negligible to minor adverse impacts due to manual disturbance, herbicide application, and revegetation. Cultural resource specialist would help identify potential impacts on archeological sites. Determination of effect would be "no adverse effect" on archeological resources.	Short-term, negligible to minor adverse impacts due to manual disturbance, herbicide application, revegetation, and restoration. Cultural resource specialist would help identify potential impacts on archeological sites. Determination of effect would be "no adverse effect" on archeological resources.
Cultural Landscapes	Short- and long-term, minor adverse impacts due to manual disturbance and herbicide application, and beneficial effects from native plant restoration. Cultural resource specialist would help identify potential impacts on cultural landscapes	Short- and long-term, minor adverse impacts due to manual disturbance herbicide application, and revegetation, and long-term minor beneficial effects from native plant restoration. Cultural resource specialist would help identify potential impacts on cultural landscapes
Health and Human Safety	Short- and long-term, minor to moderate adverse impacts due to manual activity, use of equipment, and herbicide application. A certified applicator would be used on projects involving herbicides, herbicide label would be strictly followed, and personal protective equipment would be used. UTVs, equipment, and materials would comply with applicable safety plans and guidelines.	Short- and long-term, minor to moderate adverse impacts due to manual activity, use of equipment, and herbicide application. A certified applicator would be used on projects involving herbicides, herbicide label would be strictly followed, and personal protective equipment would be used. UTVs, equipment, and materials would comply with applicable safety plans and guidelines.
Visitor Use and Experience	Short-term, negligible to minor adverse impacts due to observations of manual control and herbicide application. Treatments would occur when the least number of visitors would be impacted. Signage informing visitors about the impacts of invasive vegetation and the importance and need for the activities would be placed	Short-term, minor adverse impacts due to observations of manual control, herbicide application and restoration efforts. Treatments would occur when the least number of visitors would be impacted. Signage informing visitors about the impacts of invasive vegetation and the importance and need for the activities would be placed

Impact Topic	Alternative A: No Action	Alternative B: Integrated Weed Management
Park operations	Short-term, minor adverse impacts due to park staff employing prevention, manual control, herbicide applications and revegetation efforts.	Short-term, minor adverse impacts due to park staff employing prevention, manual control, herbicide applications, revegetation, restoration, and monitoring efforts.

Affected Environment

This chapter describes the existing environmental conditions for resources potentially affected by the alternatives set forth in this EA for the Invasive Plant Management Plan.

Soil Resources

Soils form over time from interactions among source material, climate, topography, and biotic organisms. Soil is derived from four main parent materials in Yellowstone, primarily volcanic. The soils in the western and central plateau areas formed from parent materials derived from rhyolite lava flows and ash flow tuffs. Andesitic parent material from the Eocene Absaroka Volcanics is weathering into soil along the northwest, northeast, and eastern boundaries. Andesitic soils have better moisture-holding capacity and higher levels of nutrients than do rhyolitic soils. Climax lodgepole pine is generally associated with rhyolitic soils, while climax spruce and fir are typically associated with andesitic soils. Soils from loess, evolved from glacial episodes, is found in river floodplains. About 6% of the soil in the park is derived from the fourth parent material, sedimentary rocks consisting of limestones, sandstones, and shales.

More than 80 soil types and 6 soil orders found in the park have been described (Rodman et al. 1996). Most of these types fall into three soil orders: Inceptisols, Mollisols, and Alfisols. Inceptisols, which have weakly developed soil profiles, are the most common soil order in the park and dominate within the caldera in the central and southwestern parts of the park. Mollisols have thick, dark surface horizons and are rich in organic matter. They occur primarily in grasslands in the park, but also in forests across the north and east boundaries of the park. Alfisols have thin surface horizons and subsoil accumulations of clay. They occur throughout the forested north and east parts of the park and dominate in areas weathering from sedimentary rocks.

Soil in Yellowstone constitutes a diverse, intact, and functioning ecosystem that is home to a wide range of microbial and animal groups, including bacteria, protozoa, nematodes, and fungi. Nonnative plant communities have an impact on soil systems. Nonnative plants known to occur in Yellowstone can affect nitrogen levels (Evans et al. 2001), phosphorus cycling (Zabinski, Quinn et al. 2002), and soil biota (Belnap and Phillips 2001). Changes in nutrient cycling and soil biota can contribute to conditions that foster nonnative plant invasions and reduce native plant diversity.

Geothermal Resources

Yellowstone contains the world's largest and most active geothermal areas, a principal reason for the establishment of the park. The park has more than 300 geysers and 10,000 thermal features, including hot springs, mud pots, and fumaroles. Groundwater heated by molten rock, fuels the thermal features. Thermal areas sustain unique and diverse life and support various microbial organisms, mosses, and grasses. These resources in turn support a range of animals from insects to large ungulates such as bison and elk.

Plant life in thermal areas is often dominated by mosses; since they lack roots they can tolerate high soil temperatures. Concentric patterns of vegetation reflect the upper temperature limits of different plant species. Typically, mosses grow centrally, surrounded by grasses, and then trees as the dominant life form (NPS 2002). With little shade, the light intensity and solar radiation are unrelenting. Stressful habitats often support plant species that have sacrificed the ability to compete with other species or their ability to reproduce lots of seeds in favor of the ability to

survive or tolerate a narrow range of extreme conditions. Many of the plants in the geyser basin have made adaptations to leaf structures or cells to endure the conditions or escape the heat. Thermal communities have seen a significant amount of pressure from invasive plants such as silver cinquefoil (*Potentilla argentea*), ashy cinquefoil (*Potentilla inclinata*), cheatgrass, spotted knapweed, Dalmatian toadflax, Canadian bluegrass (*Poa compressa*), bulbous bluegrass (*Poa bulbosa*), woolly mullein (*Verbascum thapsus*), alyssum (*Alyssum* spp.), soft brome (*Bromus hordeaceus*), and crane's bill (*Erodium cicutarium*).

The Yellowstone caldera, which lies entirely within the park, is approximately 55 km wide and 72 km long, with the last major eruption occurring about 640,000 years ago. The geothermal areas most accessible to park visitors include the Upper and Lower geyser basins near the Firehole River, Norris Geyser Basin near the Gibbon River, Mammoth Hot Springs, Mud Volcano, and the West Thumb Geyser Basin, which is the largest geyser basin on the shore of Yellowstone Lake.

Although thermal features may appear powerful, they are fragile systems that can be altered or destroyed if a component of their structure, such as heat, water supply, or the plumbing system, is altered. Nature itself can destroy geysers. Changes in a thermal feature's water or heat source may cause it to cease functioning. Thermal features may change or be destroyed if the seal that holds back the pressure is breeched during an eruption, seismic activity, or natural processes such as landslides.

Yellowstone's most unusual native flora communities and many rare plants occur in the thermal areas. This is also where the need to suppress invasive plants is often strongest because of the interest from visitors and the threat nonnative species pose to the flora there. Park management will need to continue to balance the suppression effort on nonnative species with concern for the thermal communities.

Wetlands and Water Resources

Wetlands, as the term is defined by the USFWS and used by the National Park Service, are lands in transition between terrestrial and aquatic systems, where the water table is usually at or near the surface, or shallow water covers the land at least seasonally. Wetlands are primarily characterized by (1) the presence of standing water throughout at least part of the growing season, (2) wetland soils, and (3) vegetation adapted to or tolerant of saturated soils. Hydrology is considered the primary driver of wetland ecosystems, creating wetland soils and leading to the development of wetland biotic communities.

Wetlands are an important part of Yellowstone's landscape, providing major contributions to ecosystem productivity and biological diversity. Many animal and plant species in the Rocky Mountains depend entirely on wetlands for habitat. Wetlands also perform vital hydrological processes such as flood abatement, sediment retention, groundwater recharge, nutrient capture, and decomposition of organic matter. Wetlands receive special protection under the Clean Water Act and Executive Order 11990.

The National Park Service uses a system created by the USFWS (Cowardin, Carter et al. 1979) to define, classify, and inventory wetlands. As part of the National Wetlands Inventory, in 1997 the USFWS published a map that identified 118,528 acres as palustrine wetlands; the total wetlands habitat in Yellowstone, including deepwater habitat such as lakes and rivers, was 228,766 acres (Elliott and Hektner 2000). Since then, wetland surveys and more precise mapping has been done by NPS staff in the Mammoth, Canyon, Old Faithful, and Lake developed areas, as well as along some road corridors.

Yellowstone wetlands include lakes, rivers, ponds, streams, seeps, spring mounds, marshes, fens, wet meadows, forested wetlands, and geothermal wetlands. Geothermal wetlands vary from having mild geothermal influence to the extreme of having vegetation driven by the thermal feature. They range from areas of little soil development (sinter) with thermal runoff to wetlands with organic soil and thermal upwellings. Geothermally influenced wetlands are found in few other places in the world, and those in Yellowstone are unusual in that many depend on the thermal feature to maintain the wetland's hydrology. Wetlands and riparian areas in Yellowstone provide essential habitat for rare plant species as well as reptiles, amphibians, and numerous insects, birds, mammals and fish in the park. Approximately 38% of the park's plant species are associated with wetlands, and 11% grow only in wetlands (NPS 2011a).

Wetlands are particularly vulnerable to nonnative plant invasions, which can degrade wetland habitat by changing sediment loading, surface and subsurface flows, and water table depth (Gordon et al. 1998). Although wetlands constitute less than 6% of Earth's land mass, 24% of the world's most invasive plants are wetland species (Zedler and Kercher 2004). Wetlands with a history of hydrological disturbance tend to promote more widespread plant invasions than do undisturbed wetlands. This is evident in Yellowstone, where nonnative perennial grasses dominate many meadows in areas where culverts and ditches alter surface and groundwater flows, and several old corrals in the park are located in wetlands that are now infested with nonnative plants.

Over 30% of the nonnative plants that have been documented in Yellowstone have the potential to occur in wetlands. These 67 nonnative species follow the same elevation pattern as infestations in other habitats in the park, and are more widespread at lower elevations than at higher elevations. They are also generally more common in the front country than the backcountry, although many of the perennial nonnative grasses such as timothy (*Phleum pratense*) and redtop (*Agrostis stolonifera*) are common in the backcountry as well. Small populations of velvet grass (*Holcus lanatus*), sweet vernal grass (*Anthoxanthum odoratum*), and evergreen blackberry (*Rubus laciniatus*) have been found in wetlands in the Old Faithful developed area within the last five years. These three species have changed ecosystems in California. Nonnative plant removal in the park's wetlands would be limited to priority I and II species with approved herbicides.

Water Quality

Yellowstone encompasses an approximately 3,500 square-mile watershed that provides the surrounding area with high quality water. Streams and lakes in Yellowstone are designated as Class I, Outstanding Resource Waters, by the state of Wyoming. Existing water quality must be maintained in Class I waters. The water resources within Yellowstone cover 112,000 acres, with more than 150 lakes covering an area of approximately 108,000 acres. Yellowstone Lake, the largest body of water above 7,500 feet elevation in North America, covers 139 square miles. Other major lakes are the Shoshone, Lewis, and Heart lakes. Hundreds of streams provide more than 2,650 miles of flowing water in the park. River systems within the park include the Gardner, Lamar, Yellowstone, Madison, Firehole, Gibbon, Snake, and Lewis rivers. The hydrology of streams and rivers in the park is driven by snowmelt, with discharge peaking in the late spring and declining gradually over summer to return to near base flow by late fall.

In 2002, the Yellowstone Center for Resources fisheries and aquatic sciences staff initiated a long-term water quality monitoring program that includes monthly sampling of 19 sites (12 in streams and 7 in Yellowstone Lake) (NPS 2010b). Water quality information collected from these sites includes temperature, dissolved oxygen, pH, specific conductance, turbidity, and total suspended solids. Several ion and nutrients metrics are also collected from stream locations.

Chemical, physical, and biological properties of the park's surface water vary considerably with season, location, elevation, geology, and proximity to thermal activity. Thermal areas affect water temperature, acidity, and dissolved chemicals. Dissolved ion concentrations in Yellowstone waters are relatively low, especially in the spring during high runoff. Distinct patterns of relative dissolved ion concentrations are observed in the Yellowstone and Madison River drainages. The most abundant ion in all watersheds is bicarbonate. The Lamar River drainage has higher concentrations of calcium ions than does the Yellowstone River main stem, which has higher concentrations of sulfate. In addition to bicarbonate ions, sodium and chloride are present in approximately equal proportions in the Madison River basin. Both phosphorus and nitrogen concentrations are generally very low in most park waters. Of the park's major rivers, the Madison River tends to have the highest nutrient concentrations.

Twelve plant species (26% of the species on the Yellowstone watch list) are considered aggressive aquatic invaders; all have been designated state noxious weeds. Surveys of much of the park adjacent to the Grand Loop Road in 2008 and 2009 did not find any nonnative aquatic plants (Barre and Eric Hellquist, pers. comm.), but these species have the ability to reproduce rapidly, forming dense populations resulting in depleted dissolved oxygen levels and causing sediment to accumulate. If these species were found within the park they could cause massive fish die-offs or change recreational opportunities.

Vegetation including Rare Plant Species

Yellowstone National Park contains diverse vegetation as a result of the extreme topographic relief, differing soils, varied slope and aspect, and range of microclimates (Despain 1990). Yellowstone's vegetation is generally typical of the Rocky Mountains, except for the extensive areas that are geothermally influenced. The northern part of the park, which is in the rainshadow of the Gallatin Range, receives the least amount of precipitation.

The five major vegetation types in the park are montane forests, sagebrush-steppe, alpine, wetlands/riparian, and hydrothermal communities.

- **Montane Forests.** Approximately 80% of the park is covered by forests, most of which are dominated by lodgepole pine (*Pinus contorta*) in a variety of successional stages at elevations between 7,000 and 9,000 feet (NPS, 2011a), where they have adapted to fire-prone terrain. The lodgepole pine's serotinous cones require fire to provide the temperature of 113 to 140 degrees needed in the tree's crown to melt the resin bond that seals in their seeds (Utah State University, 2002). While some trees in Yellowstone are several hundred years old and show fire scars from a succession of low intensity ground fires, lodgepole and whitebark pine trees have very thin bark and can be killed by ground fires (NPS, 2010b).

  In the absence of fire or in rich and moist soils, subalpine fir (*Abies lasiocarpa*) and Englemann spruce (*Picea engelmannii*) replace lodgepole pine as the dominant species in the canopy (NPS 2011a). At elevations of 6,000 to 7,000 feet, Douglas-fir (*Pseudostuga menziesii*) and aspen (*Populus tremuloides*) (NPS, 2002) are common. At elevations above 8,400 feet, whitebark pine (*Pinus albicaulis*) becomes a significant component of the forest.

  The vegetation composition in the understory depends on precipitation regime, forest type, and substrate. In lodgepole pine forests, the understory is typically very sparse and composed mostly of elk sedge (*Carex geyeri*) or grouse whortleberry (*Vaccinium scoparium*). Pinegrass (*Calamagrostis rubescens)* is frequently found in Douglas-fir forests. In other areas of the park, the understory vegetation is composed of species such as Utah honeysuckle

(*Lonicera utahensis*), snowberry (*Symphoricarpos* spp.), and buffaloberry (*Shepherdia canadensis*) (NPS, 2011a).

Montane forests seem to be at less risk of invasion by nonnative species than some of the park's other vegetation types. However, they have been invaded by Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), and old-man-in-the-spring (*Senecio vulgaris*) following wildfire, and Canada thistle, bull thistle, musk thistle, and houndstongue (*Cynoglossum officinale*) have become significant components of the understory vegetation in some places in the northern part of the park.

- **Sagebrush-Steppe**. Sagebrush-steppe vegetation is found primarily in the park's lower elevations on the northern range. It is dominated by big sagebrush (*Artemisia* spp.) and other shrubs. It provides crucial winter range habitat for ungulates and is essential for species such as Brewer's sparrow, sage thrasher, vesper sparrow, and sagebrush lizard—which are limited to sagebrush habitats year-round or during the breeding season. In winter, the evergreen foliage of sagebrush provides forage that has a higher protein level and greater digestibility than that of other shrubs and grasses. Pronghorn rely heavily on sagebrush during the winter. Sagebrush comprises a large portion of mule deer and elk diets, and provides cover for fawns and other animals.

  Idaho fescue (*Festuca idahoensis*), needle-and-thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda*), and bearded wheatgrass (*Elymus caninus*) are common, either mixed with the sagebrush or as open meadows. Numerous wildflowers and forbs can be found throughout (Despain, 1990; NPS, 2011a). These sagebrush-steppe communities contain a significant amount of nonnative annuals (cheatgrass, alyssum), as well as Dalmatian toadflax (*Linaria dalmatica*), spotted knapweed (*Centaurea stoebe*), and smooth brome (*Bromus inermis*).

- **Alpine.** This diverse group of high-elevation open areas includes alpine tundra above 10,000 feet. Some are dominated by a thick turf of alpine grasses and forbs while others are dry and rocky. Common species include sheep fescue (*Festuca spp.*), timberline bluegrass (*Poa glauca*), and lanceleaf stonecrop (*Sedum lanceolatum*). The park's alpine areas receive little human presence and have experienced the least amount of invasion from nonnative species of the park's vegetation types. The use of Bear Management Area Closures in the Gallatin Mountain Range and the Trident areas have helped protect many alpine vegetation communities from off-trail visitor use. However, timothy has been reported above 9,000 feet and nonnative dandelions as high as 9,800 feet, and it seems likely that invasive species with more serious ecological consequences will follow.

- **Wetlands and Riparian Areas,** Wetlands cover 357 square miles of Yellowstone and include lakes, rivers, ponds, streams, seeps, marshes, fens, wet meadow, forested wetlands, and hydrothermal pools. Wetlands and riparian areas in Yellowstone provide essential habitat for rare plant species as well as reptiles, amphibians, and numerous insects, birds, mammals and fish in the park. Approximately 38% of the park's plant species are associated with wetlands, and 11% grow only in wetlands (NPS 2011a).

- **Hydrothermal Communities.** Plant communities have developed in the expanses of thermally heated ground. Many of the species found in the geyser basins tolerate tremendously different conditions, and grow all over the western United States while others are typical of the central Rockies and a few are endemic to the region (NPS, 2011a). Geothermal areas, especially those with neutral acid systems, are fertile ground for invasions by nonnative species due to the extreme conditions (often high or low pH, little soil development, and high temperatures due to the thermal influence and lack of shade),

disturbance, and large amounts of unoccupied ground. Heavily visited thermal areas were likely the first places in the park to experience large scale invasions by annual weeds such as cheatgrass and pale alyssum.

Rare Plants

Yellowstone's 97 special-status taxa (vascular plant species, subspecies, and varieties) reflect the park's complex geologic substrate, thermal influence, diverse topography, and wide elevation range found in the park. They include species on state heritage lists and sensitive plant species designated by park staff. The three special-status species and one variety listed below, which include the three taxa endemic to the park, exist or have the potential to exist in the project area for this EA. No federally listed threatened or endangered plants have been documented in Yellowstone National Park. In June 2011, the USFWS determined that the whitebark pine warrants protection under the ESA but adding the species to the federal list was precluded by the need to address higher priority listing actions. This species is currently a candidate species eligible for ESA protection and its status will be reviewed annually. The Yellowstone sand verbena and Ross's bentgrass did not warrant protection because National Park Service regulatory mechanisms are adequate to protect these species.

- **Whitebark Pine** (*Pinus albicaulis*). Whitebark pine exist as both overstory and understory within many forest communities in the park (NPS 2010c). It is a major component of the forest community in areas above 8,400 feet and a major understory component of lodgepole-dominated forests from 7,000 to 8,400 feet. Whitebark pine exist as both an overstory and understory component within the forest communities in many regions of the park (NPS 2010c).Seeds of the whitebark pine are important food for grizzly bears and a variety of other wildlife species (NPS 2010c). Whitebark pine populations in Yellowstone have been declining due to native mountain pine beetles (*Dendroctonus ponderosae*) and white pine blister rust, which is caused by a nonnative fungus, *Cronartium ribicola.* This decline may be exacerbated by past and current fire management practices and potential climate change scenarios (Schwandt 2006). This species is currently a candidate species eligible for ESA protection.
- **Yellowstone Sand Verbena** (*Abronia ammophila*). The shore of Yellowstone Lake is the only place in the world where Yellowstone sand verbena grows (NPS 2010a), placing the species at risk of extinction due to the possibility of random events affecting the population. The presence of a sand verbena at 7,700 feet elevation in the northern Rockies is unexpected, as most members of this North American genus occur in the Southwest or along the Pacific Coast. Warmth provided by the geothermal activity in the area may help this species tolerate the long, cold winters followed by a brief summer in which they bloom and reproduce.
- **Yellowstone Sulfur Wild Buckwhea**t (*Eriogonum umbellatum* var. *cladophorum*). Yellowstone sulfur wild buckwheat occurs only from the vicinity of Madison Junction through the Lower and Midway geyser basins to the Upper Geyser Basin (NPS 2010a). This conspicuous wildflower blooms from late June to August. It is primarily present on glacial till deposits with some geothermal influence, such as the sagebrush-steppe community near the Old Faithful interchange. Yellowstone sulfur wild buckwheat has demonstrated its ability to recolonize after construction disturbance by its presence on the road prism around the interchange

- **Ross's Bentgrass** (*Agrostis rossiae*). Ross's bentgrass occurs only on geothermally influenced warm sites in the Lower, Midway, Upper, and Shoshone geyser basins. It is not known whether the plant populations now present in the thermal basins invaded unvegetated areas or areas previously occupied by Ross's bentgrass, but both situations are suspected to have occurred. Nonnative annual species that have invaded the thermal basins pose a significant risk to Ross's bentgrass because it is an annual with limited habitat.

Invasive Plant Species

Invasive species are increasingly considered to be important drivers of ecological change (Mack et al. 2000). The introduction of invasive species is rapidly altering relationships among plants, animals, soil, and water that have taken thousands of years to form. Invasive species have been shown to displace native organisms (Tilman 1999), damage populations of rare species (King 1985), degrade ecosystem structures, alter nutrient cycling and soil chemistry (Vitousek and Walker 1989; Ehrenfeld 2003), and change water availability for native plants and animals (D'Antonio and Mahall 1991).

A total of 220 nonnative plant taxa have been documented in Yellowstone National Park (see Appendix 2). Some low-elevation areas are dominated by them, and while vast expanses of the park's highest elevations remain free of nonnative plants, they are highly vulnerable to plant invasions.

Nonnative plant invasions occur in three phases: introduction, colonization, and naturalization (Groves 1986; Cousens and Mortimer 1995). Nonnative plants can be introduced intentionally or through accidental means. Intentional introductions occur when plants are brought in for ornamental or other economic reasons and spread beyond their initial location. The colonization phase of invasion is characterized by exponential population growth.

Soil degradation and other ecological disturbances can promote the introduction and establishment of invasive plants. In Yellowstone, sites such as campgrounds, backcountry stock sites, staging areas, road corridors, recent construction sites, and riparian corridors are particularly vulnerable to new infestations. Disturbances due to foot and vehicular traffic off of paved roads can also create suitable habitat for invasive species (Hobbs and Huenneke 1992; D'Antonio et al. 1999). The environmental changes that promote plant invasion range in scale and intensity—from localized disturbances (e.g., foot traffic along a trail) to large-scale impacts such as climate change. Natural disturbances such as floods or herbivory by native animals can also facilitate the establishment and spread of invasive species.

The National Park Service's efforts to control invasive plants began with the Dalmatian toadflax crew in 1969. More recently, a minimum of and expanded to treat at least 38 nonnative species in 2011, with a quarter of the treated acreage infested by spotted knapweed.

Fish and Wildlife Species

Yellowstone contains at least 300 species of birds, 67 species of mammals, 4 species of amphibians, 6 species of reptiles, and 12 species of native fish. The park may also contain thousands of species of invertebrates but little work done to establish a baseline for what is present. The distribution, abundance, and diversity of species within the park vary by season, elevation, and variety of habitats present.

The park is home to the largest concentration of mammals in the lower 48 states (NPS 2011b). Yellowstone mammals include the grizzly bear (*Ursus arctos horribilis*), black bear (*Ursus americanus*), grey wolf (*Canis lupis*), coyote (*Canis latrans*), fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), pine marten (*Martes americana*), striped skunk (*Mephitis mephitis*), mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), moose (*Odocoieus hemionus*), white-tailed deer (*Odocoileus virginianus*), bison (*Bison bison*), elk (*Cervus canadensis*), beaver (*Castor canadensis*), river otter (*Lontra canadensis*), deer mouse (*Peromyscus maniculatus*), red squirrel (*Sciurus vulgaris*), meadow voles (*Microtus pennsylvanicus*), porcupine (*Erethizon dorsatum*), and the snowshoe hare (*Lepus americanus*). Eight species of bats may be present in the park including the little brown bat (*Myotis lucifugus*), the big brown bat (*Eptesicus fuscus*), and the silver-haired bat (*Lasionycteris noctivagans*) (NPS 2011c).

Of the 330 bird species that have been documented in Yellowstone, approximately 148 are known to nest in the park (NPS 2011d). While some of these species reside in the park year-round, most migrate to lower elevations and more southern latitudes during the winter seasons, and others migrate to the park for the winter from further north (NPS 2010f). Raptors in the park include the bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos*), and the Swainson's hawk (*Buteo swainsoni*) (NPS 2011d). A wide variety of other birds inhabit the park in the summer, including species of waterfowl, grebes and loons, pelicans, cormorants, cranes, rails, coots, herons, egrets, bitterns, grouse, swifts, hummingbirds, kingfishers, doves, pigeons, owls, shorebirds, gulls, terns, woodpeckers, and songbirds such as chickadees, warblers, sparrows and finches (NPS 2011d).

The cool, dry conditions of Yellowstone limit the number of amphibians and reptiles found in the park. There are four known amphibian species of unknown population size: boreal toad (*Anaxyrus boreas boreas*), chorus frog (*Pseudacris maculata*), spotted frog (*Rana luteiventris*), and tiger salamander (*Ambystoma tigrinum*) (NPS 2011e). Documented reptiles in Yellowstone include the prairie rattlesnake (*Cortalis viridis viridis*), bull snake (*Pituophis catenifer sayi*), valley garter snake (*Thamnophis sirtalis fitchi*), wandering garter snake (*Thamnophis elegans vagrans*), rubber boa (*Charina bottae*), and the sagebrush lizard (*Sceloporus graciosus graciosus*) (NPS 2011f).

The fish species native to the park are the mountain whitefish (*Prosopium williamsoni*), longnose dace (*Rhinichthys cataractae*), speckled dace (*Rhinichthys osculus*), redside shiner (*Richardsonius balteatus hydrophlox*), Utah chub (*Gila atraria*), mottled sculpins (*Cottus bairdi*), longnose sucker (*Catostomus catostomus griseus*), mountain sucker (*Catostomus platyrhynchus*), Utah sucker (*Catostomus ardens*), Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), Arctic grayling (*Thymallus arcticus*) (NPS 2010d). These species provide food for both wildlife and human inhabitants. Although the park's native fish populations have declined during the past century due to exploitation, introduction of nonnative and exotic species, and natural factors, large-scale habitat degradation has not occurred in the park (NPS 2008, NPS 2010d).

Yellowstone fish management goals include a reduction in the long-term extinction risks for fluvial Arctic grayling, westslope cutthroat trout, and Yellowstone cutthroat trout. Numerous stressors threaten these fish: drought, whirling disease, stocking of nonnative fish, habitat degradation and fragmentation from land use activities.

Four of the five nonnative fish species that are well established in the park are native to North America: eastern brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), lake trout (*Salvelinus namaycush*), and lake chub (*Couesius plumbeus*). The fifth species, brown trout

(*Salmo trutta*), is native to Europe (NPS 2010d). Eurasian milfoil (*Myriophyllum spicatum*), an aggressive aquatic species on Yellowstone's watch list, reduces spawning success by covering spawning gravels (Newroth 1985).

For wildlife populations to be viable, resources and environmental conditions must be sufficient for animals to forage, hide, nest or den, and disperse. The distribution, type, and amounts of territory, shelter, water, and food must be sufficient for the basic needs of self-sustaining wildlife populations on a daily, seasonal, annual, and multi-year basis. Habitat must be distributed over a broad geographic area to allow breeding individuals to interact spatially and temporally within and among populations. The ecology of native habitats, and, therefore, the assortment of wildlife species they support, can be altered if nonnative plants become established and displace native plants. Nonnative plants can change the habitat qualities needed to support the park's wildlife species. Such changes are most prevalent at lower elevations of the park, where the majority of nonnative plant species are found. These effects include alterations in vegetation type and structure, reductions in natural food and cover plant species, and changes in natural fire regime.

In rare situations, certain wildlife species may benefit from the presence of nonnative plant species. Canada geese likely benefit from the early green up of Kentucky bluegrass, and ungulates take advantage of the timothy that has spread from the old hayfields in the park. Nonnative clover, dandelions, and timothy may have become important sources of food for grizzly bears, but they provide little net digested energy compared to trout and pine seeds (Reinhart et al. 2001) and they alter the bear's natural ecology. The greatest concentrations of clover occur along the road corridor, where its presence can increase conflicts between bears and humans. Some nonnative plants may be beneficial to individual animals, but they cause perturbations in the relationship between wildlife and its habitats. In a national park, where the mission is to protect and restore natural ecosystems, such effects are not acceptable.

Threatened, Endangered, and Special Status Wildlife

Threatened Species

Yellowstone National Park has no species on the federal list of endangered wildlife, but two species are listed as threatened under the Endangered Species Act (ESA).

- **Grizzly Bear** (*Ursus arctos horribil*is). The estimated grizzly bear population in the GYA has increased from 136 in 1975, when it was listed as a threatened species, to 593 in 2011 (NPS 2011g). Grizzly bears now occupy areas they have been absent from for decades and are expanding into areas outside of the recovery zone. A determination by the USFWS in 2007 that the GYA grizzly bear population had met all the population criteria for delisting was overturned by a federal district court, placing the grizzly bear back on the threatened species list partly because the judge found that the USFWS had not adequately considered the impacts of the potential loss of whitebark pine nuts, a grizzly bear food source. The decision was appealed by the USFWS but upheld by the Ninth Circuit Court on November 22, 2011.
- **Canada Lynx** (*Lynx canadensis*)**.** The USFWS listed the Canada lynx as a threatened species in 2000. The species is considered rare in the GYA, where its primary habitat is believed to be boreal or montane forests. Lynx prefer upper elevation coniferous forests in cool, moist vegetation types, particularly those that support abundant snowshoe hares, the primary food source for lynx. Evidence of lynx in the park comes from about 216 tracking surveys conducted during winters of 2001-2004; 118 hair-snare transects deployed parkwide

during the summers of 2001-2004; and historical sightings. Surveys have documented one possible, two probable, and two definite cases of lynx presence, including a female accompanied by a kitten. Only four lynx sightings in the park have been reported by visitors in the last 10 years. The best evidence of lynx presence is along the east shore of Yellowstone Lake.

- **Canada Lynx Critical Habitat.** The USFWS designated critical habitat for lynx in 2009. Within Yellowstone National Park, this habitat is congruent with all Lynx Analysis Units except in Bechler in the southwest corner of the park. The primary elements of habitat essential to the recovery and survival of lynx are: (1) boreal forest landscapes supporting a mosaic of differing successional forest stages with snowshoe hares and their preferred habit, (2) appropriate snow conditions, (3) denning sites, and (4) matrix habitat (e.g., hardwoods, dry forest, non-forest) providing connectivity between denning and foraging sites (50 CFR Part 17 [FWS-R6-ES-2008_0026]).

Proposed for Listing and Special Status Species

These species exist or have the potential to exist in the project area and are either species removed from listing or listed by the USFWS as proposed threatened or candidate species or by Yellowstone National Park as Species of Management Concern.

- **Wolverine** (*Gulo gulo*). The wolverine is a wide-ranging mustelid that naturally exists at low densities throughout much of northern and western North America (Beauvais and Johnson, 2004). Wolverines are highly adapted to life in extremely cold environments that have snow on the ground all or most of the year (Aubry et al.2007). In the contiguous United States, these habitats are highly mountainous and occur at elevations above 8,000 feet (Copeland et al. 2007). Overexploitation through hunting, trapping, and predator poisoning programs have likely caused wolverine populations to contract along the southern portion of their historical range in North America since the early 1900s (Banci 1994). However, recent surveys indicate wolverines are widely distributed in remote, montane regions of Idaho, Montana, Washington, and parts of Wyoming (68 FR 60113). They have been documented in Yellowstone and elsewhere in the GYA (Beauvais and Johnson, 2004; Copeland et al.2007). On February 4th, 2013, the USFWS proposed the wolverine be listed as threatened, moving it from candidate species category in the contiguous United States, with pending designation as threatened anticipated in late 2013. It has protected status under state regulation in Washington, Oregon, California, Colorado, Idaho, and Wyoming (Banci 1994); in Montana trapper harvests are managed through a quota system, but with recent proposed listing trapping may be eliminated in 2013.
- **Gray Wolf** (*Canis lupus*). Hunted for their hides and as predators, wolves were eliminated from the GYA by the 1930s. The USFWS released an environmental impact statement on wolf reintroduction in May 1994. In 1995 and 1996, a total of 31 gray wolves from Canada were released in the park (Phillips and Smith 1996). At the end of 2012, at least 80 wolves (9 packs) occupied territories that were located entirely or primarily within the park (NPS 2011b); the GYA population was approximately 500. At least one member of most packs is radio-collared, allowing NPS and USFWS personnel to monitor their movements. The USFWS delisted gray wolves in most of the Northern Rocky Mountain Distinct Population Segment in 2011; the species was removed from the list of threatened wildlife in 2012.
- **Boreal toad** *(Bufo boreas***).** The boreal toad typically breeds in park areas with water chemistry characteristics that include a pH greater than 8.0, high conductivity, and high acid-neutralization capacity; many of the sites have a geothermal influence (Koch and

Peterson 1995). Boreal toad breeding areas are common in the Lower Geyser Basin and have been documented in the Swan Lake Flats area. Boreal toads can also be found in riparian and riverine areas where they feed if adequate cover is available. Although declining throughout much of their range, boreal toads remain widespread in park.

- **Bald eagle** (*Haliaeetus leucocephalus*). The USFWS removed the bald eagle from the list of endangered and threatened wildlife on August 8, 2007. Nesting and fledgling bald eagles in Yellowstone increased incrementally from 1987 to 2005 (McEneaney 2006). Resident and migrating bald eagles are now found throughout the park, with nesting sites located primarily along the margins of lakes and shorelines of larger rivers. The bald eagle management plan for the Greater Yellowstone Ecosystem achieved the goals set for establishing a stable bald eagle population in the park.
- **American peregrine falcon** (*Falco peregrines anatum*). The American peregrine falcon was removed from the list of endangered and threatened wildlife on August 25, 1999, the population having recovered after the use of organochlorine pesticides was restricted in the United States and Canada, and the implementation of various management actions, including the release of approximately 6,000 captive-reared falcons. The USFWS has implemented a post-delisting plan pursuant to the Endangered Species Act that requires monitoring peregrine falcons at three-year intervals that will end in 2015. Monitoring estimates from 2003 indicate territory occupancy, nest success, and productivity were above target values set in the monitoring plan and that the peregrine falcon population is secure and viable (71 FR 60563). Peregrine falcons reside in Yellowstone from April through October, nesting on large cliffs. Their population in the park has increased from zero in 1983 to between 30 and 35 nesting pairs that produce from 21 to 50 fledglings per year (Baril pers. comm.).
- **Trumpeter swan** (*Cygnus buccinators*). Trumpeter swans were nearly extinct by 1900, but a small group survived by remaining year round in the GYA, and by 2010 the North American population had grown to approximately 46,000 (USFWS 2010). Yellowstone supports resident, non-migratory trumpeter swans through the year, and its areas of ice-free water that diminish as winter progresses provide limited, temporary habitat for migrants from the region, Canada, and elsewhere during the winter. The NPS is committed to the conservation of resident trumpeter swans and preserving habitat for winter migrants in Yellowstone because swans are part of the natural biota and a species with considerable historical significance. However, counts of resident, adult trumpeter swans in the park decreased from a high of 69 in 1961 to 9 in 2011. Causes of this decline are unknown, but may include decreased immigration, competition with migrants, and the effects of sustained drought, human disturbance, and predation on productivity (McEneaney 2006). The trumpeter swan population operates at a scale larger than Yellowstone, and the dynamics of resident swans in Yellowstone appear to be influenced by larger sub-populations and management actions in the GYA and elsewhere.
- **American white pelican** (*Pelecanus erythrorhynchos*). Pelican control in the 1920s followed by human disturbances in the 1940s and 1950s kept the population at low levels. Since then, pelican numbers have increased but the American white pelican was identified as a species of management concern in Yellowstone after nesting attempts decreased from more than 400 during the mid-1990s to 128 in 1999.Yellowstone has the only nesting colony in the National Park System (McEneaney 2006). The number of nest attempts and fledged juveniles fluctuates greatly from year to year. Lower numbers than normal could be the result of nest inundation by above average June rains, or the declining Yellowstone cutthroat trout population may be partially responsible for reduced fledging and nest

success. In 2011, 684 nest attempts yielded no fledglings because of record-setting water levels in Yellowstone Lake (Smith et al. 2012).

- **Yellowstone cutthroat trout** (*Oncorhynchus clarkii bouvieri*). A range-wide status review estimated that the conservation population (>90% genetic purity) of Yellowstone cutthroat trout occupies over 6,300 km within its native range in Idaho, Montana, Nevada, Utah, and Wyoming. In Yellowstone Lake, which is home to the largest population of Yellowstone cutthroat trout in existence (Varley and Schullery, 1998) lake trout introduction, drought, and whirling disease have severely diminished the ecological role of this fish which is an important food source for many animal species in the park.
- **Westslope cutthroat trout** (*Oncorhynchus clarkii lewisi*). Numerous stressors, including stocking of nonnative fish and habitat degradation and fragmentation from land use activities, have reduced the distribution and abundance of westslope cutthroat trout. The subspecies currently occupies only 19–27% of its historical range in Montana, about 36% in Idaho, and 5% in the upper Missouri River drainage. Even some of the historically most secure populations in Glacier National Park and the Flathead Basin of Montana are in serious decline. The remaining population persists as small-stream residents in isolated habitats ranging from a few to several hundred meters in extent where they face a high risk of extinction. In Yellowstone, westslope cutthroat trout are present in approximately three km of a small tributary to Grayling Creek, as a restored population in East Fork Specimen Creek, and as a population stocked in Geode Creek in the 1920s.
- **Arctic grayling** (*Thymallus arcticus*). Arctic grayling are listed as a Species of Special Management Concern by the NPS and the USFWS. Fluvial (stream-dwelling) grayling were once widespread in the Missouri River drainage, but wild grayling persist only in the Big Hole River, which is about 4% of their native range in Montana. In Yellowstone, fluvial grayling historically occupied waters of the Madison and Gallatin River drainages. Introduced populations of adfluvial (lake-dwelling) grayling exist in Wolf and Grebe lakes, which form the headwaters to the Gibbon River. A 2005–2006 study indicated the small number of grayling in the Gibbon and Madison rivers are likely emigrants from Wolf and Grebe lakes and the native fluvial grayling population has most likely been extirpated from the park.
- **North American pronghorn** (*Antilocapra americana*). Yellowstone's pronghorn population, one of the few that was not eliminated or substantially reduced by early in the 20th century, was the source for re-establishing or supplementing populations throughout much of its range (Lee et al.1994). This population contains much of the genetic variation that was formerly widespread in the species, but is no longer present elsewhere (Reat et al.1999) and sustains one of only two long-distance pronghorn migrations that persist in the GYA (White et al. 2007). Its viability cause for serious concerns because low abundance (~200) and isolation have increased its susceptibility to random, naturally occurring catastrophes (NPS, 2011c; National Resource Council, 2002).
- **Bison** (*Bison bison*)**.** For the plains bison, which was nearly extirpated in the early 20th century, the park provides sanctuary to the only wild and free-ranging bison population to continuously occupy its historical range. Intensive husbandry, protection, and relocation were used to bring back the herd, and about 3,700 bison were in the park in the summer of 2011. Bison tend to be observed in open grassland or shrub steppe habitats but use many travel corridors along rivers and over high elevation passes that provide connections to all of the park's major watersheds. Depending on conditions in the park, a varying number of bison migrate north to the Gardiner Basin during the winter and cross the park

boundary. The Yellowstone bison population has high genetic diversity compared to other populations of plains bison, and is one of the few bison that does not contain evidence of interbreeding with cattle. The USFWS has turned down two petitions in the last 15 years to list the bison in Yellowstone as an endangered species.

Archeological Resources

The National Historic Preservation Act, as amended in 1992 (16 USC 470 et seq.), the National Environmental Policy Act, and the NPS Director's Order 28 (Cultural Resource Management Guideline; NPS 1997), NPS Management Policies (NPS 2006), and Director's Order 12 (Conservation Planning, Environmental Impact Analysis and Decision-making; NPS 2001), require the consideration of impacts on cultural resources listed in or eligible for listing in the National Register of Historic Places. The activities proposed in this document are subject to Section 106 of the National Historic Preservation Act, under the terms of the 1995 Servicewide Programmatic Agreement among the NPS, the Advisory Council, and the National Conference of State Historic Preservation Officers. This document will be submitted to the Wyoming SHPO and the Advisory Council for review and comment.

Archeological resources are the material remains of past human activity and the evidence of those activities on the environment. They are the basis for research and understanding of past lifeways, and have been documented in Yellowstone since the early 1960s. Archeological sites in the park provide information about the ancestors of modern Native American tribes that have been living in the GYA for at least 11,000 years. Most of these sites are prehistoric and consist primarily of lithic debris from stone tool production; more recent sites are often associated with military or government management of the park. Obsidian Cliff, one of the most significant obsidian sources in the North America, is an archeological National Historic Landmark.

Several hundred archeological inventories and investigations have been completed in the park, generally to satisfy requirements of Section 106 and 110 of the National Historic Preservation Act. Most of the inventories have been conducted within or adjacent to developed areas or other park infrastructure such as trails, power lines and roads. In the Old Faithful, Lake, Bridge Bay, Fishing Bridge, Tower/Roosevelt, and Mammoth areas, 100% of the archeological inventory has been completed. For other developed areas and infrastructure the amount of completed archeological inventory varies widely. The entire shoreline of the Yellowstone Lake has been inventoried as has the general path of the Nez Perce National Historic Trail, which passes from west to east across the center of the park. With approximately 3% of the park inventoried, about 2,000 archeological sites have been documented, of which about two-thirds have been evaluated for eligibility for the National Register. Most archeological sites in the park are sensitive to ground-disturbing activities. Given that most invasive plants in Yellowstone are associated with disturbed areas, it is likely that invasive plant management will affect archeological resources.

Cultural Landscapes

The National Historic Preservation Act, as amended in 1992 (16 USC 470 et seq.), the National Environmental Policy Act, and the NPS Director's Order 28 (Cultural Resource Management Guideline; NPS 1997), NPS Management Policies (NPS 2006), and Director's Order 12 (Conservation Planning, Environmental Impact Analysis and Decision-making; NPS 2001), require the consideration of impacts on cultural resources listed in or eligible for listing in the National Register of Historic Places. The activities proposed in this document are subject to Section 106 of the

National Historic Preservation Act, under the terms of the 1995 Servicewide Programmatic Agreement among the NPS, the Advisory Council, and the National Conference of State Historic Preservation Officers. This document will be submitted to the Wyoming SHPO and the Advisory Council for review and comment.

A cultural landscape is "a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values." Cultural landscapes provide a living record of an area's past and a visual chronicle of its history. The character-defining features and patterns of a cultural landscape may include natural systems and features, spatial organization, topography and landforms, vegetation, circulation systems and features, land use, buildings and structures, building cluster arrangement, water features, small scale features, and views and vistas.

Starting in 1998, the NPS initiated a process that identified 41 potential areas in Yellowstone National Park where cultural landscapes may exist. A cultural landscape inventory, which identifies and documents the characteristics of a cultural landscape that make it significant and worthy of preservation, has been completed for Artist Point, Apollinaris Springs, and Historic Game Ranch at Stephens Creek, and Old Faithful, all of which have been determined eligible for listing in the National Register. Some invasive vegetation management activities may occur within historic districts or may affect cultural landscapes within the park. A cultural landscape report is in preparation for the Mammoth Hot Springs developed area.

Health and Human Safety

YNP managers seek to provide a safe and healthful environment for visitors and employees. YNP provides visitors with safety bulletins, press releases, and up-to-date information about management actions and potential risks. Standard Operating Procedures and job hazard analyses guide daily operations in an effort to provide the safest possible environment for park employees. Park managers from each division prepare a comprehensive safety plan that is reviewed by the park's Safety Office. Some plant management techniques have the potential to harm humans. Injuries can occur when using a tool whether it is a shovel, saw, fire, or herbicide. Visitors and park employees are more likely to be harmed if plant management is occurring in areas frequented by the public. For this reason, job hazard analyses are developed for activities such as using herbicide. The purpose of these analyses is to describe the correct technique, prevent injuries, and mitigate problems that may occur while performing the technique. These are reviewed every year for thoroughness and are required reading for any volunteer or staff participating in the activity.

Visitor Use and Experience

Visitation to Yellowstone National Park has grown by more than 14% in the last 15 years, from 3.1 million in 1995 to 3.6 million in 2010 (NPS 2010e). Approximately 64% of park visitation occurs during June, July, and August, although the spring and fall have grown in popularity. Visitors flock to see Yellowstone's geologic and thermal features, scenery, wildlife, remote wilderness, and rivers, and to engage in a variety of outdoor recreation opportunities. Their primary activities are viewing wildlife, photography, walking, and exploring; they also go fishing, camping, hiking, horseback riding, and boating. Most visitors spend most of their time in the park's major developed areas and along the roads. During the peak season, the park's numerous frontcountry geothermal and scenic walking trails, campgrounds, lodges, and other facilities are used at or beyond capacity. Heavy visitation and related recreational activities can damage native vegetation and promote the spread

of nonnative species in popular campsites, fishing sites, and viewing places, or by creating social trails and shortcuts to those areas.

Nonnative species have the potential to affect visitors by altering the character of scenic landscapes and limiting the visibility of scenic views. Yellow sweetclover (*Melilotus officinalis*) and Dalmatian toadflax have spread throughout much of the northern tier of the park. Other nonnative species that are at high risk of impacting visitors' experience due to their rates of spread and their persistence are spotted knapweed, alyssum, and cheatgrass.

More than 90% of the park is considered backcountry. Managed as wilderness, the park is largely undeveloped except for the 1,100 miles of trails, a network of 287 designated campsites, and 41 ranger patrol cabins and lookouts. Although only 9% of visitors take a backcountry trail and only 1% use backcountry campsites (NPS 2000), this represents approximately 306,000 visitors a year that could inadvertently transport the seeds of nonnative plant species. In some places, Canada thistle has grown so dense it impedes off-trail travel in the frontcountry and the backcountry. Nonnative evergreen blackberry, which can easily reach over five feet in height and has been found in one location in the park, poses an even greater threat than Canada thistle for making off-trail travel cumbersome.

No nonnative aquatic plant species have been found in the park, but Yellowstone is known for its many easily accessible blue-ribbon fishing opportunities and nonnative aquatic plants could diminish the quality of the angling experience as fish and equipment become tangled with certain plants.

Park visitors may also find their experience marred by seeing nonnative plant surveys and treatment, UTVs and other mechanized equipment in developed areas, blue marker dye on the ground, crew members in white full-body (Tyvek) suits, the use of brush cutters, or dead vegetation from the use of herbicides on target species. Campground loops and other areas may occasionally be closed for brief periods.

Park Operations

Park Operations consist of NPS, concessioner, and contractor operations that are responsible for protecting the park's natural resources; maintaining all roads, trails, buildings and other structures in a safe, functional, and aesthetically pleasing condition; and for providing dining, shopping and lodging opportunities to park visitors. The park superintendent is responsible for the overall management, operation, and safety operations of the park.

The National Park Service in Yellowstone is organized into six divisions, each with a functional area of responsibility and each with a role in invasive plant management.

- **The Yellowstone Center for Resources** (YCR) manages the invasive plant program and does most of the work related to invasive plant control. The YCR facilitated the environmental assessment and compliance requirements for this Invasive Vegetation Management Plan.
- **The Division of Facilities Maintenance** maintains the park infrastructure, including routine road maintenance and winter sanding that can cause persistent ground disturbance and import of nonnative plant seeds. Improvements to and repairs of buildings, roads, and bridges, and other construction projects can cause ground disturbances that promote the establishment of invasive plant populations. Facilities Maintenance employees are stationed

throughout the park, including recommended wilderness areas, and can be an asset in the early detection of invasive plant populations and in preventing their spread.

- **The Division of Concessions Management** oversees all park construction projects pertaining to facilities used by concessioners, many of which are completed by private contractors. They also administer concessioner contracts, Commercial Use Authorizations, and Special Use Permits. Concessions Management employees are responsible for making sure that contractors are in compliance with park policies that reduce the risk of spread of nonnative plants.
- **The Division of Resource and Visitor Protection** oversees law enforcement, entrance stations, fire management, the communications center, and wilderness management. Hay brought into the park for use by NPS horses is a potential source of nonnative plants in the park, and workers at entrance stations inspect hay brought in by visitors to make sure that it has weed-free certification. However, even certified forage may contain nonnative seeds for species such as timothy that are ecologically invasive but acceptable for agriculture. Each year, efforts to suppress wildland fires in order to protect life and property can involve large concentrations of fire personnel and equipment that create significant ground disturbance, and recently burned ground is highly susceptible to plant invasion. Many operational oversight functions of this division may be of assistance in implementing the Invasive Vegetation Management Plan.
- **The Division of Resource Education and Youth Programs** communicates a variety of park issues to the public. The public perception of park management policies, including those relevant to invasive plant management, is influenced by these employees, who also oversee the park's volunteer program.
- **The Division of Administration** performs fundamental services for the success of nonnative planning efforts, such as administering staff hiring, contracts, payroll, procurement, telecommunications, and computer support.

Environmental Consequences

This chapter analyzes the environmental consequences or impacts that could occur as a result of implementing each of the two alternatives. Impact topics have been selected for this analysis based on their potential to affect important resources and other key issues identified during planning. Because of the inherent uncertainty involved with adaptive management strategies, analyses in this section are qualitative assessments based on review of scientific literature and information collected by the NPS and provided by other agencies.

Potential impacts are described in terms of type (beneficial or adverse, direct or indirect), context (local or regional), duration (short-term or long-term, seasonal or continuous), and intensity (negligible, minor, moderate, or major).

- **Beneficial**—a positive change in the condition of the resource or a change that moves a resource toward its desired condition.
- **Adverse**—a negative change in the condition of the resource or a change that moves a resource away from its desired condition.
- **Direct**—an effect that is caused by and occurs at the same time and place as a vegetation control or restoration activity.
- **Indirect**—a reasonably foreseeable effect that is caused by vegetation control or restoration activity, but occurs later in time or farther removed in distance.
- **Site-specific impact**—an effect within relatively small areas in the park that are centered on where the vegetation control or restoration activity takes place.
- **Local impact**—an effect on areas within the park boundary.
- **Regional impact**—an effect on resources in the park, on lands adjacent to the park, and in surrounding communities.
- **Short-term**—an effect that would not be detectable within a short amount of time, generally within hours after the vegetation control or restoration activity has been carried out.
- **Long-term**—a change in a resource that will not return to its condition prior to the vegetation control or restoration activity for the foreseeable future.

Intensity threshold definitions using the above terms are provided for each impact topic below. These definitions explain the types of actions that could result in each level of impact (negligible, minor, moderate, and major). The potential impacts of each alternative are summarized in Table 4.

Cumulative Impacts

The Council on Environmental Quality, which is responsible for implementing the National Environmental Policy Act of 1969 (42 USC 4321 *et seq.*), requires the cumulative impacts to be assessed in the decision-making process for federal projects. A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). To determine the cumulative impacts of each alternative, it was necessary to identify other ongoing or reasonably foreseeable projects (within approximately 10 years) at Yellowstone National Park and, if relevant, the surrounding region.

- **Maintenance, Concessions** administrative activities (ongoing) that take place parkwide and could impact resources, including: placing riprap along road segments to prevent

erosion from adjacent streams, removing and replacing culverts, snow removal, and maintaining and reconstructing trails and boardwalks, and repairing and renovating buildings, facilities and campgrounds.

- **Visitor and Resource Management, Resource Protection and Monitoring** administrative activities (ongoing) such as: patrolling front- and backcountry areas using boats, livestock, and motor vehicles; research and monitoring of wildlife and plant populations; and eradication of invasive plants using chemical and manual methods.
- **Norris-Madison Road Reconstruction Project,** 2001-2010: A 16.3 km (10 miles) segment of the Grand Loop Road between Madison Junction and Norris Junction was widened to a 9.2 meter (30 feet) paved top including travel lanes and paved shoulders. The road segment between Gibbon Falls and Tanker Curve was realigned to follow an upland route above the canyon. Construction of a new bridge, removal of an existing bridge, and removal of 2.9 km (1.8 miles) of existing road along the Gibbon River was completed in 2010.
- **Canyon-Tower (Dunraven Road) Road Improvement Project,** 2003–2007 and future: The width of the 18.4 mile (29.3km) segment of the Grand Loop Road from Tower Junction to Canyon Junction, now19–22 feet, is to be increased to 24 feet, and the reconstruction will provide better drainage, more pullouts and parking areas, and slopes that can revegetate in the 2–3 month growing season. Design and construction have been planned to take place in two phases. The first phase, from Chittenden Road to Canyon Junction, began in 2003 and was completed in 2005. The second phase, from Tower Falls to Tower Junction, is scheduled to begin in 2012 and, depending —on funding, is intended to include the Tower Fall Campground road, the Tower Fall store parking, and the entrance road to Roosevelt Lodge.
- **Bridge Reconstruction/Replacement,** 2010 and future: Replacement of the Lamar River Bridge began in 2010. Plans to replace the Isa Lake Bridge are now underway.
- **Sylvan Pass Reclamation and Road Reconstruction,** 2010: This project involved reconstruction of a portion of the East Entrance Road through Sylvan Pass, and rehabilitation of an area that served as a source of gravel and rock for road reconstruction projects within the park for many years.
- **Norris-Golden Gate Road Reconstruction** (future): A portion of the Grand Loop Road between its intersection with Norris Campground and north to a point just north of Swan Lake Flats (Golden Gate) is to be reconstructed.
- **Lake Comprehensive Plan,** 2012: This plan will alter or improve visitor services, facilities buildings, roads, and paved parking areas, and utilities while protecting these developed areas by managing growth and development.
- **Old Faithful Comprehensive Plan** (future): This plan will alter or improve visitor services, facilities buildings, roads, and paved parking areas, and utilities while protecting these developed areas by managing growth and development.
- **Yellowstone Fire Management Plan**, 2004 and future: This plan allows fire to play its ecological role in the park while maintaining the safety of firefighters and the public, providing information to the public, and protecting property in developed areas. It includes the use of mechanical treatments, wildland fires, and suppression. A revision of the park's Fire Management Plan is planned for 2012.

- **Native Fish Conservation Plan**, 2010. This plan provides for restoration of Yellowstone cutthroat trout, westslope cutthroat trout, and fluvial Arctic grayling.
- **Climate Change**: While climate change was dismissed as an impact topic because the contribution of greenhouse gases from proposed actions would be minimal, climate change could contribute to the cumulative impact on resources. Temperatures in the Rocky Mountain region are generally expected to increase by approximately 1–2°C (2 – 4 °F) during the next 50 years with natural variation over years to decades. Precipitation is less well understood, but the dominant pattern in North America is generally expected to be a wetter climate in the northern tier and a drier climate in the southwestern United States. How these changes may contribute to resource impacts from the proposed actions when combined with other foreseeable future actions is impossible to quantify. What can be stated is that during the likely period of the vegetation control and revegetation activities proposed in these alternatives, climate change may contribute slightly (indirectly at the negligible to minor adverse level) but most likely not at a level that would, based on climate change alone, increase resource impacts. Climate change may make restoration efforts more difficult in the long term because changes in water level or temperature may be advantageous for nonnative organisms, but the proposed actions, if implemented quickly and aggressively, may mitigate some of these impacts by re-establishing stable native plant communities (Loeman and Anderson 2009, McWethy et al. 2010).

Soil Resources

Guiding Principles and Policies

Yellowstone's soil resources are important for their role in the ecosystem and their contribution to the plants of the park. The NPS has developed policies and guidance on soil resource management. Section 4.8 of the NPS Management Policies (2006), which addresses soils resource management, states that the NPS will maintain, preserve, and protect soil resources as integral components of the park's natural systems.

Methodology and Intensity Level Definitions

Analysis of the potential impacts on soil resources is based on the available information on the impacts of possible project activities. For details on herbicides used in the park and their effect on soils, see Appendix 7.

The impact intensities for soil resources are:

- **Negligible:** A change to a natural physical resource that would be so small that it would not be of any measurable or perceptible consequence. Soils would not be affected or the effects on these soil resources would not be detectable.
- **Minor:** A change to a natural physical resource, that would be small and localized and of little consequence. Effects on soil resources would be detectable, although these effects would be localized and short-term.
- **Moderate:** A change to a natural physical resource, that would be readily apparent and measurable, localized, and possibly long-term. Measurable effects could include physical disturbance, removal of large amounts of soil, compaction, or unnatural erosion. The appearance of soil resources would be modified or its physical properties compromised. Mitigation measures proposed to offset adverse effects would include measures to ensure

that topsoil is preserved, ground is reshaped into the natural contours, ground is de-compacted, and there is no unnatural erosion of soils.

- **Major:** A noticeable change to a physical resource that would be measurable and result in a severely adverse or major beneficial impact. Effects on soil resources would be readily apparent, measurable, severe, long-term, and occur on a regional scale. Entire soil features would be removed or the physical properties significantly altered severe compaction, and unnatural erosion. Mitigation measures proposed to offset adverse effects would be extensive and success would not be assured.

Alternative A(No Action): Impacts on Soil Resources

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Most invasive plant control would be localized and would entail spot removal or spraying specific individual plants and control of larger weed patches with backpack sprayers or UTVs with mounted boom sprayers. Limited UTV use would occur only on paved, previously disturbed and compacted non-wilderness areas such as the road prism and shoulders of existing roadways, park developed areas, powerline corridors, and areas undergoing restoration, such as sections of the Gardiner Basin. Under Alternative A, there would be no potential use of biological control agents. Revegetation would be limited to select areas associated with ground disturbing activities and would involve both top soil conservation and some direct native plant seeding. Existing invasive plant control efforts as described under Alternative A would have some effects on park soils resources as described below.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Existing invasive plant control efforts as described under Alternative A would affect the park's soil resources as described below.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances and some erosion due to wind and water from hand pulling or use of hand tools for individual plants. Foot access would occur away from roads, trails and boardwalks, and would cause negligible disturbance. Impacts to soils from mechanical treatments would be short-term, negligible, and adverse.

Chemical Treatments: Localized use of approved herbicides would leave some ingredients on the ground and could adversely affect soils. Some herbicides have the potential to persist in soils, which may lead to herbicide buildup in soils. Coarse to medium-textured soils are less likely to retain herbicides. Medium and fine-textured soils with higher organic matter content have a greater potential to retain herbicides. There is also a low potential for accidental spills of herbicides that may temporarily contaminate soils. Appendix 7 discusses more details regarding herbicide impacts.

Mitigation measures, such as requirements for staff to possess a certified applicators license, following herbicide label and MSDS instructions, and proper application techniques would reduce

potential impacts. Therefore, chemical treatments would result in soil effects that would be short-term, site-specific, negligible to minor and adverse.

Limited use of off-road equipment associated with chemical treatments would occur on previously disturbed or compacted areas and would cause localized soil compaction. Impacts to soils would be short-term, negligible to minor, and adverse for use of off-road equipment.

Cultural Treatments: Cultural treatments may include on-site revegetation efforts associated with construction activities and would create ground disturbances using hand tools and mechanized equipment. Top soil conservation would be employed to reduce impacts to soils. Impacts to soils would be short-term, negligible to minor and adverse.

Mitigation Measures employed to minimize impacts to soil resources would include herbicide and application training and hand spraying to targeted invasive plants. Removal of invasive plants would help restore soil conditions that may have been altered by invasive plant species. Restoration activities would use top soil conservation, be localized, create short-term soil disturbance, and provide long-term soil conservation.

Because of the limited degree of disturbance and proposed mitigation measures, overall invasive vegetation management actions under this alternative would be expected to have direct, short-term, negligible to minor adverse effects on park soil resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on soils in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed for general operation practices. Impacts would be reduced by top soil conservation and de-compacting soils after project completion. Backcountry operations and trail maintenance involves localized soil disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking will likely place additional pressures on soil resources. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on soils. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative A, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, and negligible to minor adverse impacts on the park's soils. Vegetation restoration activities connected with park construction activities would have long-term, beneficial, and minor impacts on soils. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, negligible to minor adverse and beneficial impacts on soil resources.

Alternative B (Preferred): Impacts on Soil Resources

Impact Analysis

Under Alternative B, overall Integrated Weed Management (IWM) would have short and long term, direct and indirect beneficial effects on soil resources due to utilizing an adaptive approach designed to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. Potential impacts from specific activities under the IWM approach are described below.

Educational, preventive and collaborative efforts of the IWM approach are anticipated to have short and long term, indirect beneficial impacts to soil resources due to the increase in preventive measures which would reduce the need for invasive plant treatments.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Proposed invasive plant control efforts under Alternative B would have some effects on park soil resources as described below.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances such as localized, minor soil destabilization and compaction from hand pulling or use of hand tools for individual plants. Foot access for weed treatments would be minimized away from roads, trails and boardwalks. However, some disturbance associated with foot traffic would occur. Impacts to soils from this type of treatment would be short-term, negligible, and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground and could adversely affect soils. Some herbicides have the potential to persist in soils, which may lead to herbicide buildup in soils. Coarse to medium-textured soils are less likely to retain herbicides. Medium and fine-textured soils with higher organic matter content have a greater potential to retain herbicides. There is also a low potential for accidental spills of herbicides that may temporarily contaminate soils. Appendix 7 discusses more details regarding herbicide impacts.

Limited UTV use would occur only on paved, previously disturbed and compacted non-wilderness areas such as the road prism and shoulders of existing roadways, park developed areas, powerline corridors, and areas undergoing restoration, such as sections of the Gardiner Basin. Impacts to soils would be short-term, negligible to minor, and adverse. Limited use of off-road equipment associated with chemical treatments would occur on previously disturbed or compacted areas and would cause localized soil compaction. Impacts to soils would be short-term, negligible to minor, and adverse for use of off-road equipment.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, and use of competition from native plants) would cause short term, negligible to minor adverse as well as beneficial impacts to soil resources. For example, top soil conservation could be used to augment the recovery of disturbed soils and prevent soil loss from construction projects.

Prescribed fire would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. This seed reduction and increased nutrient

content would benefit both native and non-native vegetation growth. Impacts of prescribed fire on soil resources would be directly beneficial (promote native species) and adverse (increase non-native species such as cheatgrass), site-specific, short-term, and negligible.

Biological Control: Limited use of biological control agents would be considered under this alternative only after other invasive plant control treatments prove to be ineffective and only after a detailed technical review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target plant and animal species. Impacts to soil resources would be assessed and would not occur unless they would be determined to be less than short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin project would cause negligible, short term adverse impacts resulting from compaction, destabilization and disturbances of the soil profile. These impacts would be temporary and site-specific. There would be a long-term benefit to soils and native plant communities due to soil conservation and restoration of soil microbiology and chemistry critical to the reestablishment of healthy native plant communities. Overall, the impact would have beneficial, long-term minor to moderate impacts on soils.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible to moderate short- to long-term adverse disturbances to soil. Routes used to access monitoring sites could later be used by visitors as social trails, potentially amplifying these impacts in the long term. Effects would include soil compaction and disturbance to the upper soil profile. To reduce impacts on soils, park staff would try to stay on established trails where possible and access sites using areas most resilient to soil impacts (e.g., slick rock) and work in small teams. The impact of foot traffic and monitoring activities would be direct, adverse, short-term and minor.

Mitigation Measures, such as requirements for staff to possess a certified applicators license, following herbicide label and MSDS instructions, and proper application techniques would reduce potential impacts. Therefore, chemical treatments would result in soil effects that would be short-term, site-specific, negligible to minor and adverse.

Overall, survey and treatment activities under Alternative B would be expected to have short-term, negligible to minor adverse and long-term minor beneficial effects on park soil resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on soils in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed for general operation practices. Impacts would be reduced by top soil conservation and de-compacting soils after project completion. Backcountry operations and trail maintenance involves localized disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on soil resources. These past, present, and foreseeable future actions activities are having short-term, minor adverse impacts on soils. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would affect the park's soils through short-term and negligible to minor adverse impacts. Vegetation restoration activities connected with park construction activities would be expanded and have long-term, beneficial and minor effects on soils. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, negligible to minor adverse and beneficial impacts on soil resources.

Geothermal Resources

Guiding Principles and Policies

The geologic setting is the fundamental underlying factor for the behavior and characteristics of a landscape. NPS geologic resources are important for their role in the ecosystem, their scenic grandeur, and their contribution to visitor enjoyment. Yellowstone was established specifically to protect geothermal resources. The park contains geologic resources and hydrothermal features of international renown. For the purpose of this discussion, this topic includes primarily hydrothermal or geothermal resources. The NPS has developed policies and guidance on geothermal resource management. Section 4.8.2.3 of NPS Management Policies states that the NPS will maintain, preserve, and protect geothermal resources as integral components of the park's natural systems.

Methodology and Intensity Level Definitions

Analysis of the potential impacts on geothermal and hydrothermal features is based on the available information on the impacts of possible project activities. Analyses of potential intensity of impacts to geothermal or hydrothermal features were derived from information on park geothermal features and basins and from park geology staff observations.

The impact intensities for geothermal and hydrothermal features are:

- **Negligible:** A change to a natural physical or geothermal resource that would be so small that it would not be of any measurable or perceptible consequence. Hydrothermal resources would not be affected or the effects on these geothermal resources would not be detectable.
- **Minor:** A change to a natural physical or geothermal resource that would be small and localized and of little consequence. Effects on geothermal and hydrothermal resources would be detectable, although these effects would be localized and short-term.
- **Moderate:** A noticeable change to a natural physical or geothermal resource that would be readily apparent and measurable, localized, and possibly long-term. Measurable effects could include physical disturbance or slight alteration of the hydrothermal function. The appearance of a hydrothermal resource would be modified or its physical properties compromised. Mitigation to offset adverse effects would include measures to ensure that geothermal function is preserved.
- **Major:** A significant change to a physical or geothermal resource that would be measurable and result in a severely adverse or major beneficial impact. Effects on geothermal resources would be readily apparent, measurable, severe, long-term, and occur on a local and regional scale. Hydrothermal features could be altered or removed or the physical properties significantly affected. Mitigation measures to offset adverse effects would be extensive and success would not be assured.

Alternative A (No Action): Impacts on Geothermal Resources

Impact Analysis

Existing efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Most invasive plant control in geothermal areas would be localized and would entail spot removal or spraying specific individual plants and control of larger weed patches with backpack sprayers. Limited UTV use would occur only on paved, previously disturbed and compacted non-wilderness areas such as the road prism and shoulders of existing roadways, park developed areas, powerline corridors, and areas undergoing restoration, such as sections of the Gardiner Basin. Revegetation would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding. Invasive plant control efforts would affect the park's geothermal resources as described below.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Existing invasive plant control efforts as described under Alternative A would affect the park's geothermal resources as described below.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Foot access for weed treatments would be minimized away from roads, trails and boardwalks. However, some disturbance associated with foot traffic will be required into geothermal areas. Impacts to geothermal resources would be short-term, negligible and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients in geothermal areas. Park staff would not use UTVs in geothermal areas. Impacts to geothermal resources would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances using hand tools and mechanized equipment. Top soil conservation would be employed to reduce impacts to geothermally influenced soils. Impacts to geothermal resources would be short-term, minor and adverse.

Mitigation Measures would include consultation with park geology staff and minimizing access to geothermal areas for employee safety as well as resource protection. Park staff would employ more manual invasive plant removal than herbicide use. Use of herbicides would be limited to active ingredients approved for these areas. Revegetation activities would occur primarily outside of geothermal areas and use top soil conservation. This would be localized and would create short- and long-term disturbance in geothermal areas. Because of the limited degree of disturbance and proposed mitigation measures, invasive vegetation management under this alternative would be expected to have direct, short- and long-term, minor adverse effects on park geothermal resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse

effects on geothermal resources. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where geothermal areas may be disturbed. Impacts would be reduced following park protocols for work in geothermal areas and with consultation with the park geologist. Backcountry operations and trail maintenance involves localized disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on geothermal resources. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on geothermal resources. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short- and long-term, minor adverse impacts on the park's geothermal resources. Revegetation activities connected with park construction activities would have short-term adverse and minor impacts on geothermal resources. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, minor adverse impacts on the park's geothermal resources.

Alternative B (Preferred): Impacts on Geothermal Resources

Impact Analysis

Under Alternative B, overall Integrated Weed Management would have anticipated short- and long-term, indirect beneficial effects to geothermal features and associated vegetation communities. This would be due to utilizing an adaptive approach designed to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. Educational, preventive and collaborative efforts would strive to reduce the introduction and proliferation of invasive vegetation in the park and would result in long-term beneficial effects to geothermal resources.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Proposed invasive plant control efforts under Alternative B would have some effects on park geothermal resources as described below.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Foot access for weed treatments would be minimized away from roads, trails and boardwalks. However, some disturbance associated with foot traffic will be required into geothermal areas. Impacts to geothermal resources would be short-term, negligible and adverse.

Chemical Treatments: Localized use of limited approved herbicides would affect geothermal areas. Invasive plant control would be localized and entail spot removal or spraying specific individual plants with backpack sprayers in geothermal areas. Park staff would not use UTVs in geothermal areas other than limited UTV use would occur only on paved, previously disturbed and

compacted non-wilderness areas such as the road prism and shoulders of existing roadways, park developed areas, powerline corridors, and areas undergoing restoration, such as sections of the Gardiner Basin. Limited use of off-road equipment for weed treatments would cause localized disturbance and compaction. Mitigation measures, such as requirements for certified applicators license, following herbicide label and MSDS instructions, and proper application techniques would reduce potential impacts. Chemical treatments would result in effects to geothermal areas that would be short-term, minor sand adverse. Potential impacts to geothermal resources would be short- and long-term, minor, and adverse.

There is a low potential for accidental spills of herbicides that may temporarily contaminate geothermal areas. Potential impacts of accidental spills would be addressed according to safety practices described in Mitigation Measures in Chapter 2 and would be minor and short-term. Individuals involved with invasive plant management activities in geothermal areas would be trained and certified to use herbicides and would be aware of procedures for the cleanup of herbicides, which would decrease response time and reduce potential impacts. Impacts may be short-term and site-specific. The impacts of accidental spills on geothermal resources would therefore be adverse, site-specific, short-term and minor.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, and use of competition from native plants) would cause short term, minor adverse impacts to geothermal resources. Treatments would include on-site revegetation efforts associated with construction activities would create ground disturbances using hand tools and mechanized equipment. Top soil conservation would be employed to reduce impacts to geothermal soils. Impacts to geothermal resources would be short-term, minor and adverse.

Prescribed fire would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific geothermal areas. This seed reduction and increased nutrient content would benefit both native and non-native vegetation growth. Impacts of prescribed fire on geothermal resources would be directly beneficial (promote native species) and adverse (increase non-native species such as cheatgrass), site-specific, short-term, and negligible.

Biological Control: Limited use of biological control agents would be considered under this alternative only after other invasive plant control treatments prove to be ineffective and only after a detailed technical review and appropriate analysis and compliance has been completed as to the effectiveness and potential impacts on non-target plant and animal species. Impacts to geothermal resources would be assessed and would not occur unless they would be determined to be less than short-term, minor and adverse.

Restoration: Where foot traffic or boardwalk construction causes compaction, destabilization and disturbances in geothermal areas, larger-scale ecological vegetation restoration projects would possibly occur. These restoration projects would cause negligible to minor short-term impacts to geothermal resources resulting from hand tools and limited use of mechanized equipment. There would be long-term benefit to native plant communities due to soil conservation and restoration and reestablishment of healthy native plant communities. Overall, the impact would be beneficial, long-term minor impacts on geothermal resources.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible to moderate short- to long-term adverse disturbances to geothermal areas. Trails used to access monitoring sites could later be used by visitors, potentially amplifying these impacts. Effects would include soil compaction and disturbance to geothermal areas. To reduce impacts on geothermal resources, park staff would try to stay on trails where possible and access sites using

areas most resilient to soil impacts (e.g., slick rock) and work in small teams. The impact of foot traffic and monitoring activities would be direct, adverse, short-term and minor.

Mitigation Measures would include consultation with park geology staff and minimizing access to geothermal areas for employee safety as well as resource protection. Park staff would employ more manual invasive plant removal than herbicide use. Use of herbicides would be limited to active ingredients approved for these areas. Restoration activities would occur primarily outside of hydrothermal areas and when applied, would use top soil conservation. This would be localized and create short- and long-term disturbance in geothermal areas. Because of the limited degree of disturbance and proposed mitigation measures, invasive vegetation management under this alternative would be expected to have direct, short- and long-term, minor adverse effects on the park's geothermal resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on geothermal resources. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where geothermal areas may be disturbed. Impacts would be reduced following park protocols for work in geothermal areas and with consultation with the park geologist. Backcountry operations and trail maintenance involves localized disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which would likely place additional pressures on geothermal resources. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on geothermal resources. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program would have direct, short- and long-term, minor adverse impacts on the park's geothermal resources. Vegetation restoration activities connected with park construction activities would have short-term, minor adverse effects on geothermal resources. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, minor adverse impacts on the park's geothermal resources.

Wetlands and Water Resources

Guiding Principles and Policies

Executive Order 11990, *Protection of Wetlands* (42 Fed. Reg. 26961). This document directs the NPS to (1) provide leadership and take actions to minimize the destruction, loss, or degradation of wetlands; (2) preserve and enhance the natural and beneficial values of wetlands; and (3) avoid direct or indirect support of new construction in wetlands unless there are no practicable alternatives and the proposed actions include all practicable measures to minimize harm to wetlands.

Director's Order 77-1, *Wetland Protection* and the accompanying Procedural Manual, reissued February 2008, establish NPS policies, requirements, and standards for implementing Executive

Order 11990. They set forth a "no net loss of wetlands" goal, first proclaimed in 1989 by President George Bush and sustained by subsequent administrations. Proposed actions that have the potential to adversely impact wetlands must be addressed in a statement of findings and included in an EA. Section 4.2 of the Director's Order lists certain water-dependent actions that do not require preparation of a statement of findings, such as those "designed specifically for the purpose of restoring degraded (or completely lost) natural wetland, streams, riparian, or other aquatic habitats or ecological processes." Temporary disturbances to wetlands that are directly associated with and necessary for implementing the restoration are allowed. Actions causing a cumulative total of up to 0.25 acres of new long-term adverse impacts on natural wetlands may be allowed if they are directly associated with and necessary for the restoration, such as small structures or berms, and provided conditions stated in Appendix 2 of the Director's Order are satisfied. For purposes of a statement of findings, the Director's Order indirectly defines "adverse" impacts to be "minimal" impacts greater than negligible.

Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers (USACOE) issues permits for activities that result in the discharge of dredged or fill material into U.S. waters, including wetlands. Regulated activities range from depositing fill for building pads or roads to discharges associated with mechanized land clearing. The NPS Procedural Manual 77-1 for wetland protection explains the relationship between Section 404 and the requirements of Director's Order 77-1. Although portions of the USACOE 404 permit procedures (33 CFR 320-330) are similar to requirements in Director's Order 77-1, the significant differences in scope warrant a separate NPS wetland protection process: (1) the 404 permit program regulates only the discharge of dredged or fill material, while Executive Order 11990 covers a broader range of actions that can have adverse impacts on wetlands, including ground water withdrawals, water diversions, and nutrient enrichment; (2) the wetland definition used for the 404 permit program (33 CFR 328.3) is narrower than the Cowardin et al. (1979) wetland definition used for NPS compliance with Executive Order 11990 (see Section 4.1.1. of the procedures); and (3) the USACOE has "general permit" provisions that allow many projects affecting wetlands to proceed with minimal review.

All NPS actions with the potential to have adverse impacts on wetlands must comply with Director's Order 77-1, and those actions that involve placing dredged or fill material in wetlands or other "waters of the U.S." must comply with Section 404 of the Clean Water Act as well. In cases where both NPS and USACOE requirements apply, duplication of effort can be avoided by coordinating with the appropriate Corps of Engineers office early in the process of developing workable alternatives. Also, if wetland compensation is necessary (Section 5.2.3. of the procedures), every effort should be made to assure that the wetland restoration proposal meets the compensation requirements of both programs.

Methodology and Intensity Level Definitions

The methodology used for assessing impacts on floodplains, wetlands, and other waters is based on the available information on the impacts of possible project activities. This analysis focuses on the potential actions to impact the natural and beneficial functions and values of wetlands including:

- **Biotic functions**—fish and wildlife habitat, floral and faunal productivity, native species and habitat diversity, unusual wetlands on landscape, special-status species.
- **Hydrologic functions**—flood attenuation, stream flow maintenance, groundwater recharge and discharge, water supply, erosion and sediment control, water purification.

For details on herbicides used in the park and their effect on wetlands and waters, see Appendix 7.

The impact intensities for wetlands and other waters are:

- **Negligible:** Impacts would occur outside the regulatory floodplain, or there would be no perceptible change in an existing wetland area or function, ability of a floodplain to convey floodwaters, or hydrologic function. No changes to native vegetation and wildlife communities would occur, and there would be no measurable or detectable effect on hydrology would occur.
- **Minor:** Impacts would be measurable or perceptible but slight, affecting a few individuals of plant or wildlife species within an existing wetland or riparian area, or could change wetland or floodplain functions or hydrologic processes in a localized area. Changes to hydrology would be considered insignificant and short-term.
- **Moderate:** Impacts would have a measurable effect on plant or wildlife species within an existing wetland or riparian area, but all species would remain indefinitely viable within the park be measurable and short-term but relatively local. Actions within the regulatory floodplain would interfere with floodplain function/values. The impact would be sufficient to cause a measurable change in the size, integrity, or continuity of the wetland. Impacts would result in a small but permanent loss or gain in wetland acreage. Mitigation measures associated with the water resources, floodplains, and hydrology would be necessary. Impacts on existing wetland areas or floodplain functions could be mitigated by the restoration of impacted wetlands elsewhere in the park or modification of proposed facilities in floodplains.
- **Major:** Impacts would result in a measurable change in size, integrity, and continuity or a permanent loss of large wetland areas or floodplain function that could not be mitigated. The impact would be substantial and highly noticeable. Wetland and riparian species dynamics would be upset, and species changes would be noticeable on a regional scale.

Alternative A (No Action): Impacts on Wetlands and Water Resources

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to identify and control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control, including near water ways (lakes and streams) or within wetlands would be localized and entail manual control or spot removal or spraying specific individual plants and control of larger weed patches with backpack or UTV mounted boom sprayers. Vegetation restoration would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding. Wetlands have been susceptible to invasive vegetation and park staff would work to control nonnative plant species where they occur. Particular species such as velvet grass, sweet vernal grass, hawkweed species, and tall buttercup that occur in wetlands would be treated manually or with approved herbicides that are specifically prescribed by label near water and wetlands.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Existing invasive plant control efforts as described under Alternative A would affect the park's wetland and waters as described below.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants in wetlands or near waters would create localized ground disturbances from hand pulling or use of hand tools on individual plants. Foot access would occur near water and wetlands away from roads, trails and boardwalks and would cause negligible to minor impacts. Impacts to wetlands and water resources from mechanical treatments would be short-term, minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides for wetlands or near park waters would leave some ingredients on the ground due to some herbicide drift affect. Potential impacts would be minimized due to use of herbicides approved near water and wetlands. Use of off-road equipment for weed treatments in wetlands would not occur or create soil compaction. Impacts to wetlands and water resources would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances using hand tools and mechanized equipment near waters and wetlands. Top soil conservation would be employed to reduce impacts to wetland soils. Impacts to wetlands and water resources would be short-term, minor and adverse.

Mitigation Measures would include consultation with a park wetland specialist and minimal use of herbicides to control nonnative plants in wetlands and near waters. Compared with manual and mechanical treatments, the use of approved herbicides would potentially reduce the extent and intensity of disturbance to wetland soils. Park staff would employ more manual plant removal than herbicide use when appropriate. Herbicide use would occur with herbicides specifically approved near waters and within wetlands. Where needed, restoration activities would occur in wetlands. Restoration would be localized and would create short-term disturbance and, if successful, long-term benefits to park wetlands. Because of the limited degree of disturbance and the mitigation measures implemented, overall invasive vegetation management actions under this alternative would be expected to have direct, short-term, minor adverse impacts on the park's wetland and water resources.

Cumulative Impact Analysis

Ongoing park activities such as road construction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on wetland resources in the park. Road maintenance and construction activities would require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where in many cases wetlands have already been identified for planning purposes. Where wetlands have been identified, they can easily be avoided or mitigated for. Impacts would be reduced following park protocols for work in wetlands and with consultation with the park wetland specialist. Backcountry operations and trail maintenance involves localized wetland disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking are expected to increase parkwide. An increase in recreational users would likely place additional pressures on wetlands. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on wetlands and water resources. These impacts, combined with the short-term,

minor adverse impacts of Alternative A, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts under Alternative A would have direct, short - term, minor adverse impacts on the park's wetlands and water resources. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would have direct, short-term, minor adverse impacts on wetland and water resources.

Alternative B (Preferred): Impacts on Wetlands and Water Resources

Impact Analysis

Actions associated with Alternative B would allow an overall IWM approach and have direct, short- and long-term, direct and indirect beneficial effects on wetlands and water resources due to utilizing an adaptive approach designed to preserve the biological diversity of native plant communities associated with wetlands through prevention, containment, and control of invasive plants. Educational, preventative, and collaborative efforts would strive to reduce the introduction and proliferation of invasive vegetation in the park and would result in long-term beneficial effects to park wetlands and water resources.

Wetlands have been susceptible to invasive vegetation and park staff would work to control nonnative plant species where they occur. Under Alternative B, particular species such as velvet grass, sweet vernal grass, hawkweed species, and tall buttercup that occur in wetlands would be treated manually or with approved herbicides that are specifically prescribed by label near water and wetlands.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Proposed invasive plant control efforts under Alternative B would have some effects on park wetlands and water resources in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Foot access away from roads and trails would be minimized, and would cause some disturbance to wetlands. Impacts to wetlands and water resources would be short-term, minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides for invasive plants within wetlands and near park waters would leave some ingredients on the ground due to some drift effect. Potential impacts would be minimized due to use of herbicides approved near water and wetlands. There would be no use of off-road equipment for weed treatments in wetlands that would cause localized soil compaction. Impacts to wetlands and water resources would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation, top soil conservation, fire, shading and use of competition from native plants would cause short-term, minor adverse impacts to wetlands and water resources. Revegetation efforts associated with

construction activities would create ground disturbances using hand tools and mechanized equipment. Top soil conservation would be employed to reduce impacts to wetland soils. Burns would not be employed in wetlands to reduce invasive plant build-up and seed sources and increase soil nutrient availability. Impacts to wetlands and water resources would be short-term, minor and adverse.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target plant species. Impacts to wetlands and water resources would be assessed and would not occur unless they would be determined less than short-term, minor and adverse.

Restoration: Larger scale ecological restoration projects would cause short-term, minor, adverse impacts resulting from ground disturbances associated with compaction and disturbance to wetlands and water resources. These impacts would be temporary and site specific. There would be long-term benefit to wetlands and native plant communities. Impacts would therefore have short- and long-term adverse minor effects on wetland and water resources.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances to wetland areas. Trails used to access monitoring sites could later be used by visitors, potentially amplifying these impacts. Effects would include compaction and disturbance to wetlands areas. To reduce impacts, park staff would try to stay on trails where possible and access sites using more resilient surfaces. The impact of foot traffic and monitoring activities on wetlands and water resources would be direct, adverse, short-term and negligible.

Mitigation Measures would be employed to minimize potential impacts, including consultation with an NPS wetland specialist. Use of herbicides in wetland areas would be limited to high and medium priority species. Park staff would employ more manual invasive plant removal than herbicide use. When herbicides are used, they would be limited to active ingredients approved for application in wetland areas. Surfactants used would have the least impact on aquatic species. Restoration activities would occur in wetlands that have a high potential for successful restoration of native species. Restoration would be localized and would create short-term disturbance and long term benefit to park ecosystem. Because of the limited degree of disturbance and the mitigation measures implemented, overall invasive vegetation management actions under Alternative B would be expected to have direct, short-term, minor adverse effects on park wetland and water resources.

Cumulative Impact Analysis

Ongoing park activities such as road construction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on wetland resources in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where wetland areas may be disturbed from general operation practices. Impacts would be reduced following park protocols for work in wetlands and with consultation with the park wetland specialist. Backcountry operations and trail maintenance involves localized wetland disturbance and compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users would likely place additional pressures on wetlands. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on wetland and water resources. These impacts, combined with the short-term,

minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park have direct, short -term, minor adverse impacts on the park's wetlands and water resources. The impact of vegetation restoration connected with construction activities occurring in wetlands would have short-term, adverse and minor to wetlands. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, minor adverse impacts on wetland and water resources.

Water Quality

Guiding Principles and Policies

Section 4.6.3 of the 2006 NPS Management Policies states that the pollution of surface and groundwater by point and nonpoint sources can impair the natural functioning of aquatic and terrestrial ecosystems and diminish the utility of park waters for visitor use and enjoyment. The NPS is to determine the quality of park surface and groundwater resources and avoid, whenever possible, the pollution of park waters by human activities occurring within and outside the parks. The NPS is to (1) work with appropriate governmental bodies to obtain the highest possible standards available under the Clean Water Act (CWA) for the protection of park waters; (2) take all necessary actions to maintain or restore the quality of surface waters and groundwater within the park consistent with the CWA and all other applicable federal, state, and local laws and regulations; and (3) enter into agreements with other agencies and governing bodies, as appropriate, to secure their cooperation in maintaining or restoring the quality of park waters.

The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Under the CWA, the Environmental Protection Agency has implemented pollution control programs such as setting wastewater standards for industry and water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollution from a point source (a discrete conveyance such as a human-made ditch or pipe) into navigable waters unless a permit is obtained. The EPA's National Pollutant Discharge Eliminations System permit program controls discharges.

Methodology and Intensity Level Definitions

Vegetation control and restoration activities under both alternatives would result in two types of impacts on water quality: changes in sediment loading from soil disturbance and inputs of pollutants from herbicide use. Disturbances to the land surface can increase the quantity of sediment in surface waters, which can adversely affect aquatic habitat and biota. This analysis considers the potential of each alternative to increase turbidity and chemical contaminants in the park's surface and subsurface waters. For details on herbicides used in the park and their effect on wetlands, see Appendix 7.

The impact intensities for water quality and quantity are:

- **Negligible:** Impacts would be very slight and, if detectable, highly localized. No impacts are expected to occur to water quantity, water temperature, dissolved oxygen, or pH.

- **Minor:** Impacts would be measurable and could affect a small area of the watershed. The impact would be measurable or perceptible but slight, and could affect one or more water quality parameters but would not exceed federal water quality standards. Changes to water quality and quantity would be considered short-term.
- **Moderate:** Impacts on water quality and aquatic plant and animal communities would be detectable affect a sizable area of the watershed. This impact would be sufficient to cause a measurable deviation from baseline water quality and water quantity measurements; mitigation measures would be needed to avoid exceeding federal water quality standards for one or more water quality parameters.
- **Major:** Impacts would results in a detectable change in water quality and aquatic plant and animal communities and have consequences that could not be mitigated for a large portion of the watershed or extend beyond the watershed. The impact would be substantial and highly noticeable. The impact would cause a die-off of species or result in a loss of ecosystem function. Aquatic plant and animal species would disappear permanently, with species changes occurring on a regional scale. An action could result in a detectable change in aquatic plant and animal communities throughout the region.

Alternative A (No Action): Impacts on Water Quality

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to identify and control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control would be localized and entail spot removal or spraying specific individual plants and control of larger weed patches with backpack or UTV mounted boom sprayers. Vegetation restoration would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts under Alternative A would have some effects on the park's water quality in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances and potential sedimentation. Impacts to water quality would be short-term, minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground due to drift affects and potentially impact surface and groundwater quality with chemical contaminants. Limited off-road equipment for weed treatments would create soil disturbance and potential sedimentation. Impacts to water quality would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances. Impacts to water quality would be short-term, minor and adverse.

Mitigation Measures would include minimal use of herbicides near waterways and only use of herbicides with active ingredients that have been approved for application in wetland areas. Restoration activities to restore native vegetation would use top soil conservation and reestablish hydrological flow. This would be localized and would create short-term disturbance and turbidity and potentially long term benefit to the park's water quality. Because of the limited degree of disturbance and the mitigation measures implemented, over invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on the park's water quality.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on water quality in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where water quality may be affected for general operation practices. Backcountry operations and trail maintenance involves localized disturbance and compaction. Park visitation is expected to increase each year. Therefore, recreational use such as angling, camping, and boating is expected to increase parkwide. An increase in recreational users would likely place additional pressures on water quality as more people hike, fish, and camp in Yellowstone. Waterways are often natural corridors for animals as well as humans, increasing the likelihood of the introduction of a new nonnative plant species or spread of a species already present. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on water quality. These impacts, combined with the short-term, minor adverse impacts of Alternative A, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, minor adverse impacts on the park's water quality. Vegetation restoration activities connected with park construction activities would have short-term, minor adverse impacts on water quality. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short-term, minor adverse impacts on water quality.

Alternative B (Preferred): Impacts on Water Quality

Impact Analysis

Actions associated with Alternative B would affect park water quality. Actions would allow an overall IWM approach and have direct, short- and long-term, direct and indirect beneficial effects on water quality due to utilizing an adaptive approach designed to preserve the biological diversity of native plant communities through prevention, containment, and control of invasive plants. Educational, preventative, and collaborative efforts would strive to reduce the introduction and proliferation of invasive vegetation in the park and would result in long-term beneficial effects to park water quality.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts would affect water quality in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances and sedimentation. Impacts to water quality would be short-term, minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground due to drift and potentially affect surface and groundwater quality with chemical contaminants. Limited off-road equipment for weed treatments would cause localized soil disturbance and sedimentation. Impacts to water quality would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site restoration efforts associated with construction activities would create ground disturbances and sedimentation from use of hand tools and mechanized equipment. Impacts to water quality would be short-term, minor and adverse

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target plant species. Impacts to water quality would be assessed and would not occur unless they would be determined less than short-term, minor and adverse.

Restoration: Larger scale ecological restoration projects would cause short-term, minor, adverse impacts resulting from ground disturbances and sedimentation to water quality. These impacts would be temporary and site specific. Impacts would therefore have short- and long-term adverse minor effects on water quality.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse impacts to water quality. Trails used to access monitoring sites could later be used by visitors, potentially amplifying these impacts. Effects would include compaction and disturbance to wetlands areas. To reduce impacts, park staff would try to stay on trails where possible and access sites using more resilient areas and work in small teams. The impact of foot traffic and monitoring activities to water quality would be direct, adverse, short-term and negligible.

Mitigation Measures would include minimal use of herbicides near waterways and only use of herbicides with active ingredients that have been approved for application in wetland and water areas. Restoration activities to restore native vegetation would use top soil conservation and reestablish hydrological flow. This would be localized and would create short-term disturbance and potentially long term benefit to the park's water quality. Because of the limited degree of disturbance and the mitigation measures implemented, overall invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on the park's water quality.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on water quality in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations and water quality perturbations. Most facilities maintenance takes place in developed areas that may be disturbed for general operation practices and affect water quality. Backcountry operations and trail maintenance involves localized wetland disturbance and compaction. Park visitation is expected to increase along with recreational use such as boating, angling, camping, and hiking would increase parkwide. An increase in recreational users would likely place additional pressures on water quality as more people boat, hike and camp in Yellowstone. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on water quality. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, minor adverse impacts on the park's water quality. Vegetation restoration activities connected with park construction activities would have short-term, minor adverse impacts on water quality. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, minor adverse impacts to water quality.

Vegetation including Rare Plants

Guiding Regulations and Policies

Section 4.4 of the 2006 NPS Management Policies states that the NPS is to maintain all plants native to park ecosystems. "The National Park Service will inventory, monitor, and manage state and locally listed plant species of concern in a manner similar to its treatment of federally listed species to the greatest extent possible. In addition, the Service will inventory other native species that are of special management concern to parks (such as rare, declining, sensitive, or unique species and their habitats) and will manage them to maintain their natural distribution and abundance." This is to be done by preserving native plant populations in the parks, restoring them when they have been extirpated by human actions, and minimizing human impacts on native plant populations, communities, ecosystems, and the processes that sustain them.

Adverse impacts on rare plants would be avoided to the extent possible. Impacts that cannot be avoided would be minimized and, if possible, mitigated by seed collection and plant salvage from on-site or nearby suitable habitats prior to disturbance that can be used to re-establish the plants after the project is completed.

Methodology and Intensity Level Definitions

Before projects are initiated, the park vegetation resource specialist would be consulted, and current plant information and literature reviewed. Individual surveys would evaluate and address potential for vegetation community introductions or promotion of nonnative plant species. Each special status species has been evaluated to determine known or likely occurrence or preferred habitat in the vicinity of known nonnative plant species. The analysis also evaluates the potential for

direct or physical loss or fragmentation of special status species habitat. For details on herbicides used in the park and their effect on vegetation, see Appendix 7.

The thresholds of change for the intensity of an impact on vegetation are:

- **Negligible:** No rare plant species or uncommon plant communities would be affected. Individual native plants might be affected, but impacts would be localized, short-term, and of no consequence to the species.
- **Minor:** Native vegetation would be affected, but impacts would occur in a relatively minor portion of the species' occurrence within the park. Individual rare plants or uncommon plant communities could be affected, but proposed mitigation measures to avoid adverse impacts on the species or community would be effective.
- **Moderate:** A sizable segment of native vegetation and/or rare plant species or uncommon plant communities within the park would be affected, and mitigation measures to offset adverse effects would have to be extensive.
- **Major:** Effects on native vegetation within the park, potentially including rare plants or uncommon plant communities, would be extensive and long-term. Mitigation measures to offset the adverse effects would be extensive and their success could not be guaranteed.

Alternative A (No Action): Impacts on Vegetation including Rare Plants

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to identify and control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control would be localized and entail spot removal or spraying specific individual plants and control of larger weed patches with backpack or UTV with mounted boom sprayers on paved, previously disturbed areas such as roads, shoulders, powerline corridors, and restorations areas . Revegetation would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding. Overall management of invasive, nonnative vegetation would create more conducive environment for the establishment and persistence of native vegetation.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts would affect the park's vegetation including rare plant species in the following ways.

Mechanical Treatment: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling and hand tools for individual plants affecting individual native plants. Foot access away from roads and trails would cause negligible trampling to vegetation. Impacts to native vegetation would be short-term, negligible and adverse and long-term minor and beneficial.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground or affect native plants through sprayer drift. Limited use of off-road equipment

associated with chemical treatments would occur on previously disturbed or compacted areas and would cause localized trampling of vegetation. Impacts to native vegetation would be short-term, negligible to minor and adverse and long-term minor and beneficial.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances and removal of vegetation. Top soil conservation would be employed to reduce impacts to soils and increase regeneration of native vegetation. Impacts to native vegetation would be short-term, minor and adverse, and long-term, minor and beneficial.

Mitigation Measures would include annual training for staff on plant identification, treatment strategies for target species and herbicide sprayer calibration to minimize sprayer drift. Monitoring of invasive plant control treatments would enable park staff to adjust treatment to maximize control efforts with minimum impact on native plant species. Restoration activities would use top soil conservation, be localized, create short-term soil disturbance, and provide long-term soil conservation and native vegetation growth. Because of the limited degree of vegetation disturbance, proposed mitigation measures, and the capacity to facilitate the conservation of native and rare plant species, invasive vegetation control and native vegetation restoration under Alternative A would be expected to have direct, short-term, negligible to minor adverse effects and long-term minor beneficial effects on park vegetation and rare plant species.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on native vegetation in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to nonnative plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on vegetation resources. Often many of the park's special plant assemblages are found in thermal areas, the focal point of many visitors visit to the park, subjecting these assemblages to more pressure from trampling and the spread and introduction of weed species. Whitebark pine restoration activities would continue in the GYA. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on vegetation. These impacts, combined with the short-term, minor adverse impacts of Alternative A, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts have direct, short-term, negligible to minor adverse impacts and long-term, minor beneficial effects on the park's vegetation, including rare plants. Vegetation restoration activities connected with park construction activities would have long-term, beneficial and minor effects on vegetation. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, negligible to minor adverse and beneficial impacts on vegetation and rare plants.

Alternative B (Preferred): Impacts on Vegetation including Rare Plants

Impact Analysis

Under Alternative B, overall Integrated Weed Management (IWM) would have short and long term, direct and indirect beneficial effects on native vegetation and rare plants due to utilizing an adaptive approach designed to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. Control of invasive species in would positively affect native, rare plant species such as Yellowstone sulfur buckwheat, which grows often in close proximity with spotted knapweed in thermal areas where many special status plants grow. Overall management of invasive, nonnative vegetation would create more conducive environment for the establishment and persistence of native vegetation and rare plant species.

Educational, preventive and collaborative efforts of the IWM approach are anticipated to have short and long term, indirect beneficial impacts to native vegetation and rare plants due to the increase in preventive measures which would reduce the need for invasive plant treatments. Potential impacts from specific activities under the IWM approach are described below.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts Under Alternative B would affect the park's vegetation including rare plant species in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances such as localized, minor soil destabilization and compaction from hand pulling or use of hand tools affecting individual native plants. Foot access away from roads and trails would cause negligible trampling to vegetation. Impacts to native vegetation would be short-term, negligible and adverse and long-term minor and beneficial.

Chemical Treatments: Localized use of approved herbicides would leave some ingredients on the ground or affect individual native plants through inadvertent sprayer drift. Mitigation measures, such as requirements for certified applicators license, following herbicide label and MSDS instructions, and proper application techniques would reduce potential impacts to native vegetation. Limited use of off-road equipment associated with chemical treatments would occur on previously disturbed or compacted areas and would cause localized trampling of vegetation. Impacts to native vegetation would be short-term, negligible to minor and adverse and long-term minor and beneficial.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would cause short term, negligible to minor adverse as well as beneficial impacts to soil resources. For example, top soil conservation could be used to augment the recovery of disturbed soils and regeneration of native plants from construction projects.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. This seed reduction and increased nutrient content would benefit both native and non-native vegetation growth. Impacts of burning on native vegetation would be directly beneficial (promote native

species) and adverse (increase non-native species such as cheatgrass), site-specific, short-term, and negligible to minor.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target native plant species. Impacts to native vegetation and rare plants would be assessed and would not occur unless they would be determined to be less than short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor, short term adverse impacts resulting from compaction, and disturbances to native vegetation. These impacts would be temporary and site-specific. As vegetation restoration is implemented, there would be a long-term benefit to native plant communities due to soil conservation and revegetation of native plants toward the reestablishment of healthy native plant communities. Overall, the impact would be beneficial, long-term minor to moderate impacts on native vegetation and rare plants.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances and affects to vegetation. Trails used to access monitoring sites could later be used by visitors, potentially amplifying these impacts to native plants. Effects would include compaction and disturbance to soil and vegetation. To reduce impacts on soils, park staff would try to stay on trails where possible and access sites using areas most resilient to vegetation impacts, and work in small teams. The impact of foot traffic and monitoring activities to native vegetation and rare plants would be direct, adverse, short-term and negligible.

Mitigation Measures would include annual training for staff on plant identification, treatment strategies for target species and herbicide sprayer calibration to minimize sprayer drift. Monitoring of invasive plant control treatments would enable park staff to adjust treatment types to maximize control efforts with minimum impacts on native plant species. Biological control would be used only if other control methods prove to be ineffective and a specific biological control has been through a thorough review and compliance for effectiveness and no significant adverse impacts on native vegetation and rare plants. Monitoring of invasive plant control treatments would enable park staff to adjust treatment types to maximize control efforts with minimum impacts on native plant species. Restoration activities would increase, use top soil conservation, be localized, create short-term soil disturbance, and provide long-term soil conservation and native vegetation growth. Larger-scale ecological restoration efforts would have larger short- and long-term, beneficial effects on soil and native vegetation resources. Overall, Alternative B would be expected to have direct, short-term, negligible to minor adverse effects and long-term, minor to moderate beneficial effects on park vegetation and rare plant species.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on native vegetation in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is

expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on native plant communities. Whitebark pine restoration activities would continue in the Greater Yellowstone Area. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on vegetation. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, negligible to minor adverse impacts and long-term, minor beneficial effects on the park's vegetation, including rare plants. Vegetation restoration activities connected with park construction activities would be expanded and have long-term, beneficial and minor effects on native vegetation. Biological control of invasive vegetation species would be employed after appropriate review and analysis would be completed and would have long-term, minor beneficial effects on native plant communities. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, negligible to minor adverse impacts and short- and long-term, minor to moderate beneficial effects on native vegetation and rare plant species.

Fish and Wildlife Species

Guiding Regulations and Policies

Federal laws governing wildlife not protected by the Endangered Species Act (1973), include the Migratory Bird Protection Act, the Bald Eagle Protection Act, and the Lacey Act. (Yellowstone species of management concern and federally listed threatened species are considered separately under "Threatened and Special Status Wildlife" below.) Section 4.4.1.1.of the 2006 NPS Management Policies states that the National Park Service is to maintain all native plant and animal species and their habitat inside parks. "The Service will … use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks." Section 4.4.2 states that natural processes are to be relied upon to maintain native plant and animal species and influence natural fluctuations in their populations.

Methodology and Intensity Level Definitions

Analysis of the impacts on native wildlife is based on the knowledge of park resource specialists and current literature. For details on impacts from herbicides used in the park and their effects on fish and wildlife, see Appendix 7.

The thresholds of change for the intensity of an impact on fish and wildlife species are:

- **Negligible:** Adverse or beneficial impacts on individuals, their habitat, or the key ecosystem processes sustaining them would be extremely unlikely to occur or not measurable.
- **Minor:** Adverse or beneficial impacts on individuals, their habitat, or the key ecosystem processes sustaining them would affect a small, localized portion of the species or its range in the park. Short- or long-term disturbances to individuals may occur and/or a small amount of habitat could be permanently modified or removed. Impacts would not

measurably affect the migration patterns, or other demographic characteristic of the population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change).

- **Moderate:** Adverse or beneficial impacts for populations, their habitat, or the key ecosystem processes sustaining them would affect a moderate portion of the species or its range in the park. Short- or long-term disturbances could measurably affect the migration patterns or other demographic characteristics of a population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Impacts would not significantly increase the susceptibility of populations in or near the park to environmental or demographic uncertainties (e.g., severe winters, droughts, disease epidemics, skewed age or sex ratios).
- **Major:** Adverse or beneficial impacts for populations, their habitat, or the key ecosystem processes sustaining them would be long term and affect a large proportion of the species' range across the region. The susceptibility of populations throughout the region to environmental or demographic uncertainty would significantly increase.

Alternative A (No Action): Impacts on Fish and Wildlife Species

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to identify and control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control would be localized and entail spot removal or spraying specific individual plants and control of larger weed patches with backpack or UTV mounted boom sprayers. Revegetation would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding.

Invasive plant treatments would affect some nonnative plant species that are considered wildlife forage. However, native vegetation and wildlife forage would be protected with invasive plant removal. Overall invasive vegetation management impacts would be short- and long-term negligible, adverse and negligible to minor beneficial to fish and wildlife species.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts Under Alternative A would affect the park's fish and wildlife species and their habitat in the following ways.

Mechanical Treatments: Manual and mechanical removal of invasive plants would create localize disturbances to wildlife associated with control access and hand work. Impacts to fish and wildlife species would be short-term, negligible and adverse.

Chemical Treatments: Use of approved herbicides would leave some ingredients on the ground and on vegetation for a short time. There would be a small likelihood that wildlife may consume vegetation that was recently treated with herbicides. Herbicides selected for park use on invasive vegetation has shown negligible effects on terrestrial wildlife species. Chemical treatments near wetlands and waterways that may affect aquatic species (fish and amphibians) would only use

herbicides that are permitted for such use. Impacts to fish and wildlife species would be short-term, negligible to minor and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized disturbances to wildlife associated with human activity. Impacts to fish and wildlife species would be short-term, negligible and adverse.

Mitigation Measures would include removal of invasive vegetation considered to be high value forage would occur with consultation with the parks wildlife staff. Because of the limited degree of disturbance, impacts on invasive vegetation management and native vegetation restoration under this alternative would be expected to have direct, short-term, negligible to minor adverse effects and long-term, negligible beneficial effects on the park's fish and wildlife species.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on fish and wildlife in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on the park's fish and wildlife species. These past, present, and foreseeable future activities are having short-term, negligible adverse impacts on fish and wildlife. These impacts, combined with the short-term, negligible adverse impacts of Alternative A, would result in short-term, negligible adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, negligible adverse impacts and long-term, negligible beneficial effects on the park's fish and wildlife. Vegetation restoration activities connected with park construction activities would have long-term, beneficial and negligible effects on fish and wildlife species. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, negligible adverse and beneficial impacts on fish and wildlife species.

Alternative B (Preferred): Impacts on Fish and Wildlife Species

Impact Analysis

Under Alternative B, overall Integrated Weed Management (IWM) would have short and long term, direct and indirect beneficial effects on native vegetation and wildlife forage due to utilizing an adaptive approach designed to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. Overall management of invasive, nonnative vegetation would create more wildlife foraging opportunities.

Educational, preventive and collaborative efforts of the IWM approach are anticipated to have short and long term, indirect beneficial impacts to wildlife use of native forage due to the increase in preventive measures which would reduce the need for invasive plant treatments. Potential impacts from specific activities under the IWM approach are described below.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Potential impacts to fish and wildlife species from specific activities under Alternative B are described below.

Mechanical Treatments: Manual and mechanical removal of invasive plants would create localize disturbances to wildlife associated with control access and hand work. Impacts to fish and wildlife species would be short-term, negligible and adverse.

Chemical Treatments: Use of approved herbicides would leave some ingredients on the ground and on vegetation for a short time. There would be a small likelihood that wildlife may consume vegetation that was recently treated with herbicides. Herbicides selected for park use on invasive vegetation has show negligible effect on terrestrial wildlife species. Chemical treatments near wetlands and waterways that may affect aquatic species (fish and amphibians) would only use herbicides that are permitted for such use. Impacts to fish and wildlife species would be short-term, negligible to minor and adverse.

Cultural Treatments: Cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would create localized disturbances and human activity and cause short term, negligible adverse as well as beneficial impacts to fish and wildlife species . For example, top soil conservation could be used to augment the recovery of disturbed soils and regeneration of native plants from construction projects.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target native plant species. Impacts to fish and wildlife would be assessed and would not occur unless they would be determined less than short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor, short term adverse impacts to fish and wildlife resulting from disturbances activities . These impacts would be temporary and site-specific. As vegetation restoration is implemented, there would be a long-term benefit to wildlife due to revegetation of native plants toward the reestablishment of healthy wildlife forage communities. Overall, the impact would be beneficial, long-term minor to moderate impacts on fish and wildlife species.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances and access. Effects would include disturbance to vegetation and wildlife forage species. The impact of foot traffic and monitoring activities to fish and wildlife would be direct, adverse, short-term and negligible.

Mitigation Measures would include consultation with park's wildlife staff when address control of invasive vegetation considered wildlife forage. Larger ecological restoration efforts would have larger short- and long-term, beneficial effects on native vegetation and wildlife habitat. Because of the degree of disturbance, invasive vegetation management and native vegetation restoration, this

alternative would be expected to have direct, short-term, negligible to minor and adverse and long-term, minor beneficial effects on the park's fish and wildlife species.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on native vegetation in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to nonnative plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on the park's fish and wildlife species. These past, present, and foreseeable future activities are having short-term, negligible adverse impacts on fish and wildlife. These impacts, combined with the short-term, negligible adverse impacts of Alternative B, would result in short-term, negligible adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, negligible to minor adverse impacts and long-term, minor beneficial effects on the park's fish and wildlife. Vegetation restoration activities connected with park construction activities would be expanded and have long-term, beneficial and minor effects on fish and wildlife habitat. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, negligible to minor adverse and minor beneficial impacts on fish and wildlife species and their habitats.

Threatened, Endangered, and Special Status Wildlife

Guiding Principles and Policies

Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS for fresh-water and wildlife when they are proposing an action that may affect a listed species. An action warrants a "may affect, not likely to be adversely affected" finding from the when its effects are wholly beneficial, insignificant or discountable. The threshold for a "likely to adversely affect" determination is an adverse effect to one or more individuals of the species or its critical habitat as described in "Major Effects" description in Intensity Level Definitions listed below.

Section 4.4.23 of the 2006 NPS Management Policies states that the National Park Service will survey for, protect, and strive to recover all native species listed under the Endangered Species Act. Section 4.4.1.1 states that the National Park Service is to maintain all native plant and animal species and their habitat inside parks. "The Service will … use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks."

Methodology and Intensity Level Definitions

Identification of federally listed species and designated critical habitats was accomplished through discussions with the U.S. Fish and Wildlife Service through informal consultation, and with YNP wildlife staff. Yellowstone has no endangered wildlife species. Federally listed threatened species are the grizzly bear and the Canada lynx and lynx critical habitat. Wolverines are now proposed for listing under the ESA with a designation as threatened pending in 2013. Special status species include certain fish, amphibians, birds, and mammals. Plant species of special concern are described above under "Vegetation and Rare Plants." Impacts on threatened wildlife species and Yellowstone wildlife species of special management concern were analyzed based on scientific literature and the knowledge of NPS and other resource specialists. For details on herbicides used in the park and their possible effects on fish and wildlife, see Appendix 7.

The impact intensities for threatened and special status wildlife species are:

- **Negligible:** No effect or the effects to federally listed species or its critical habitat would be at or below the level of detection, would be short-term, and the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population. Any impact would be site-specific and short-term, and would equate with a "no effect" determination.
- **Minor:** Effects to federally listed species or its critical habitat would be detectable, although the effects would be localized, and would be small and of little consequence to the species' population or critical habitat. Mitigation measures, if needed to offset adverse effects, would be simple and successful. Any impact would be site-specific and short-term, and would equate with a "may affect but are not likely to adversely affect" determination.
- **Moderate:** Effects to federally listed species or its critical habitat would be readily detectable, long-term, and localized, with consequences at the population level. Mitigation measures needed to offset adverse effects would likely be successful. Any impact would be site-specific and short-and long-term, and would equate with a "may affect but are not likely to adversely affect" determination.
- **Major:** Effects to federally listed species or its critical habitat would be obvious, long-term, and have substantial consequences for the species' population in the region. Mitigation measures needed to offset adverse effects would be extensive and success would not be guaranteed. Any impact would be site- and population level specific and short-and long-term, and would equate with a "affect and likely to adversely affect" determination.

Alternative A (No Action): Impacts on Threatened and Special Status Wildlife

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to identify and control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control would be localized and entail spot removal or spraying specific individual plants and control of larger weed patches with backpack or UTV mounted boom sprayers. Revegetation activities would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding.

Invasive plant treatments would affect some nonnative plant species that are considered forage for grizzly bears. However, native vegetation and wildlife forage would be protected with invasive plant removal. Overall invasive vegetation management impacts to threatened species such as grizzly bears, lynx and lynx critical habitat, or proposed threatened species (wolverine) would be short- and long-term negligible and adverse and negligible to minor beneficial to threatened species and critical habitat.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts under Alternative A would affect the park's threatened and special status wildlife species and their critical habitat in the following ways.

Mechanical Treatments: Manual and mechanical removal of invasive plants would create localize disturbances to threatened wildlife associated with control access and hand work. Impacts to threatened or proposed threatened species would be short-term, negligible and adverse.

Chemical Treatments: Use of approved herbicides would leave some ingredients on the ground and on vegetation for a short time. There would be a small likelihood that threatened grizzly bears may consume vegetation that was recently treated with herbicides. Herbicides selected for park use on invasive vegetation has shown negligible effect on terrestrial wildlife species. Impacts to threatened or proposed threatened species and critical habitat would be short-term, negligible to minor and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized disturbances and human activity. Top soil conservation would be employed to reduce impacts to native vegetation. Impacts to threatened or proposed threatened species and critical habitat would be short-term, negligible and adverse.

Mitigation Measures would include removal of invasive vegetation considered to be high value forage to grizzly bears or that would potentially affect Canada lynx critical habitat would occur with consultation with the parks Threatened and Endangered Species Biologists. Existing NPS efforts do not overlap with previously documented wolverine occurrences, movements, or habitat, and so are not discussed further in this alternative given their proposed status. Access for invasive vegetation treatments would not occur in park designated Bear Management Areas unless under consultation with the park's Bear Management Biologist. Monitoring of nonnative plant control treatments would enable park staff to adjust treatment types to maximize control efforts with minimum impacts on native plant species. Restoration activities would use top soil conservation, be localized, create short-term disturbance, and provide long-term native vegetation growth.

Effects for listed species and critical habitat include:

- **Grizzly bears** are observed throughout the park and forage on native and nonnative vegetation. Some nonnative plant species that are considered wildlife forage would be treated. For example, red clover (*Trifolium repens*), which is considered high quality forage for grizzly bears would be treated in front country areas at the request of NPS bear management to remove it as a bear attractant near park developments. Invasive vegetation control activities would not occur in Bear Management Areas unless under consultation with the park's Bear Management Biologist. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed grizzly bears.

- **Canada lynx** are considered rare in Yellowstone National Park. Some invasive plant treatment would occur in lynx habitat. However, the small scale of this activity would have a negligible impact on lynx. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed Canada lynx.
- **Canada lynx critical habitat** has been designated in Yellowstone National Park. Invasive plant treatment would occur in specific areas in this habitat. The presence of invasive plants would indirectly affect the food and cover available to snowshoe hares, a primary lynx food source, if they became components of the forest understory in the designated habitat (J. Whipple, pers. comm.). No extensive changes in forest vegetation would be anticipated as a result of invasive plant treatments. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed Canada lynx critical habitat.

Because of the limited degree of disturbance associated with invasive vegetation management and native vegetation restoration under this alternative, the activities would be expected to have direct, short-term, negligible to minor adverse effects and long-term, negligible beneficial effects on threatened and special status wildlife species and their habitats in the park.

Cumulative Impact Analysis

Cumulative impacts for federally listed species and critical habitat under the ESA are those future actions by state and local governments or private parties that are reasonably certain to occur in the project area. The project area is entirely within Yellowstone National Park, and there are no private in-holdings within the park. The vast majority of the lands adjacent to the park are federally owned by the U.S. Forest Service (USFS) with the exception of the small gateway communities of West Yellowstone, Gardiner, Silver Gate, and Cooke City, and possible private in-holdings on USFS lands.

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on threatened and special status wildlife species and their habitats in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on the park's fish and wildlife, including threatened and special status species. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on them. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative A, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, negligible to minor adverse impacts and long-term, negligible beneficial effects on the park's threatened and proposed threatened wildlife species, critical habitat, and special status species. Vegetation restoration activities connected with park construction activities would have long-term, beneficial, and negligible effects on them. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would have direct, short-term, negligible to minor adverse, and long-

term, negligible beneficial impacts on threatened and special status wildlife species. When combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short-term, negligible to minor adverse and indirect, long-term, negligible to minor beneficial impacts on the park's threatened and proposed threatened wildlife species, critical habitat, and special status species. Actions proposed under this alternative "may affect but are not likely to adversely affect" federally listed species or critical habitat.

Alternative B (Preferred): Impacts on Threatened and Special Status Wildlife

Impact Analysis

Under Alternative B, overall Integrated Weed Management (IWM) would have short and long term, direct and indirect beneficial effects on native vegetation and threatened wildlife species forage and critical habitat due to utilizing an adaptive approach designed to preserve the biological diversity of native flora through prevention, containment, and control of invasive plants. Overall management of invasive, nonnative vegetation would create more threatened wildlife foraging opportunities.

Educational, preventive and collaborative efforts of the IWM approach are anticipated to have short and long term, indirect beneficial impacts to threatened wildlife use of native forage due to the increase in preventive measures which would reduce the need for invasive plant treatments. Potential impacts from specific activities under the IWM approach are described below.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts under Alternative B would affect the park's threatened and proposed threatened wildlife species, critical habitat, and special status species in the following ways.

Mechanical Treatments: Manual and mechanical removal of invasive plants would create localize disturbances to wildlife associated with access and hand work. Impacts to threatened and proposed threatened wildlife species and critical habitat would be short-term, negligible and adverse.

Chemical Treatments: Use of approved herbicides would leave some ingredients on the ground and on vegetation for a short time. There would be a small likelihood that grizzly bears may consume vegetation that was recently treated with herbicides. Herbicides selected for park use on invasive vegetation has shown negligible effect on threatened wildlife species. Impacts to threatened and candidate wildlife species and critical habitat would be short-term, negligible to minor and adverse.

Cultural Treatments: Cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would create localized disturbances and human activity and cause short term, negligible adverse as well as beneficial impacts to threatened wildlife species. For example, top soil conservation could be used to augment the recovery and regeneration of native plants from construction projects. Impacts to threatened and proposed threatened wildlife species and critical habitat would be short-term, negligible to minor and adverse.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target native plant species. Impacts to threatened and proposed threatened wildlife and critical habitat would be assessed and would not occur unless they would be determined to be less than short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor, short term adverse impacts to threatened wildlife species and critical habitat, resulting from disturbances activities. These impacts would be temporary and site-specific. As vegetation restoration is implemented, there would be a long-term benefit to wildlife due to revegetation of native plants toward the reestablishment of healthy vegetation communities and wildlife forage. Overall, the impact would be short-term negligible to minor adverse and long-term minor to moderate beneficial impacts on native vegetation, and threatened and proposed threatened wildlife and critical habitat.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances and access. Effects would include disturbance to vegetation and wildlife forage species. The impact of foot traffic and monitoring activities to threatened and proposed threatened wildlife and critical habitat would be direct, adverse, short-term and negligible.

Mitigation Measures would include removal of invasive vegetation considered to be high value forage to grizzly bears or that would potentially affect Canada lynx critical habitat would occur with consultation with the parks Threatened and Endangered Species Biologists. Existing NPS efforts do not overlap with previously documented wolverine occurrences, movements, or habitat, and so are not discussed further in this alternative given their proposed status. Access for invasive vegetation treatments would not occur in park designated Bear Management Areas unless under consultation with the park's Bear Management Biologist. Monitoring of nonnative plant control treatments would enable park staff to adjust treatment types to maximize control efforts with minimum impacts on native plant species. Restoration activities would use top soil conservation, be localized, create short-term disturbance, and provide long-term native vegetation growth.

Overall, survey and treatment activities under Alternative B would be expected to have short-term, negligible to minor adverse and minor long-term beneficial effects on threatened and candidate wildlife species and critical habitat.

Effects for listed species and critical habitat include:

- **Grizzly bears** are observed throughout the park and forage on native and nonnative vegetation. Some nonnative plant species that are considered wildlife forage would be treated. For example, red clover (*Trifolium repens*), which is considered high quality forage for grizzly bears, would be treated in front country areas at the request of NPS bear management to remove it as a bear attractant. Invasive vegetation control activities would not occur in Bear Management Areas unless under consultation with the park's Bear Management Biologist. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed grizzly bears.

- **Canada lynx** are considered rare in Yellowstone National Park. Some invasive plant treatment would occur in lynx habitat. However, the small scale of this activity would have a negligible impact on lynx. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed Canada lynx.

- **Canada lynx critical habitat** has been designated in Yellowstone National Park. Invasive plant treatment would occur in specific areas in this habitat. The presence of nonnative plants would indirectly affect the food and cover available to snowshoe hares, a primary lynx food source, if they became components of the forest understory in the designated habitat (J. Whipple, pers. comm). No extensive changes in forest vegetation would be anticipated as a result of invasive plant treatments. Actions proposed under this alternative "may affect but would not likely to adversely affect" listed Canada lynx critical habitat.

Because of the limited degree of disturbance associated with invasive vegetation management and native vegetation restoration under this alternative, there would be direct, short-term, negligible to minor adverse effects and long-term, negligible beneficial effects on threatened, candidate, and special status wildlife species and its critical habitat.

Cumulative Impact Analysis

Cumulative impacts for federally listed species and critical habitat under the ESA are those future actions by state and local governments or private parties that are reasonably certain to occur in the project area. The project area is entirely within Yellowstone National Park, and there are no private in-holdings within the park. The vast majority of the lands adjacent to the park are federally owned by the U.S. Forest Service (USFS) with the exception of the small gateway communities of West Yellowstone, Gardiner, Silver Gate, and Cooke City, and possible private in-holdings on USFS lands.

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on threatened and special status species wildlife species and their habitat in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on the park's fish and wildlife species, including threatened and special status wildlife species. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on threatened and them. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative B, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, negligible to minor adverse impacts and long-term, negligible beneficial effects on the park's threatened, proposed threatened, critical habitat, and special status species. Vegetation restoration activities connected with park construction activities would be expanded and have long-term, beneficial and negligible effects on them. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, negligible to minor adverse and long-term, negligible to minor beneficial impacts on threatened and special status wildlife species. When combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, negligible to minor adverse and indirect long-term, negligible to minor beneficial impacts on threatened and special

status wildlife species. Actions proposed under this alternative "may affect but are not likely to adversely affect" federally listed species or critical habitat.

Archeological Resources

Guiding Principles and Policies

Impacts to cultural resources are described in terms of type, context, duration, and intensity, which is consistent with the regulations of the Council of Environmental Quality (CEQ) that implement the National Environmental Policy Act (NEPA). These impact analyses are intended, however to comply with the requirements of both NEPA and section 106 of the NHPA (36 CFR Part 800, Protection of Historic Properties), impacts to cultural resources will be identified and evaluated by (1) determining the area of potential effects, (2) identifying historic properties present in the area of potential effects that were listed in or eligible to be listed on the National Register of Historic Places, (3) applying criteria of adverse effect to affected historic properties which are unevaluated, listed in, or eligible to be listed on the National Register, and (4) considering ways to avoid, minimize, or mitigate adverse effects.

Under ACHP's regulations, a determination of either "*adverse effect*" or "*no adverse effect*" also must be made for affected National Register-eligible historic properties. An "*adverse effect*" occurs whenever an impact alters, directly, or indirectly, any characteristics or historic properties that qualify it for inclusion on the National Register, e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by an alternative that would occur later in time, be farther removed in distance or be cumulative (36 CFR Part 800.5, *Assessment of Adverse Effects*). Although adverse effects under section 106 may be mitigated, the effect remains adverse. A determination of no adverse effect means there is an effect, but the effect would not diminish in any way the characteristics of the historic property that qualify it for inclusion on the National Register.

CEQ regulations and the NPS's *Conservation Planning, Environmental Impact Analysis and Decision-making* (Director's Order 12) also call for a discussion of the appropriateness of mitigation, as well as analysis of how effective the mitigation would be in reducing the intensity of a potential impact, for example, reducing the intensity of an impact from major to moderate or minor. However, any reeducation in intensity of an impact resulting from mitigation is an estimate of the effectiveness of mitigation under NEPA only. It does not suggest that the level of effect as defined by section 106 is similarly reduced. Although adverse effects under section 106 may be mitigated, the effect remains adverse.

A section 106 summary is included in the impact analysis sections under the preferred alternative. The section 106 summary is intended to meet the requirements of section 106 and is an assessment of the effect of the undertaking (implementation of the alternative) on historic properties based upon the criterion of effect and criteria of adverse effect found in the ACHP's regulations. Consideration of potential impacts on archeological resources is required under the provisions of Section 106 of the National Historic Preservation Act (36 CFR Part 800, Protection of Historic Properties) as well as other law, policy, and regulation. The NPS has developed policies that require consideration of the effects that proposed actions may have on properties listed in or eligible for inclusion in the National Register.

Methodology and Intensity Level Definitions

In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106, a determination of either "adverse effect" or "no adverse effect" must be made for archeological resources that are eligible for or listed on the National Register of Historic Places, along with consideration of ways to avoid, minimize, or mitigate any adverse effects. Impacts on archeological resources are described in terms of type, context, duration, and intensity, which is consistent with the Council on Environmental Quality regulations that implement the National Environmental Policy Act. An adverse effect occurs when an impact alters, directly or indirectly, those characteristics of a cultural resource that would qualify it for inclusion in the National Register (e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects c that could occur later, be farther removed in distance, or be cumulative (36 CFR Part 800.5, Assessment of Adverse Effects). A determination of no adverse effect means that any effect would not diminish the characteristics of the cultural resource that qualify it for inclusion in the National Register. Analyses of the potential impacts on archeological resources are derived from available information on the impacts from possible projects and activities. It is important to distinguish between the description of impacts as adverse—which refers to the fact that the impact is not desirable or negative in nature—and the formal determination of affect under Section 106. An action or impact can be adverse in nature but may not rise to an "adverse effect" determination under Section 106.

The impact intensities for archeology are:

- **Negligible:** Impact would not alter contributing features or patterns of the archeological property. The impact of the proposed projects is not measurable. For purposes of Section 106, the determination would be "no adverse effect".
- **Minor:** Impact would alter contributing features or patterns of the archeological property or its setting, but the integrity of the property is not diminished. Stabilization and preservation of character defining features and patterns in accordance with *The Secretary of the Interior's Standards for the Treatment of Historic Properties*, and *Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation* would be beneficial. For purposes of Section 106, the determination would be "no adverse effect".
- **Moderate:** Impact alters contributing features or patterns of an eligible archeological property, and the integrity is diminished or altered. The diminished or altered characteristics are easily measurable and quantifiable. For purposes of Section 106, the determination would be "adverse effect". A memorandum of agreement (MOA) would be executed among the National Park Service and applicable state historic preservation officer and, if necessary, the Advisory Council on Historic Preservation in accordance with 36 CFR 800.6(b).
- **Major:** Alteration of an archeological property would diminish the overall integrity of the resource. For purposes of Section 106, the determination would be "adverse effect". Measures to minimize or mitigate adverse impacts cannot be agreed upon and the National Park Service and applicable state historic preservation officer and/or Advisory Council are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Alternative A (No Action): Impacts on Archeological Resources

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Most invasive plant control would be localized and would entail spot removal or spraying of individual plants and control of larger patches with backpack sprayers. UTV with mounted boom sprayers occur on paved or previously disturbed areas. Revegetation would be limited to select areas associated with ground disturbing activities involving top soil conservation and direct native plant seeding.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts would affect the park's known and potential archeological resources in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Impacts to archeological resources would occur on a site-specific, localized level and would be short-term, negligible, and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground that may indirectly affect archeology with small amounts of chemical potentially reacting with surface artifacts. Limited use of off-road equipment for weed treatments would cause localized soil disturbance. Impacts to archeological resources would occur on a site-specific, localized level and would be short-term, negligible to minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances using hand tools and mechanized equipment. Impacts to archeology would be short-term, negligible to minor and adverse.

Mitigation Measures would include prior to major nonnative control treatments and vegetation restoration activities within archeological properties, a cultural resource specialist would help identify potential impacts. Because restoration activities would be confined to areas where archeological sites have historically been identified, no additional disturbance to archeological sites would occur. Because of the limited vegetation and surface disturbance and herbicide application, overall, there would be direct, short-term, and negligible to minor adverse effects on archeological resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on archeological resources in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by

top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on archeological resources. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on archeological resources. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative A, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, negligible to minor adverse impacts on the park's archeological resources. Vegetation restoration activities connected with park construction activities would have negligible impacts on archeological resources. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- negligible to minor adverse impacts on archeological resources. For purposes of Section 106, the determination would be "no adverse effect" on archeological resources under this alternative.

Alternative B (Preferred): Impacts on Archeological Resources

Impact Analysis

Actions associated with Alternative B would affect park archeological resources and would be short-term, direct and indirect, and adverse. Under Alternative B, park staff would apply an Integrated Weed Management (IWM) approach to identify and control invasive plant populations to preserve native flora through prevention, containment, and control of invasive plants. Education, prevention, and collaborative efforts of the IWM approach would have short-term indirect adverse and beneficial impacts to archeological resources due to prevention and reduction of weed treatment activities.

Survey and Treatments

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts under Alternative B would affect the park's archeological resources in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Impacts to archeological resources would occur on a site-specific, localized level and would be short-term, negligible to minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides would leave some ingredients on the ground that may indirectly affect archeology with small amounts of chemical potentially reacting with surface artifacts. Limited use of off-road equipment for weed treatments would cause localized soil disturbance. Impacts to archeological resources would occur on a site-specific, localized level and would be short-term, negligible to minor, and adverse.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would cause short term, negligible to minor adverse impacts to archeological resources.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. Impacts of burning on archeological resources would occur because of ground disturbance associated with burn activities and would be site-specific, short-term, adverse, and minor.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target native plant species. Impacts to archeology would occur because of foot access and be short-term, negligible and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor, short-term adverse impacts to archeological resources resulting from compaction, and ground disturbances due to the use of hand tools and mechanized equipment associated with native vegetation restoration. These impacts would be temporary and site-specific. Overall, the impact would be short-term minor, and adverse on archeological resources.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances and affects to archeological resources. Effects would include localized compaction and ground disturbance. To reduce impacts on soils, park staff would try to stay on trails where possible and access sites using areas most resilient to vegetation impacts, and work in small teams. The impact of foot traffic and monitoring activities to archeological resources would be adverse, short-term and negligible.

Mitigation Measures would include prior to major nonnative control treatments and vegetation restoration activities within archeological sites, a cultural resource specialist would help identify and reduce potential impacts. Known areas of high archeological sensitivity would not employ mechanized off-road equipment. Larger-scale ecological restoration efforts would have larger short-term effects on archeological resources. Because of the limited degree of vegetation disturbance, introduction of herbicide to areas that may contain archeological resources, and the Gardiner Basin restoration program, overall, there would be direct, short-term, negligible to minor adverse effects on park archeological resources.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have minor effects on archeological resources in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas and historic properties where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on archeological resources. These past, present, and foreseeable future activities are having short-term, negligible to minor adverse impacts on archeological resources. These impacts, combined with the short-term, negligible to

minor adverse impacts of Alternative B, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, negligible to minor adverse impacts on the park's archeological resources. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, negligible to minor adverse impacts on archeological resources. For purposes of Section 106, the determination would be no adverse effect on archeological resources.

Cultural Landscapes

Guiding Principles and Policies

Consideration of potential impacts on cultural landscapes is required under the provisions of Section 106 of the National Historic Preservation Act (36 CFR Part 800, Protection of Historic Properties). The NPS has developed policies that require consideration of the that effects proposed actions may have on properties listed in or eligible for inclusion in the National Register of Historic Places.

Methodology and Intensity Level Definitions

In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106, a determination of either adverse effect or no adverse effect must be made for affected cultural landscapes that are eligible for or listed on the National Register of Historic Places. Impacts on cultural landscapes are described in terms of type, context, duration, and intensity, as described above, which is consistent with the of the Council on Environmental Quality regulations that implement the National Environmental Policy Act. An adverse effect occurs when an impact alters, directly or indirectly, those characteristics of a cultural resource that would qualify it for inclusion in the National Register (e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects that would occur later, be farther removed in distance, or be cumulative (36 CFR Part 800.5, Assessment of Adverse Effects). A determination of no adverse effect means that there will be no effect that would diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the National Register. An impact can be adverse in nature but may not rise to an "adverse effect" determination under Section 106.

The impact intensities for cultural landscapes are:

- **Negligible:** Impact would not alter contributing features or patterns of the cultural landscape. The impact of the proposed projects is not measurable. For purposes of Section 106, the determination would be no "adverse effect".
- **Minor:** Impact would alter contributing features or patterns of the cultural landscape, but the integrity of the property is not diminished. The proposed projects are not detectable within fundamental viewsheds. Stabilization and preservation of character defining features and patterns in accordance with *The Secretary of the Interior's Standards for the Treatment of Historic Properties*, and T*he Secretary of the Interior's Standards for the Treatment of Historic Properties with Guideline for the Treatment of Historic Landscapes* would be

adverse or beneficial. For purposes of Section 106, the determination would be "no adverse effect".

- **Moderate:** Impact alters contributing features or patterns of a cultural landscape and the integrity is slightly diminished but it is only detectable from a small portion of the cultural landscape. A memorandum of agreement (MOA) is executed among the National Park Service and applicable state historic preservation officer and, if necessary, the Advisory Council on Historic Preservation. Rehabilitation and restoration of a landscape in accordance with *The Secretary of the Interior's Standards for the Treatment of Historic Properties*, and *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guideline for the Treatment of Historic Landscapes* would be adverse or beneficial. For purposes of Section 106, the determination of effect would be "adverse effect".
- **Major:** Alteration of a cultural landscape would diminish the overall integrity of the resource. Measures to minimize or mitigate adverse impacts cannot be agreed upon and the National Park Service and applicable state historic preservation officer and/or Advisory Council are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b). The proposed projects can be seen from/within a majority of the cultural landscape or historic district and can be seen within fundamental viewsheds. Reconstruction of a structure, building, or landscape in accordance with The Secretary of the Interior's Standards for the Treatment of Historic Properties and The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guideline for the Treatment of Historic Landscapes would be adverse or beneficial. For purposes of Section 106, the determination of effect would be "adverse effect".

Alternative A (No Action): Impacts on Cultural Landscapes

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides and limited cultural method activities. Most invasive plant control would be localized and would entail spot removal or spraying of individual plants and control of larger patches with backpack sprayers. Revegetation would be limited to select areas associated with ground disturbing activities involving top soil conservation and direct native plant seeding. Control of invasive vegetation would be beneficial to native vegetation and potentially beneficial to park cultural landscapes where native flora is identified as contributing. Nonnative vegetation that is identified as contributing to a cultural landscape as contributing would not be managed as an invasive plant species under this alternative. The potential for invasive plant control treatments to affect native plant species would create short- and long-term minor adverse and beneficial impacts to cultural landscapes.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts would have an effect on cultural landscapes in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling and use of hand tools. Impacts to cultural landscapes would be short-term, negligible to minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides and blue dye would leave some ingredients on the ground. Limited use of off-road equipment for weed treatments would cause localized disturbance. Impacts to cultural landscapes would be short-term, minor, and adverse.

Cultural Treatments: Cultural treatments would include on-site revegetation efforts associated with construction activities and would create localized ground disturbances using hand tools and mechanized equipment. Impacts to cultural landscaped would be short-term, minor and adverse and beneficial.

Mitigation Measures would be employed to minimize adverse impacts to cultural landscapes. Prior to major invasive control treatments and vegetation restoration activities within cultural landscapes, a cultural resource specialist would help identify potential impacts to cultural landscapes and identify measures to reduce impacts on them. Nonnative vegetation species identified as contributing to the historical setting would not be targeted for control treatments. Restoration activities would be localized and create short-term soil disturbance and long-term soil conservation and native vegetation growth. Because of the limited degree of vegetation disturbance, proposed mitigation measures, and the capacity to facilitate the conservation of native plants within cultural landscapes with invasive vegetation control and native vegetation restoration, Alternative A would be expected to have direct, short-term, minor adverse effects and long-term minor beneficial effects on cultural landscapes.

Cumulative Impact Analysis

Ongoing activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on cultural landscapes in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas and historic properties where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on the vegetation in cultural landscapes. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on cultural landscapes. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative A, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, minor adverse impacts and long-term, minor beneficial effects on vegetation within and adjacent to cultural landscapes. Vegetation restoration activities connected with park construction activities would have long-term, beneficial and minor effects. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, minor adverse and beneficial impacts on cultural landscapes in the park. For purposes of Section

106, the determination of effect would be no adverse effect to cultural landscapes under this alternative.

Alternative B (Preferred): Impacts on Cultural Landscapes

Impact Analysis

Actions associated with Alternative B would affect park cultural landscapes and would be short-term, direct and indirect, and adverse and beneficial. Under this alternative, park staff would apply an Integrated Weed Management (IWM) approach to identify and control invasive plant populations using to preserve native flora through prevention, containment, and control of invasive plants. Education, prevention, and collaborative efforts of the IWM approach would have short- and long-term indirect beneficial impacts to cultural landscapes due to prevention and reduction of expanded weed treatments. .

Control of invasive vegetation would be beneficial to native vegetation and potentially beneficial to park cultural landscapes where native flora is identified as contributing. Nonnative vegetation that is identified as contributing to a cultural landscape as contributing would not be managed as an invasive plant species under this alternative. The potential for invasive plant control treatments to affect native plant species would create short- and long-term minor adverse and beneficial impacts to cultural landscapes.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Proposed invasive plant control efforts would affect cultural landscapes in the following ways.

Proposed invasive plant control efforts would affect cultural landscapes in the following ways.

Mechanical Treatments: Manual and mechanical removal of individual invasive plants would create localized ground disturbances from hand pulling or use of hand tools for individual plants. Impacts to cultural landscapes would occur on a site-specific, localized level and would be short-term, minor, and adverse.

Chemical Treatments: Localized use of limited approved herbicides and blue dye would leave some ingredients on the ground that may affect vegetation and cultural landscapes. Limited use of off-road equipment for weed treatments would cause localized soil disturbance. Impacts to cultural landscapes resources would occur on a site-specific, localized level and would be short-term, minor and adverse.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would cause short term, minor adverse as well as beneficial impacts to cultural landscapes. For example, ground disturbance from top soil conservation could be used to augment the recovery of disturbed soils and regeneration of native plants from construction projects.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas.

Impacts of burning on cultural landscapes would occur because of ground disturbance associated with burn activities and would be site-specific, short-term, minor, adverse and beneficial.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance has been completed as to their effectiveness and potential impacts on non-target native plant species. Impacts to cultural landscapes would not occur unless they would be determined to be to be less than short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor, short-term adverse and beneficial impacts to cultural landscapes resulting from compaction, and ground disturbances due to the use of hand tools and mechanized equipment associated with native vegetation restoration. These impacts would be temporary and site-specific. Overall, the impact would be short-and long-term minor, and adverse on native vegetation and cultural landscapes.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause negligible short-term adverse disturbances and affects to cultural landscapes. Effects would include localized compaction and ground disturbance. To reduce impacts on vegetation, park staff would try to stay on trails where possible and access sites using areas most resilient to vegetation impacts, and work in small teams. The impact of foot traffic and monitoring activities to cultural landscapes would be adverse, short-term and negligible.

Overall, survey and treatment activities under Alternative B would be expected to have short-term, negligible to minor adverse and beneficial effects on park cultural landscapes.

Mitigation Measures would be employed to minimize adverse impacts to cultural landscapes. Prior to major invasive control treatments and vegetation restoration activities within cultural landscapes, a cultural resource specialist would help identify potential impacts to cultural landscapes and identify measures to reduce impacts on them. Nonnative vegetation species identified as contributing to the historical setting would not be targeted for control treatments. Restoration activities would be localized and create short-term soil disturbance and long-term soil conservation and native vegetation growth. Because of the limited degree of vegetation disturbance, proposed mitigation measures, and the capacity to facilitate the conservation of native plants within cultural landscapes with invasive vegetation control and native vegetation restoration, Alternative B would be expected to have direct, short-term, minor adverse effects and long-term minor beneficial effects on cultural landscapes.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on native vegetation in the park. Road maintenance and reconstruction activities require disturbance and removal of soils by heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas and historic properties where soils may be removed and vegetation disturbed for general operation practices. Impacts would be reduced by top soil conservation and native plant growth after project completion. Backcountry operations and trail maintenance involves localized plant disturbance and soil compaction. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on vegetation resources in and adjacent to cultural landscapes. These past,

present, and foreseeable future activities are having short-term, minor adverse impacts on cultural landscapes. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Implementation of an Integrated Weed Management program in Yellowstone National Park would have direct, short-term, minor adverse impacts and long-term, minor beneficial effects on vegetation within and adjacent to cultural landscapes. Vegetation restoration activities connected with park construction activities would be expanded and have long-term. minor beneficial impacts on cultural landscapes. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, minor adverse impacts and short- and long-term, minor beneficial effects on cultural landscapes in the park. For purposes of Section 106, the determination would be no adverse effect to cultural landscapes under this alternative.

Health and Human Safety

Guiding Principles and Policies

The National Park Service is concerned about the safety of visitors to its parks and cooperates with proposals to enhance visitor safety as long as those proposals do not result in a derogation of park resources or conflict with the current or planned use of NPS property (NPS 2006). The safety of staff, volunteers, and contractors is also a top priority for the NPS. The 2006 NPS Management Policies state that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The policies also state, "While recognizing that there are limitations on its capability to totally eliminate all hazards, the National Park Service and its concessionaires, contractors, and cooperators will seek to provide a safe and healthful environment for visitors and employees" (sec. 8.2.5.1). Further, the NPS will strive to "protect human life and provide for injury-free visits" (sec.8.2.5.1).

Methodology and Intensity Level Definitions

The analysis of human health and safety was based on previous experience with projects of similar scope and characteristics. Analysis of the potential intensity of impacts on safety was derived from the available information on the park and best professional judgment. For details on herbicides used in the park and their effect on human health and safety, see Appendix 7.

Impact intensities for safety are:

- **Negligible:** The impact on visitor or park personnel safety would not be measurable or perceptible.
- **Minor:** The impact would be measurable or perceptible, but it would be limited to a relatively small number of visitors or park personnel in localized areas. Mitigation measures would be followed to offset any adverse effects.
- **Moderate:** The impact would be measurable and perceptible and would involve a large number of visitors or park personnel in many areas of the park.
- **Major:** The impact would be substantial. Impacts on the safety of park visitors and park personnel would be readily apparent throughout the park.

Alternative A (No Action): Impacts on Health and Human Safety

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Trips and falls on uneven terrain, injury from vegetation hand tools, UTV and other vehicle mishaps, muscle strains and pulls from lifting and moving large and/or heavy objects, and repetitive stress injuries from constant bending, pulling invasive plants, weather exposure and other activities. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts would have some effects on health and human safety in the park in the following ways.

Mechanical Treatments: Manual and mechanical removal of invasive plants would result in physical activity and strains from pulling or with hand tools for individual plants. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Chemical Treatments: Use of approved herbicides would result in exposure by park staff and visitors. Project staff would have the greatest direct exposure to project activities and herbicide exposure. Threats of injury originate from the potential for accidents from herbicide exposure during mixing and application. Dangers to the public would be minimal and would include exposure to recently applied herbicide. Use of UTV equipment and risks of accidents associated with herbicide application would affect employee safety. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Cultural Treatments: Cultural treatments would include revegetation associated with construction activities and would affect human health safety with the use of hand tools and mechanized equipment. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Mitigation Measures would include use of UTVs, equipment, and materials that comply with applicable safety plans and guidelines. Appropriate personal protective equipment would be used during control treatments. Federal regulations regarding herbicide use would be followed at all times. Herbicide use would be approved annually in consultation with regional and national NPS Integrated Pest Management specialists. Herbicides would be applied by or under the supervision of a certified pesticide applicator, and in conformance with label instructions. Copies of the labels and Material Safety Data Sheets (MSDS) would be kept onsite when herbicides are used. Appropriate signage and closures would be used when applying herbicides in public areas. Accidents, as well as near-miss incidents, would be reported to the Yellowstone Safety Office and lessons learned are immediately relayed to project staff and incorporated into future safety training. Training would be the primary tool used to reduce the incidence of accidents. Invasive vegetation control activities would have short-term risks for visitors and short- and long-term risks for park staff directly engaged in applying them. Because of the limited degree of risk and the mitigation measures implemented, overall invasive vegetation management under this alternative would be expected to have direct, short- and long-term, minor to moderate adverse effects on health and human safety.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on health and human safety in the park. Road maintenance and reconstruction activities require risks associated with heavy equipment operation. Most facilities maintenance takes place in developed areas where there may be increase staff and visitors around general operation practices. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on human safety. These past, present, and foreseeable future activities are having a short- and long-term, minor to moderate adverse impact on health and human safety. These impacts, combined with the short term, minor adverse impacts of Alternative A, would result in short-term, minor to moderate adverse cumulative impacts.

Conclusion

Continued invasive vegetation management efforts would have direct, short- and long-term and minor to moderate adverse impacts on health and human safety in the park. Vegetation restoration activities connected with park construction activities would have short- and long-term adverse and minor to moderate impacts on human health and safety. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short- and long-term, minor to moderate adverse impacts on health and human safety for park staff and visitors.

Alternative B (Preferred): Impacts on Health and Human Safety

Impact Analysis

Actions associated with Alternative B would affect human health and safety. Park staff would expand current practices to identify and control invasive plant populations using an Integrated Weed management (IWM) approach that would adapt weed control treatments toward cost-effective and human safety solutions. Park staff would comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would employ adaptive practices to control invasive plant populations using manual control, approved chemical herbicides, cultural method activities. Ecological vegetation restoration would be developed, including the implementation of the Gardiner Basin Restoration Plan. Restoration would also be associated with ground disturbing activities and would involve top soil conservation and some direct native plant seeding. Trips and falls on uneven terrain, injury from vegetation hand tools, UTV and other vehicle mishaps, muscle strains and pulls from lifting and moving large and/or heavy objects, and repetitive stress injuries from constant bending, pulling invasive plants, weather exposure and other activities. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts would have some effects on health and human safety in the park in the following ways.

Mechanical Treatment: Manual and mechanical removal of invasive plants would result in physical activity and strains with pulling or use of hand tools for individual plants and using

motorized equipment. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Chemical Treatments: Use of approved herbicides would result in some degree of exposure by park staff and visitors. Project staff would have the greatest direct exposure to project activities and herbicide exposure. Threats of injury originate from the potential for accidents from herbicide exposure during mixing and application. Dangers to the public are minimal and would include exposure to recently applied herbicide. Use of UTV equipment associated with herbicide application would affect employee safety. Impacts to health and human safety would be short- and long-term, adverse, minor to moderate.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would affect park staff with using hand tools and mechanized equipment and cause short term, minor to moderate adverse impacts to human health and safety.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. Impacts of burning activities on human health and safety would occur because of risks associated with fire activities and would be short- and long-term, minor to moderate, and adverse impacts.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance have been completed as to their effectiveness and potential impacts. Impacts to human health and safety would occur as potential distribution of agents would involve foot travel, and be short-term, minor and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor to moderate, short-term adverse impacts to health and safety resulting from the use of hand tools and mechanized equipment associated with native vegetation restoration. These impacts would be temporary. Overall, the impacts would be short-term minor to moderate, and adverse on human health and safety.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause minor short-term adverse impacts to health and safety The impact of foot traffic and monitoring activities to human and safety would be adverse, short-term and minor.

Mitigation Measures would include use of UTVs, equipment and materials that comply with applicable safety plans and guidelines. Appropriate personal protective equipment would be utilized during control treatments. All federal regulations regarding herbicide use would be followed at all times. Herbicide use would be approved annually in consultation with NPS regional and Washington Office IPM specialists. Herbicides would be applied by, or under the supervision of a certified pesticide applicator. Herbicides would be applied in conformance with label instructions and copies of the label and MSDS would be kept onsite when herbicides are used. Appropriate signage and/or closures would be used when applying herbicides in public areas. Accidents, as well as near-miss incidents, are reported to the Yellowstone Safety Office and lessons learned are immediately relayed to project staff and incorporated into safety training, which is the primary tool used to reduce the incidence of accidents. Restoration activities would follow appropriate safety measures. Invasive vegetation control activities would create short-term risks to visitors and short- and long-term risks to park staff directly engaged in them. Accidents, as well as near-miss incidents, are reported to the Yellowstone Safety Office and lessons learned are immediately relayed to project staff and incorporated into future safety training. Training would be the primary

tool used to reduce the incidence of accidents, Impacts to health and human safety would be short- and long-term, adverse, minor to moderate. Because of the limited degree of risk and the mitigation measures implemented, invasive vegetation management under this alternative would be expected to have direct, short- and long-term, minor to moderate adverse effects on health and human safety.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on health and human safety in the park. Road maintenance and reconstruction activities require risks associated with heavy equipment operation. Most facilities maintenance takes place in developed areas where there may be increase staff and visitors around general operation practices. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking which will likely place additional pressures on human safety. These past, present, and foreseeable future activities are having a short- and long-term, minor to moderate adverse impact on health and human safety. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, minor to moderate adverse cumulative impacts.

Conclusion

Proposed invasive vegetation management efforts would have direct, short- and long-term and minor to moderate adverse impacts on health and human safety in the park. Vegetation restoration activities connected with park construction activities would have short- and long-term adverse and minor to moderate impacts on human health and safety. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short- and long-term, minor to moderate adverse impacts on health and human safety for park staff and visitors.

Visitor Use and Experience

Guiding Principles and Policies

The 2006 NPS Management Policies state that enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of national parks and that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy them (Section 1.4.3). The NPS Management Policies also states that scenic views and visual resources are considered highly valued characteristics that the NPS should strive to protect. The aspects of the visitor use and experience affected by invasive vegetation management are access, visual quality, encounter levels, and opportunities for solitude. Other aspects of visitor use and experience would generally be unaffected by the actions proposed.

Methodology and Intensity Level Definitions

To determine impacts, invasive vegetation management activities were evaluated for their potential effects on current and past visitor uses and experiences, such as photography, scenic viewing, hiking, fishing, camping, and horseback riding. This section analyses the impacts on visitor use and experience of protecting and restoring native plant communities. For details on herbicides used in the park and their effect on visitor health and safety, see Appendix 7.

The impact intensities for visitor use and experience are:

- **Negligible:** Impacts associated with invasive vegetation management would be slight and, if detectable, would be very short-term and highly localized. Visitors would not likely be aware of them or affected by them. There would be no noticeable change in visitor use and experience in any defined indicators of visitor satisfaction or behavior.
- **Minor:** Impacts would be detectable but short-term and localized. Visitors would likely be aware of them, but visitor use and experience would be neither diminished nor improved. Changes would be slight and detectable, but would not appreciably limit or enhance the critical characteristics of the visitor experience. Visitor satisfaction would remain unchanged.
- **Moderate:** Impacts would be detectable, short- or long-term, but not be localized. Visitors would be aware of them, and visitor use and experience would be diminished or improved somewhat. A few critical characteristics of the existing visitor experience would change, and the number of visitors engaging in a specified activity would be altered. Some visitors participating in an activity might have to pursue it in another local or regional area. Visitor satisfaction at the park would either decline or increase.
- **Major:** Impacts would be detectable, frequent, long-term, and cover a large area. Visitors would be readily aware of them, and visitor use and experience would be substantially diminished or increased. A number of critical characteristics of the existing visitor experience would change and/or the number of participants engaging in an activity would be greatly reduced or increased. Many visitors who desire to continue using and enjoying an activity or visitor experience would have to pursue it in another local or regional area. Overall visitor satisfaction would markedly decline or increase.

Alternative A (No Action): Impacts on Visitor Use and Experience

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Current NPS efforts to control invasive plants occur in all areas of the park each year from approximately June through September, the peak season for visitors. Park staff would continue current practices to identify and control invasive plant populations using the current methods: manual control, use of approved chemical herbicides, and limited cultural methods. Visitors would be exposed to park staff implementation invasive plant treatments. Impacts on visitor use and experience from observing invasive vegetation management activities would be localized, short-term, negligible to minor, and adverse.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Some invasive plant management activities would likely to occur while visitors are present and affect visitor use and experience in the following ways.

Mechanical Treatments: Most invasive plant control would be localized and would entail visitors observing park staff hand pulling and using hand tools for individual plants. Impacts on visitor use

and experience from invasive vegetation management activities would be localized, short-term, negligible, and adverse.

Chemical Treatments: This would involve visitors observing spraying individual plants and control of larger patches with backpack or UTV-mounted boom sprayers. The experience of some visitors could be affected by use of these techniques, including the presence of crews wearing Personal Protective Equipment and blue marker dye on the ground. Temporary closures may be necessary (e.g., campground loop or trail) and slow-moving vehicles treating roadside areas would delay some visitors. These management activities would have short-term effects generally lasting less than a day and most only a few hours. Impacts on visitor use and experience from invasive vegetation management activities would be localized, short-term, negligible to minor, and adverse.

Cultural Treatments: Revegetation would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some seeding of native plants. Impacts on visitor use and experience from observing invasive vegetation management activities would be localized, short-term, negligible to minor and adverse.

Mitigation Measures would include conducting, when possible, invasive vegetation management activities and closures when fewer visitors are likely to be affected (early morning, avoid congested areas during peak season, etc.). Signage and other means of informing visitors about the impacts of invasive vegetation and the need to control it may also help reduce visitor experience impacts.

Impacts on visitor use and experience from invasive vegetation management activities would be localized, short-term, negligible to minor and adverse. Over the long-term, there would be a minor improvement in the visitor experience as visitors become more informed about the reason for invasive vegetation management and the restoration of native plant communities. These beneficial impacts would include reversing impacts of invasive vegetation on recreational activities such as photography, scenic viewing, and viewing annual wildflower blooms. Overall, invasive vegetation management activities under this alternative would be expected to have direct, short-term, negligible to minor adverse effects on visitor use and experience.

Cumulative Impact Analysis

Ongoing major park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on overall visitor use and experience. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking, which will likely place additional impacts on access, availability and quality of visitor experiences. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on visitor use and experience. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative A, would result in short-term, negligible to minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Invasive vegetation management activities would have direct, short-term, minor adverse impacts on visitor use and experience. Vegetation restoration activities connected with park construction activities would have short-term, minor adverse impacts on visitor use and experience. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short-term, negligible to minor adverse impacts on visitor use and experience.

Alternative B (Preferred): Impacts on Visitor Use and Experience

Impact Analysis

Actions associated with Alternative B would affect visitor use and experience. Park staff would identify and control invasive plant populations using an Integrated Weed management (IWM) approach that would adapt weed control treatments toward cost-effective, environmental solutions and would employ adaptive practices to control invasive plant populations using an array of control activities. Park efforts to control invasive plants occur in all areas of the park each year from approximately June through September, the peak season for visitors. Ecological vegetation restoration would be developed, including the implementation of the Gardiner Basin Restoration Plan. Visitors would be exposed to park staff implementation of invasive plant treatments. Impacts on visitor use and experience from observing invasive vegetation management activities would be localized, short-term, and negligible to minor.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Invasive plant control efforts would have some effects on health and human safety in the park in the following ways.

Mechanical Treatment: Most invasive plant control would be localized and would entail park staff hand pulling and using hand tools for individual plants. Impacts on visitor use and experience from invasive vegetation management activities would be localized, short-term, and negligible.

Chemical Treatments: This would involve spot removal or spraying individual plants and control of larger patches with backpack or UTV-mounted boom sprayers. The experience of some visitors could be affected by observing the use of these techniques, including the presence of crews wearing Personal Protective Equipment and blue marker dye on the ground. Temporary closures may be necessary (e.g., campground loop or trail) and slow-moving vehicles treating roadside areas may delay some visitors. These management activities would have short-term effects generally lasting less than a day and most only a few hours. Impacts on visitor use and experience from observing invasive vegetation management activities would be localized, short-term, and negligible to minor.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would affect visitor use and experience. Impacts on visitor use and experience from observing invasive vegetation management activities would be localized, short-term, negligible to minor and adverse.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. Impacts of burning activities on visitor use and experience would occur because of higher visibility and smoke associated with fire activities and would be short- and long-term, minor, and adverse.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance have been completed as to their effectiveness and potential impacts. Impacts to visitor use and experience would occur as potential distribution would involve foot travel, and be short-term, negligible and adverse.

Restoration: Larger-scale ecological restoration projects such as the Gardiner Basin restoration project would cause minor to moderate, short-term adverse impacts visitor use and experience resulting from observations of staff and contractors using hand tools and mechanized equipment associated with native vegetation restoration. These impacts would be temporary. Overall, the impacts would be short-term negligible to minor and adverse on visitor use and experience.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause minor short-term adverse impacts to visitor use and experience The impact of foot traffic and monitoring activities to visitor use and experience would be adverse, short-term and negligible.

Mitigation Measures would include conducting, when possible, invasive vegetation management activities and closures when fewer visitors are likely to be affected (early morning, avoid congested areas during peak season, etc.). Signage and other means of informing visitors about the impacts of invasive vegetation and the need to control it may also help reduce visitor experience impacts. Impacts on visitor use and experience from invasive vegetation management activities would be localized, short-term, and negligible. Over the long-term, there would be a minor improvement in the visitor experience as visitors become more informed about the reason for invasive vegetation management and the restoration of native plant communities. These beneficial impacts would include reversing impacts of invasive vegetation on recreational activities such as photography, scenic viewing, and viewing annual wildflower blooms. Overall, invasive vegetation management activities under this alternative would be expected to have direct, short-term, negligible to minor adverse effects on visitor use and experience. Actions associated with Alternative B would affect visitor use and experience. Invasive vegetation management under this alternative would be expected to have direct, short-term, negligible to minor adverse effects on visitor use and experience.

Cumulative Impact Analysis

Ongoing major park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on overall visitor use and experience. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking, which will likely place additional impacts on access, availability and quality of visitor experiences. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on visitor use and experience. These impacts, combined with the short-term, negligible to minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management activities would have direct, short-term, minor adverse impacts on visitor use and experience. Vegetation restoration activities connected with park construction activities would have short-term adverse and negligible to minor impacts on visitor use and experience. In conclusion, when combined with past, present, and foreseeable future actions, Alternative B would be expected to have direct, short-term, minor adverse impacts on visitor use and experience.

Park Operations

Guiding Principles and Policies

The 2006 NPS Management Policies do not contain a specific chapter on park operations; however, virtually every action or proposal that is evaluated in this NEPA process has either a direct or indirect effect on park operations. There are also a number of Director's Orders that pertain to park operations.

Methodology and Intensity Level Definitions

Essential park operations include interpretation, maintenance, administration, law enforcement, visitor protection, and resource management. Park staff manage nine visitor centers, museums, and contact stations; 1,700 administrative buildings, 12 campgrounds with more than 2,150 sites; 466 miles of roads; 15 miles of boardwalk; 1,100 miles of trails with 92 trailheads; and 301 backcountry campsites. Natural and cultural resources include threatened and endangered species; 412 species of mammals and birds, birds, fish, reptiles and amphibians; over 10,000 hydrothermal features; 1,500 archeological sites; 379,000 cultural objects and natural science specimens; and 5 million items in the park archives. The NPS employs more than 800 people during the peak summer season; park concessioners, 3,400 people.

Implementation of the proposed plan would affect the operations of the park including the number of employees needed; the type of duties that need to be carried out; who would perform these duties and when and how; and administrative procedures. Additional staff would need to be hired to carry out the invasive vegetation plan. Other park divisions, concessioners, and private sector contractors would need to comply with additional requirements to meet program objectives. The proposed actions would affect park operations throughout the park during the periods that those operations occur. For details on herbicides used in the park and their effect on park staff health and safety, see Appendix 7.

The impact intensities for park operations are:

- **Negligible:** No effect or no appreciable affect; the effect would be at or below the lower levels of detection.
- **Minor:** The effect would be detectable, but would be of a magnitude that would not have an appreciable adverse or beneficial effect on park operations. If mitigation were needed to offset adverse effects, it would be relatively simple and successful.
- **Moderate:** The effects would be readily apparent and would result in a substantial adverse or beneficial change in park operations in a manner noticeable to staff and the public. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful.
- **Major:** The effects would be readily apparent and would result in a substantial adverse or beneficial change in park operations in a manner noticeable to staff and the public, and be markedly different from existing operations. Mitigation measures to offset adverse effects would be needed, could be expensive, and their success could not be guaranteed.

Alternative A (No Action): Impacts on Park Operations

Impact Analysis

Existing NPS efforts would continue to control invasive vegetation in Yellowstone National Park. Park staff would continue to comply with existing weed management laws and policies to identify and prevent the spread of nonnative invasive plants, and would continue current practices to control invasive plant populations using manual control, approved chemical herbicides, and limited cultural method activities. Park staff, contractors, and concessioners would continue to be involved in the inspection and approval of gravel pits and source materials for park use, and cleaning earth-moving equipment prior to use within park. These activities would have short-term, minor adverse effects on park operations. Resource management staff would accomplish the goals of this program with existing funding levels. Because of the limited degree of risk, invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on park operations.

Survey and Treatment

These activities would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including revegetation. Invasive plant control efforts would have some effects on park operations in the following ways.

Mechanical Treatment: Manual and mechanical removal of invasive plants would result in physical activity with hand tools and motorized equipment by park staff and volunteers. Invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on park operations.

Chemical treatments: Use of approved herbicides would be applied by park staff. and could result in exposure by park staff and visitors. Project staff would have the greatest direct exposure to herbicides. Invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on park operations.

Cultural Treatments: Revegetation would be limited to select areas associated with ground disturbing activities and would involve top soil conservation and some seeding of native plants. Impacts on park operations from invasive vegetation management activities would be localized, short-term, minor and adverse.

Mitigation Measures would include use of UTVs, equipment, and materials that comply with applicable safety plans and guidelines. Herbicides would be applied by or under the supervision of a certified pesticide applicator, and in conformance with label instructions. Prevention measures would include use of inspection and approval of gravel pits and source materials for park use, and cleaning earth-moving equipment prior to use within park. Overall, survey and treatment activities under Alternative A would be expected to have short-term, minor adverse effects on park operations.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on park operations. Road maintenance and reconstruction activities would have impacts associated with heavy equipment operation and disturbance and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where there may be increase staff and visitors around general operation practices. Park visitation is expected to increase along with recreational

use such as angling, camping, and hiking, which will likely place additional pressures on park operations. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on park operations. These impacts, combined with the short-term, minor adverse impacts of Alternative A, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative A to this cumulative impact would be minimal.

Conclusion

Continued invasive vegetation management efforts would have direct, short-term, minor adverse impacts on park operations. Vegetation restoration activities connected with park construction activities would have short-term, minor adverse impacts on park operations. In conclusion, when combined with past, present, and foreseeable future actions, Alternative A would be expected to have direct, short-term, minor adverse impacts on park operations.

Alternative B (Preferred): Impacts on Park Operations

Impact Analysis

Actions associated with Alternative B would affect park operations. Park staff would expand current practices to identify and control invasive plant populations using cost-effective and environmentally sound solutions. These would include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation.

Park staff, contractors, and concessioners would continue to be involved in the inspection and approval of gravel pits and source materials for park use, and cleaning earth-moving equipment prior to use within park. These activities would have short-term, minor adverse effects on park operations. Resource management staff would accomplish the goals of this program with existing funding levels. Because of the limited degree of risk, invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on park operations.

Survey and Treatment

These activities include manual and mechanical control, use of approved chemical herbicides, and cultural method activities including fire, revegetation, and cultivation, and the possible use of limited biological control with additional review and compliance. Proposed invasive plant control efforts would have some effects on park operations in the following ways.

Mechanical Treatment: Most invasive plant control would be localized and would entail park staff and volunteers hand pulling and using hand tools for individual plants. Impacts on park operations from invasive vegetation management activities would be localized, short-term, and negligible.

Chemical Treatments: Use of approved herbicides would be applied by park staff. and could result in exposure by park staff and visitors. Project staff would have the greatest direct exposure to herbicides. Invasive vegetation management under this alternative would be expected to have direct, short-term, minor adverse effects on park operations.

Cultural Treatments: Activities implemented under cultural treatments (revegetation, top soil conservation, fire, shading, and use of competition from native plants) would cause short term, minor adverse impacts to park operations.

Burns, primarily as part of vegetation restoration, would be employed to reduce invasive plant build-up and seed sources and increase nutrient availability in soil in very site-specific areas. Impacts of burning activities on park operations would occur because of smoke associated with fire activities and would be short- and long-term, minor, and adverse.

Biological Control: Limited use of biological control agents would be considered only after other control treatments prove to be ineffective and a thorough review and appropriate analysis and compliance have been completed as to their effectiveness and potential impacts. Impacts to park operations would occur as potential distribution would involve foot travel, and be short-term, negligible and adverse.

Restoration: Larger-scale ecological restoration projects, such as the Gardiner Basin restoration project would cause minor short-term adverse impacts park operations resulting from the staff and contractors using hand tools and mechanized equipment associated with native vegetation restoration. These impacts would be temporary. Overall, the impacts would be short-term negligible to minor and adverse on park operations.

Recordkeeping and Monitoring: Foot traffic and activities related to monitoring would cause minor short-term impacts to park operations. The impact to park operations would be adverse, short-term and negligible.

Mitigation Measures would include use of UTVs, equipment, and materials that comply with applicable safety plans and guidelines. Herbicides would be applied by or under the supervision of a certified pesticide applicator, and in conformance with label instructions. Prevention measures would include use of inspection and approval of gravel pits and source materials for park use, and cleaning earth-moving equipment prior to use within park. Overall, survey and treatment activities under Alternative B would be expected to have short-term, minor adverse effects on park operations.

Cumulative Impact Analysis

Ongoing park activities such as road reconstruction and maintenance, NPS and concession facilities repair and maintenance, and hazard fuels reduction projects would continue to have adverse effects on park operations. Road maintenance and reconstruction activities would have impacts associated with heavy equipment operation and contribute to invasive plant infestations. Most facilities maintenance takes place in developed areas where there may be increase staff and visitors around general operation practices. Park visitation is expected to increase along with recreational use such as angling, camping, and hiking, which will likely place additional pressures on park operations. These past, present, and foreseeable future activities are having short-term, minor adverse impacts on park operations. These impacts, combined with the short-term, minor adverse impacts of Alternative B, would result in short-term, minor adverse cumulative impacts. The contribution of Alternative B to this cumulative impact would be minimal.

Conclusion

Proposed invasive vegetation management actions would have direct, short-term, minor adverse impacts on park operations. Vegetation restoration following construction in the park would have short-term, minor adverse impacts on park operations. When combined with past, present, and foreseeable future actions, Alternative B is expected to have direct, short-term, minor adverse impacts on park operations.

Consultation and Coordination

Internal Scoping

Internal scoping was conducted by an interdisciplinary team of professionals from the park. Team members met to discuss the purpose and need for the project; various alternatives; potential environmental impacts; past, present, and reasonably foreseeable projects that may have cumulative effects; and possible mitigation measures. The team also gathered background information and discussed public outreach for the project. Over the course of the project, team members have conducted site visits to evaluate the proposed project sites.

External Scoping

External scoping was conducted to inform various agencies and the public about the proposal to develop an invasive vegetation management plan for the park and to generate input for preparation of this environmental assessment. The scoping effort began on March 31, 2011, with a press release, mailing to interested parties, and posting of a newsletter on the NPS Planning, Environment and Public Comment (PEPC) website. The 30-day scoping period ended on April 30, 2011. A total of 11 pieces of correspondence were received containing comments which fell into seven general categories. The scoping comments are discussed further in the section on Purpose and Need.

Agency Consultation

Endangered Species Act

As required under the Endangered Species Act, the National Park Service contacted the U.S. Fish and Wildlife Service regarding the potential impact of Invasive plant management on the park's three federally listed species: the Canada lynx, the grizzly bear, and the gray wolf that could be affected by this project. The USFWS determined that implementation of either alternative may affect but is not likely to adversely affect" any of these species. For details, see the section on threatened and special status species under" Environmental Consequences."

National Historic Preservation Act

For all archeological and historic properties including cultural landscapes, the proposed invasive vegetation management activities fall within the standard procedures outlined in Section 106 of the National Historic Preservation Act. Both of the proposed alternatives would be expected to have direct, short-term, minor adverse impacts on archeological resources and direct, short- and long-term, minor adverse impacts and short- and long-term, minor beneficial effects on cultural landscapes in the park. Preliminary consultation and concurrence of no adverse effect for the project was received from the Montana State Historic Preservation Office in 2012 and inquiries concerning the project from the Wyoming State Historic Preservation Office have been addressed. Final determination of effect will be conducted through review of this environmental assessment. Subsequent site-specific consultations will take place as actions are designed more fully. The results of this consultation are described in the Cultural Resources section in the Environmental Consequences chapter.

Native American Consultation

A scoping letter describing the proposed action was mailed to 102 Native American tribal government officials and tribal members belonging to 27 tribes traditionally associated with the park. No comments or correspondence related to the proposed action have been received at the time of this writing. The following tribes were contacted:

- Assiniboine & Sioux Tribes, Fort Peck
- Blackfeet Tribe
- Cheyenne River Sioux Tribe
- Coeur d'Alene Tribe
- Comanche Tribe of Oklahoma
- Confederated Salish and Kootenai Tribes
- Confederated Tribes of the Colville Indian Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Crow Creek Sioux Tribe
- Crow Tribe
- Eastern Shoshone Tribe
- Flandreau Santee Sioux Tribe
- Gros Ventre and Assiniboine Tribes
- Kiowa Tribe of Oklahoma
- Lower Brule Sioux Tribe
- Nez Perce Tribe
- Northern Arapaho Tribe
- Northern Cheyenne Tribe
- Oglala Sioux Tribe
- Rosebud Sioux Tribe
- Shoshone-Bannock Tribes
- Sisseton-Wahpeton Sioux Tribe
- Spirit Lake Sioux Tribe
- Standing Rock Sioux Tribe
- Turtle Mountain Band of Chippewa Indians
- Yankton Sioux Tribe

Release of this Environmental Assessment will be accompanied by additional correspondence to the tribal mailing list to request input and comments.

Environmental Assessment Review and List of Recipients

The EA will be released for public review on February 21, 2013. An NPS letter or press release will be distributed to various agencies, tribes, and members of the public on the park's mailing list and posted on the Planning, Environment and Public Comment website (http://parkplanning.nps.gov/yell) along with the EA. Copies of the document will also be provided to interested individuals who request by writing to the NPS address at the beginning of this document.

The EA is subject to a 30-day public comment period. During this time, the public is encouraged to submit their written comments to the NPS address provided at the beginning of this document. All public comments will be read and analyzed prior to the release of a decision document. The NPS will issue responses to substantive comments received during the public comment period, and will make appropriate changes to the environmental assessment as needed.

List of Preparers

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Appendix 1

Invasive Vegetation Authority and Policy

The National Park Service (NPS) is mandated to prevent exotic plant introduction and to control established exotic plants by law, executive order, and management policy. The following legislation guides the management of exotic plants in Yellowstone National Park.

National Park Service Organic Act of 1916 (16 USC s/s 1)

Directed the U.S. Department of Interior and the NPS to manage parks "to conserve the scenery and the natural and historic objects and the wild life therein to provide for the enjoyment of the same in such a manner and by such means as would leave them unimpaired for the enjoyment of future generations."

Carlson-Foley Act of 1968 (P.L. 90-583)

Authorizes and directs heads of Federal department and agencies to permit control of noxious plants on Federal land by state and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-Federal land. This Act carries the provision "That such reimbursement shall be only to the extent that funds appropriated specifically to carry out the purposes of this Act are available, therefore, during the fiscal year in which the expenses are incurred."

National Environmental Policy Act (NEPA) of 1969 as amended.

This requires the analysis of proposed actions through an environmental assessment (EA) or environmental impact statement (EIS) using public participation and an interdisciplinary process.

Department of the Interior Manual (1970), Part 517 DM1

On July 31, 1970, the Department of the Interior issued policies and guidelines on the use of chemical pesticides in the pest control programs of agencies under its jurisdiction. The policy and guidelines of the NPS with respect to pesticide use will reflect compliance with these USDI requirements.

Federal Noxious Weed Act of 1975 (PL 93-629) as amended (7 U.S.C.A. 2801 *et seq.*)

Provides for the control and eradication of noxious weeds and the regulation of movement in interstate or foreign commerce of noxious weed and potential carriers thereof. It authorizes the Secretary to "cooperate with other Federal agencies, state agencies, or political subdivisions thereof, and individuals in carrying out measures to eradicate, suppress, control or prevent the spread of any noxious weed."

Occupational Health and Safety Hazard Communication Standard (29 CFR 1910.1200) 1987

Under the OSHA Hazard Communication Standard (Section 1910.1200), employers must provide workers with training, protective equipment, and information about hazardous substances. The employer is required to maintain Material Safety Data Sheets (MSDS) about these substances and to provide the employee with a copy of the sheets if they are requested.

The Food, Agriculture, Conservation and Trade Act of 1990 (1990 Farm Bill), P.L. 101-624

Requires that each Federal land management agency establish and fund an undesirable plant management program for lands under its jurisdiction.

Natural Resources Management Guidelines: NPS-77 (1991)

Provides resource managers with an overview of the integrated pest management concept, summarizes NPS policies regarding pesticide use, and provides direction for applying for approval to use pesticides. Also provides general guidelines and recommendations for exotic plant management.

Guidelines for Coordinated Management of Noxious Weeds in the GYA (1991)

Provides guidelines for coordinated state, federal, and private land weed management in the GYA. Establishes a process for creating weed management areas based on ecological rather than political boundaries for monitoring and controlling noxious weeds.

Federal Insecticide, Fungicide and Rodenticide Act of 1996 (FIFRA) 7 USC s/s 136

Pesticide users must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that if in accordance with specifications, will not cause unreasonable harm to the environment.

Yellowstone's Resource Management Plan (1998)

Recommends that managers use an Integrated Pest Management approach in managing exotic vegetation, maintain cooperative efforts with adjacent weed control agencies, and update the Exotic Plant Management Plan for the park, using current data and recommended control techniques.

Invasive Species Executive Order of 1999

Executive Order 13112 calls on Federal agencies to: "1) prevent the introduction of invasive species; 2) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; 3) monitor invasive species populations accurately and reliably; 4) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; 5) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and 6) promote public education on invasive species and the means to address them."

Plant Protection Act of 2000

Provides APHIS with the authority to regulate biological control agents, or "any enemy, antagonist, or competitor used to control a plant pest or noxious weed." APHIS' Plant Protection and Quarantine (PPQ) is responsible for granting permission for the use of biological control agents in the U.S.

National Weed Control and Eradication Act, P.L. 108-412 2004

Public Law 108-412 (Oct 30, 2004) Amends the Plant Protection Act. Establishes program to provide financial and technical assistance to control or eradicate noxious weeds. Enables the USDA to make grants, financial and technical assistance to weed management entities

National Park Service Management Policies (2006)

Directs parks to give high priority "to managing exotic species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controllable."

Code of Federal Regulations 36 CFR 2.1(a)(2)

Prohibits introducing wildlife, fish, or plants, including their reproductive bodies, into a park area ecosystem.

Idaho State Laws

Idaho Statutes: Title 22, Chapter 24 requires landowners to control noxious weeds including prevention, eradication and restoration. A new revision in Idaho's weed law states that all control efforts must be directed at eradication.

Montana State Laws

Montana Weed Control Act (80-7-701 *et seq*., MCA) requires landowners to control weeds.
Montana Pesticides Act (80-8-801 *et seq*., MCA)
County Noxious Weed Control Act (7-22-2101 *et seq*., MCA)
Montana Water Quality Act (75-5-101 *et seq*., MCA)
Montana Agricultural Chemical Ground Water Protection Act of 1989 (80-15-100 *et seq*., MCA)

Wyoming State Laws

Wyoming Weed and Pest Control Act, Title 11, Chapter 5, requires federal agencies and other land managers to control weed infestations.

Appendix 2

Invasive Nonnative Plant Species Priority List

Revised March 28, 2012
and updated annually

State abbreviations in parentheses indicate species on state noxious weed lists.

Watch List: Invasive plant species not documented or established in the park. The goal is to prevent establishment through staff education, early detection, and eradication. Those species noted with an asterisk (*) have been found in the park, but were removed prior to seed dispersal.

Aegilops cylindrica	jointed goatgrass (ID)
Anchusa arvensis	small bugloss (ID)
*Arctium lappa**	great burdock
Azolla pinnata	feathered mosquito fern (ID)
Bryonia alba	white bryony (ID)
Butomus umbellatus	flowering rush (ID, MT)
*Centaurea moncktonii**	meadow knapweed (ID as *C. debeauxii*)
Centaurea solstitialis	yellow starthistle (ID, MT)
Centaurea triumfetti	squarrose knapweed (ID)
Chondrilla juncea	rush skeletonweed (ID, MT)
Cobomba caroliniana	fanwort (ID)
*Conium maculatum**	poison hemlock (ID)
Crupina vulgaris	common crupina (ID)
Cytisus scoparius	Scotch broom (ID, MT)
Echium vulgare	vipers bugloss (ID, MT)
Egeria densa	Brazilian elodea (ID)
Elaeagnus angustifolia	Russian olive (WY)
Franseria discolor	skeletonleaf bursage (WY)
Heracleum mantegazzianum	giant hogweed (ID)
Hieracium piloselloides	tall hawkweed (ID, MT)
Hieracium glomeratum	yellow devil hawkweed (ID, MT)
Hydrilla verticillata	hydrilla (ID)
Hydrocharis morsus-ranae	common or European frogbit (ID)
Impatiens glandulifera	policeman's helmet (ID)
Iris pseudocorus	yellow flag iris (ID, MT)
*Isatis tinctoria**	dyer's woad (ID, MT, WY)
Lythrum salicaria	purple loosestrife (ID, MT, WY)
Milium vernale	milium (ID)
Myriophyllum aquaticum	parrotfeather milfoil (ID)
Myriophyllum heterophyllum	variable-leaf milfoil (ID)
Myriophyllum spicatum	Eurasian watermilfoil (ID, MT)
Nardus stricta	matgrass (ID)
Nymphoides pelata	yellow floating heart (ID)
*Onopardum acanthium**	Scotch thistle (ID, WY)
Phragmites australis (nonnative genotype)	common reed (ID)
Polygonum bohemicum	Bohemian knotweed (ID, MT)
Polygonum cuspidatum	Japanese knotweed (ID, MT)

Polygonum sachalinense	giant knotweed (ID, MT)
Potamogeton crispus	curly pondweed (ID, MT)
Salvia aethiopsis	Mediterranean sage (ID)
Salvinia molesta	giant salvinia (ID)
*Senecio jacobaea**	tansy ragwort (ID, MT)
Solanum rostratum	buffalobur (ID)
Sorghum halepense	Johnsongrass (ID)
Trapa natans	water chestnut (ID)
Tribulus terrestris	puncturevine (ID)
Zygophyllum fabago	Syrian beancaper (ID)

Priority 1: Nonnative plant species that have produced seed in the park, but populations are small and limited in number (<1 acre infestation). These species have a high probability for eradication with continued annual monitoring and treatment. They are also the most cost effective species to control.

Anthoxanthum odoratum	sweet vernal grass
Arctium minus	common burdock (WY)
Astragalus cicer	chick-pea milkvetch
Barbarea vulgaris	bitter wintercress
Centaurea diffusa	diffuse knapweed (ID, MT, WY)
Centaurea repens (*Acroptilon repens*)	Russian knapweed (ID, MT, WY)
Chorispora tenella	blue mustard
Euphorbia esula	leafy spurge (ID, MT, WY)
Hieracium floribundum	glaucous king devil (MT)
Holcus lanatus	velvet grass
Hyoscyamus niger	black henbane (ID)
Lepidium latifolium	perennial pepperweed (ID, MT, WY)
Matricaria maritime	false mayweed, scentless chamomile
Potentilla recta	sulfur cinquefoil (MT)
Rubus laciniatus	evergreen blackberry
Silene vulgaris	bladder campion
Tamarix spp. (*T. chinensis* in park)	tamarisk (ID, MT, WY)
Tanacetum vulgare	tansy aster (MT, WY)
Trifolium aureum	yellow clover
Vicia cracca	bird vetch

Priority 2: Aggressive invaders, some of which are well established in some localities making eradication impractical (identified by •), but most are confined to relatively small areas at specific locations. Containment will be the primary goal for these species in established infestations, and as funding permits as a secondary goal, annual control to reduce seed production with possible future eradication. Individual plants or small infestations away from core infestation areas will be a high priority for aggressive control. Control efforts have a high probability of successfully limiting their spread, and will be undertaken. Monitoring of and for these species should be frequent.

Berteroa incana•	berteroa (ID, MT)
Cardaria chalapensis	Chalapa whitetop
Cardaria draba	heart-pod whitetop (ID, MT, WY)
Cardaria pubescens	globe-podded whitetop, hoary cress WY)

Carduus acanthoides	plumeless thistle (ID, WY)
Carduus nutans	musk thistle (ID, WY)
Centaurea stoebe• (*C. maculosa*)	spotted knapweed (ID, MT, WY)
Chrysanthemum leucanthemum (*L. vulgare*)	ox-eye daisy (ID, MT, WY)
Cirsium vulgare•	bull thistle
Convolvulus arvensis	field bindweed (ID, MT, WY)
Cynoglossum officinale•	houndstongue (ID, MT, WY)
Dianthus armeria	grass pink
Hieracium aurantiacum	orange hawkweed (ID, MT)
Hieracium caespitosum	yellow king devil (ID, MT)
Hieracium flagellare	whiplash hawkweed (MT)
Hypericum perforatum	St. Johns wort (MT, WY)
Linaria dalmatica•	Dalmatian toadflax (ID, MT, WY)
Linaria vulgaris•	yellow toadflax (ID, MT, WY)
Melilotus albus	white sweet clover
Melilotus officinalis•	yellow sweet clover
Potentilla argentea	silvery cinquefoil
Potentilla inclinata	ashy cinquefoil
Ranunculus acris	tall buttercup (MT)
Sonchus arvensis ssp. *Arvensis*	perennial sow-thistle (ID, WY)
Sonchus arvensis ssp. *uliginosus*	marsh sow-thistle (ID, WY)
Verbascum thapsus•	wooly mullein

Priority 3: Aggressive species that are dispersed over large areas and have deleterious effects on the park. Control efforts are likely to be ineffective and costly. Work may be done to confine the spread of these plants in sensitive areas. Monitoring would be beneficial, but after Priorities 1 and 2.

Agropyron cristatum	crested wheatgrass
Agropyron triticium	annual wheatgrass
Alopecurus arundinacea	creeping meadow foxtail
Alopecurus pratensis	meadow foxtail
Alyssum alyssoides	pale alyssum
Alyssum desertorum	desert alyssum
Alyssum simplex	field alyssum
Bassia sieversiana (*Kochia scoparia*)	kochia, summer cypress
Bromus inermis	smooth brome
Bromus japonicas	Japanese brome
Bromus tectorum	cheatgrass, downy chess
Cirsium arvense	Canada thistle (ID, MT, WY)
Elymus repens (*Agropyron repens*)	quackgrass (WY)
Medicago lupulina	black medic
Phleum pretense	common timothy
Poa annua	annual bluegrass
Poa bulbosa	bulbous bluegrass
Poa compressa	Canadian bluegrass
Poa palustris	fowl bluegrass
Poa pratensis ssp. *pratensis*	Kentucky bluegrass
Salsola tragus	Russian thistle, tumbleweed
Taraxacum laevigatum	red-seeded dandelion

Taraxacum officinale	common dandelion
Trifolium dubium	suckling clover
Trifolium hybridum	alsike clover
Trifolium repens	white clover

Priority 4: Nonnative species for which little or no control efforts are foreseen. Though many displace native plants, control of high priority species takes precedence, and limited monitoring may be done. There are 142 taxa included in this category (overall number of species = 217; 220 total taxa). None are listed as noxious by surrounding states.

Acer negundo	box-elder
Agrostis capillaries	browntop
Agrostis gigantean	redtop
Agrostis stolonifera	creeping bentgrass
Aira carophyllea	silver hairgrass
Alcea rosea	hollyhock
Amaranthus albus	tumbleweed amaranth
Amaranthus blitoides	prostrate pigweed
Amaranthus retroflexus	redroot pigweed
Ambrosia artemisiifolia	annual ragweed
Ambrosia psilostachya	western ragweed
Anthemis tinctoria	yellow chamomile
Apera interrupta	interrupted windgrass
Arenaria serpyllifolia	thyme-leaf sandwort
Arrhenatherum elatius	tall oatgrass
Artemisia absinthium	wormwood
Asparagus officinalis	asparagus
Asperugo procumbens	madwort
Atriplex heterosperma	Russian atriplex
Atriplex hortensis	garden orache
Atriplex patula	spear orache
Atriplex rosea	tumbling orache
Avena fatua	wild oats
Avena sativa	oats
Bassia hyssopifolia	bassia
Brassica rapa	field mustard
Bromus briziformis	rattlesnake brome
Bromus hordeaceus	soft brome
Camelina microcarpa	littlepod falseflax
Camelina sativa	falseflax
Campanula rapunculoides	creeping bellflower
Cannabis sativa	hemp
Capsella bursa-partoris	shepherd's-purse
Carum carvi	caraway
Cerastium fontanum	common mouse-ear chickweed
Cerastium glomeratum	sticky mouse-ear chickweed
Cerastium semidecandrum	5-stamen mouse-ear chickweed
Chamaesyce maculate	spotted spurge
Chenopodium strictum	lambsquarters
Cichorium intybus	chicory

Crepis tectorum	annual hawksbeard
Dactylis glomerata	orchard-grass
Daucus carota	wild carrot
Descurainia sophia	flixweed
Dianthus barbatus	sweet william
Dipsacus fullonum	teasel
Dracocephalum thymiflorum	thyme-leaf dragonhead
Dysphania botrys	Jerusalem oak
Echinochloa crusgalli	large barnyard grass
Elymus hispidus var. *hispidus*	intermediate wheatgrass
Elymus hispidus var. *ruthenicus*	hairy intermediate wheatgrass
Elymus junceus	Russian wildrye
Erodium cicutarium	crane's-bill
Euclidium syriacum	euclidium
Festuca arundinacea	tall fescue
Festuca pratensis	meadow fescue
Fraxinus pennsylvanica	green ash
Galeopsis ladanum	hemp nettle
Galium mollugo	wild madder
Galium verum	yellow bedstraw
Glecoma hederacea	gill-over-the-ground
Gysophila paniculata	baby's breath
Hedeoma nana	dwarf false pennyroyal
Hesperis matronalis	Dame's-rocket
Holosteum umbellatum	jagged chickweed
Humulus lupulus	hops
Hypochaeris radicata	hairy cat's-ear
Juncus compressus	flattened rush
Lactuca serriola	prickly lettuce
Lamium amplexicaule	henbit deadnettle
Lappula squarrosa	European stickseed
Lepidium campestre	field peppergrass
Lepidium perfoliatum	clasping peppergrass
Lepidium sativum	garden cress
Lithospermum arvense	corn gromwell
Logfia arvensis	fluffweed
Lolium perenne	perennial ryegrass
Lonicera tatarica	Tatarian honeysuckle
Lotus corniculatus	birdsfoot trefoil
Lycium barbarum	matrimony vine
Malus pumila	apple
Malva neglecta	dwarf mallow
Malva pusilla	low mallow
Medicago sativa var. *falcata*	yellow alfalfa
Medicago sativa var. sativa	alfalfa
Myosotis micrantha	blue scorpionweed
Nasturtium officinale	water-cress
Nepeta cataria	catnip
Onobrychis viciifolia	sainfoin
Oxalis dillenii	Dillen's wood-sorrel

Pastinaca sativa	wild parsnip
Plantago lanceolata	English plantain
Plantago major	common plantain
Poa trivialis	rough bluegrass
Polygonum aviculare	common knotweed
Polypogon monspeliensis	rabbitsfoot grass
Portulaca oleracea	common purslane
Prunus avium	sweet cherry
Puccinellia distans	weeping alkali grass
Ranunculus repens	creeping buttercup
Ranunculus testiculatus	hornseed buttercup
Ratibida columnifera	prairie coneflower
Rumex acetosella	sheep sorrel
Rumex crispus	curly dock
Rumex patientia	patience dock
Rumex pseudonatronatus	Finnish dock
Salix fragilis	crack willow
Salsola collina	slender Russian thistle
Salvia nemorosa	violet sage
Saponaria officinalis	bouncing bet
Scirpus cyperinus	wool grass
Secale cereal	rye
Senecio vulgaris	old-man-in-the-spring
Setaria viridis	green bristlegrass
Silene antirrhina	sleepy catchfly
Silene latifolia	white campion
Sinapsis arvensis	charlock
Sisymbrium altissimum	Jim Hill tumblemustard
Sisymbrium loeselii	Loesel tumblemustard
Solanum lycopersicon	tomato
Solanum physalifolium	hairy nightshade
Solidago rigida	stiff-leaved goldenrod
Sonchus asper	prickly sow-thistle
Spergularia rubra	red sand-spurry
Stellaria media	common chickweed
Thlaspi arvense	fanweed
Thymus serpyllum	thyme
Tragopogon dubius	yellow salsify
Tragopogon pratensis	meadow salsify
Tragopogon porrifolius	salsify
Trifolium campestre	hop clover
Trifolium pretense	red clover
Triticum aestivum	wheat
Urtica urens	dwarf nettle
Vaccaria hispanica	cowcockle
Verbena stricta	hoary verbena
Veronica anagallis-aquatica	water speedwell
Veronica arvensis	wall speedwell
Veronica biloba	bilobed speedwell
Veronica verna	spring speedwell

Viola tricolor	johnny jump-up
Yucca glauca	Great Plains yucca

Appendix 3

GREATER YELLOWSTONE EXOTICS TRACKING SHEET 11/11/09

Date: _____ Road Section:_____ Observers: _____

County, State: _____ Node: _____

Sub-District: _____ Person Hours:_____

Field #	Rec. #	Species	Status	UTM	Location-ID	Treated Area Size	# of Plants	Distance from Road	Land Use Disturbed	Treatment Re-treat	Effort person hours	Comments:	Chemical Name Code	Chemical Mixed (oz or gm/gal)	Mix Amt (gal)
				E N											
				E N											
				E N											
				E N											
				E N											
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				E N											

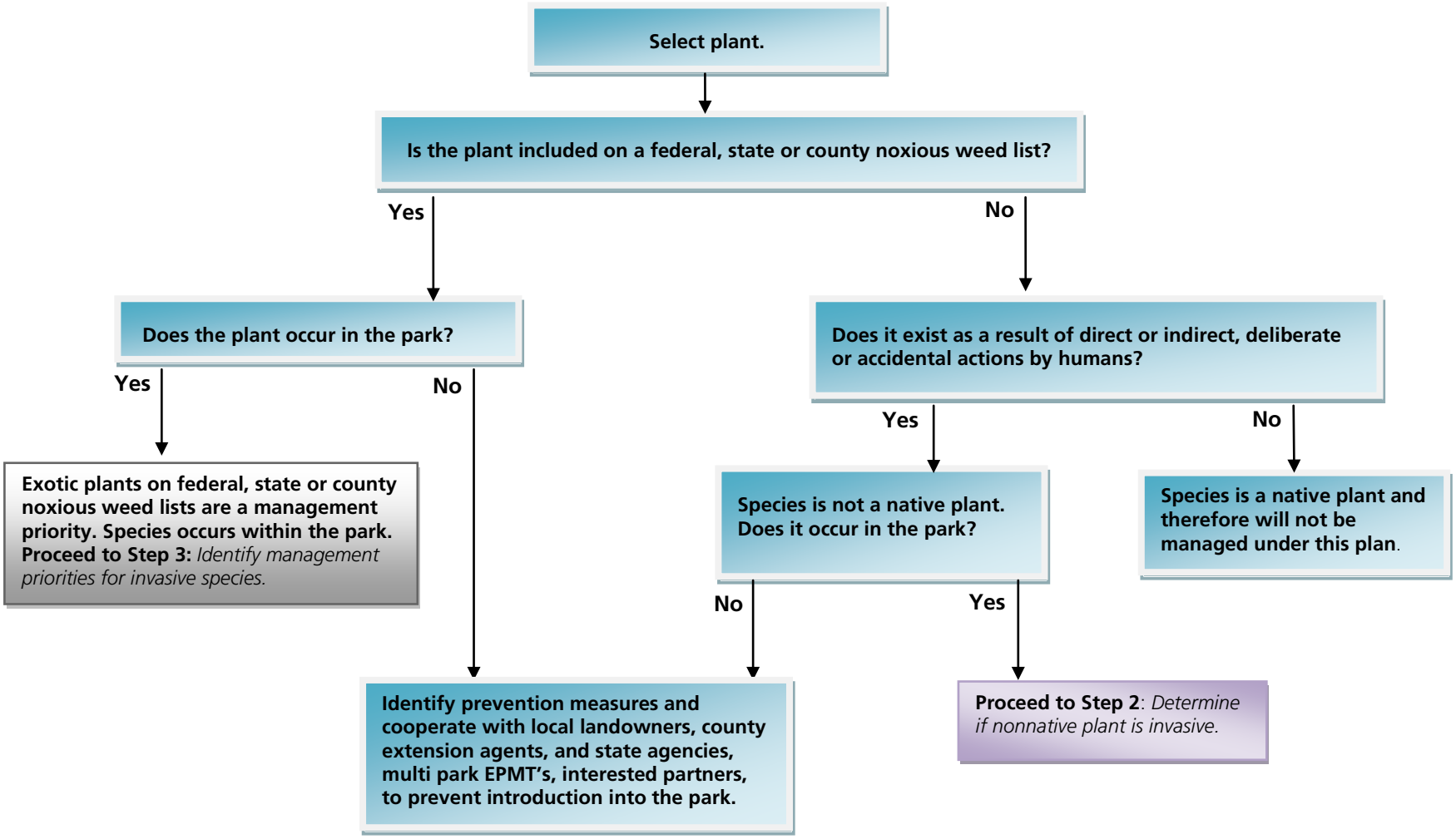
Field #	Report #	Status	Species (SPEC) Priority 1, 2, 3	UTM	Location ID	Treated Area Size	# of plants	Road Segment (R_S)	Distance from Road	Land Use	Land Disturbance	Treatment Retreat	Effort (man hrs)
Number of Entries on Data Form Each Data Form Should Start With #1 and Continue Numerically Upward.	LEAVE BLANK To Be Filled in By the Data Entry Person to Cross Reference With the Database	(1) New (2) Existing (3) Clean (4) Incidentals	Alphalpha MEDSA Berteroa BEFIN Black Henbane HSYNI Black Medic MEDLU Bladder Campion SILVU Blue Mustard COBTE Blue Scorpion Grass MYSMI Bull Thistle CIRVU Canada Thistle CIRAR Catchweed ASPPR Cheatgrass BROTE Curly Dock RUMCR Dalmatian Toadflax LINDA Dianthus Armeria DIAAR Diffuse Knapweed CENDI Dyer's Woad ISATI Fanweed THLAR Field Bindweed CONAR Flixweed DESSO Goatsbeard TRODM Houndstongue CYWOF Kochia KCHSC Lambsquarters CHEAL Leafy Spurge EPHES Musk Thistle CRUNU Orange Hawkweed HIEAU Oxeye Daisy CHYLE Pigweed AMASP Plumeless Thistle CRUAC Prostrate Vervain VERBR Red Clover TRFPR Russian Knapweed CENRE Russian Thistle SALIB Scentless Chamomile MATPE Shepards Purse CABUR Sowthistle SONOL Spotted Knapweed CENMA St. Johnswort HYPPE Sticktight LPLOC Sulfur Cinquefoil PTLRC Tall Butter Cup RANAC Tansy Aster CHYVU Velvet Grass HOLLA White Campion MELAL White Clover TRFRE Whitetop CADDR Wooly Mullein VESTH Yellow Hawkweed HIECA Whiplash Hawkweed HIEFLA *Floribundum* HIEFLO (Yellow Devil Hawkweed) Yellow Sweetclover MEUOF Yellow Toadflax LINVU	UTM @ Center of Patch or Beginning of Node East UTM-6 Digits North UTM-7 Digits	Verbal Description Preset and Consistent Location ID's are Required ---------- I =Incidental	Treated Area Size in Square Feet Dimensions This is TREATED AREA!!! NOT GROSS INFESTED AREA!!!!! Gross Infested Area is the total size of the polygon. TREATED AREA should be calculated by using the Number of Plants or Herbicide Amounts. # of Plants: Area = # of Plants x 4 (Unless this number is larger than the Infested Area Size) Herbicide: Area = # of Gallons x 1500	# of Plants are counted only in locations where it is practical or where it can be done accurately. It is important when doing mechanical treatments as well as when treating a minimal number of plants such that the amount of herbicide used is negligible and not easily discernable. Percent Cover is now be calculated in the Geodatabase using the Gross infested Area and the Treated Area	Name or Code 1-Gardiner/Mamm. 2-Mammoth/Tower 3-Tower/N.E. 4-Tower/Dunraven. Pass 5-Mammoth/Norris 6-Norris/Madison 7-Madison/W.Entr. 8-YNP 191 9-Madison/OldFath. 10-OF/Isa Lake 11-Isa Lk/W. Thumb 12-W.Thumb/S.Ent. 13-W.Thumb/FshBrg 14-Fshbrg/E.Ent. 15-Fshbrg/Canyon 16-Canyon/Dunraven 17-Canyon/Norris 18-Riverside Drive 19-Outside YNP 20-Stephens Creek 21-Old Mamm-Gard 22-Bunsen Peak Rd 23-Blacktail Deer Plat. 24-Barns Road 25-Fountain Frt Rd 26-Firehole Lake Dr 27-Virginia Cascade 28-Canyon Rim 29-Lake Butte 30-Gull Point 31-Firehole Canyon 32-Grassy Lake Rd 33-Grebe Pit Road	Distance from pavement to farthest point of infestation in feet. Only for entries associated with the road.	0= Unknown 1= Road-YNP 2= Road-MT 3=NPS Frontcountry Campground 4=Developed Area-YNP 5= Developed Area-Xanterra 6= Developed Area-Delaware North 7= Developed Area-YPSS 8= Trailhead 9= Trail 10= Backcountry Campsite 11= Backcountry Offtrail 12= Fishing access 13= Phone-utility 14= Power-utility 15= Service Rd	0= Unknown 1= None 2= Roadway 3= Construction 4= Stock Grazing 5=Geothermal 6= Fire 7= Flooding 8= Wildlife 9=Foot Traffic 10= Maintenance 11= Housing	Type of treatment on infestation 1= Surveyed 2= Mechanical 3= Chemical 4= Biological 5= Cultural 6= Burn 7=Revegetation 8=No Weeds Found Retreatment (Yes/No) There Must Be an Entry From an Earlier Date With the Identical Location Name and UTM to be Considered a Repeat Treatment.	Report in 1 Hr Intervals. Include: ALL TIME Prep. Time Drive Time Survey Time Control Time

Comments	Chemical Name Code	Chemical Mix (CHEM_MIX)	Mix Amount	Management Jurisdiction (District)	Jurisdiction Unit (Sub-District)	State	County	Report # (RPT_NUM)		
Anything That Could Be Important or Interesting. Dates: Enter all patch treatment dates in this section. Enter additional dates for incidental treatments. If Incidental is a High Priority Species Enter UTM's in the Comment Section For Each Location List names or initials of those involved with treatment if different from names in observers above	TD= Tordon TL= Transline DA= 2,4D amine ES= Escort CT= Curtail RU= Roundup RE= Rodeo MS= Milestone OU= Oust PL= Plateau PA= Paramount If using a mix list all alphabetically Ex. ES/MS	1 gm = 0.035 oz 1 oz = 28.35 gm 3cc=0.1 oz If using a mix list amounts in the same order as in chem. name	Number of Mixed Gallons	1 Outside YNP 2 North 3 West 4 East	0 = -Outside YNP 1 = Mammoth 2 = Tower 3 = Lamar 4 = Canyon 5 = Lake 6 = East 7 = Grant 8 = South 9 = Old Faithful 10 = Madison 11 = Gallatin 12 = Bechler 13 = Norris 14 = Other	1 = Idaho 2 = Montana 3 =Wyoming	1= Idaho 2= Montana 3=Wyoming			

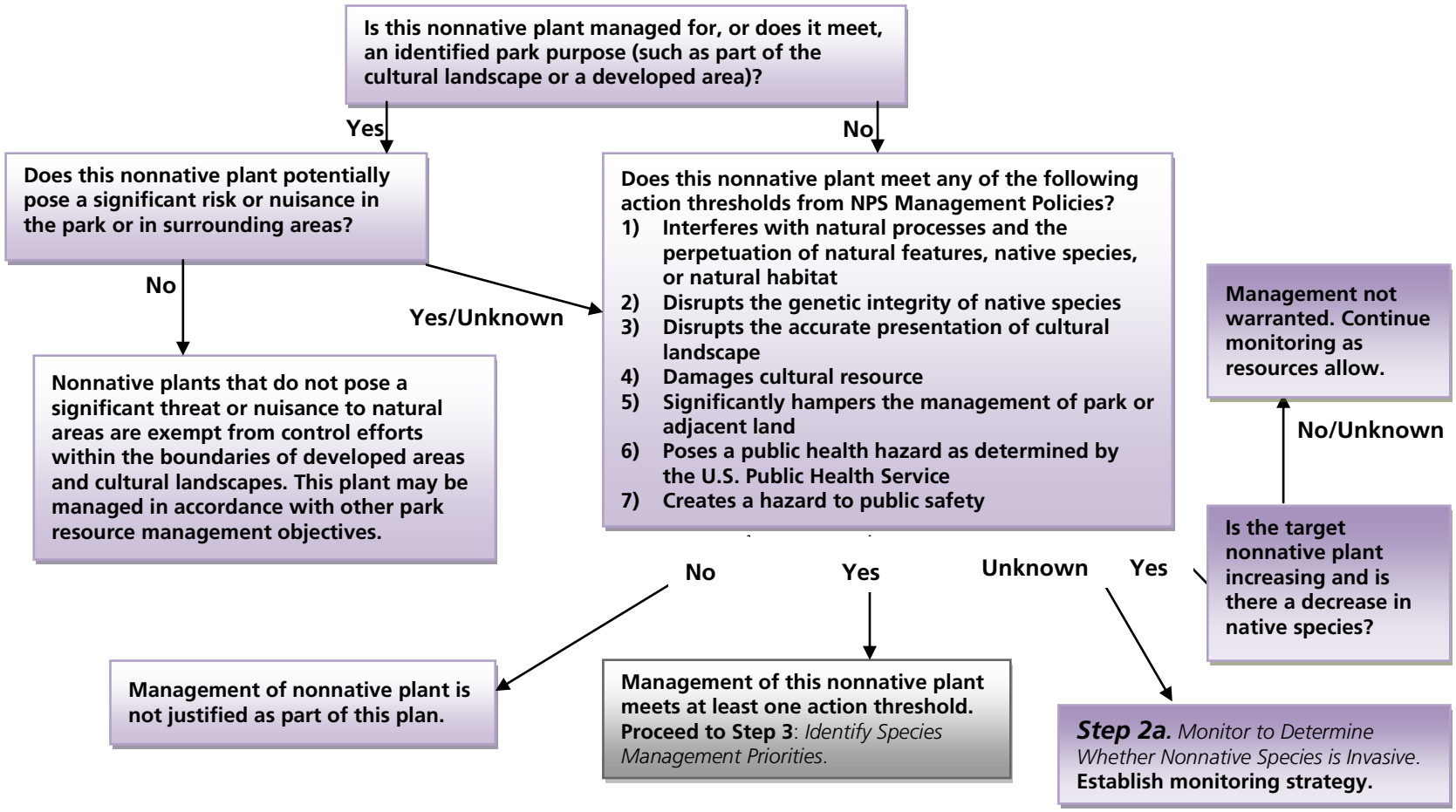
Appendix 4: Seven- Step Decision Flow Charts

Step 1: Identify Nonnative Plants

Identified plants may come from early detection protocol, federal, state or county noxious weed lists, new invaders database, cooperators, or other floral surveys.



Step 2: Determine whether a nonnative plant is invasive.

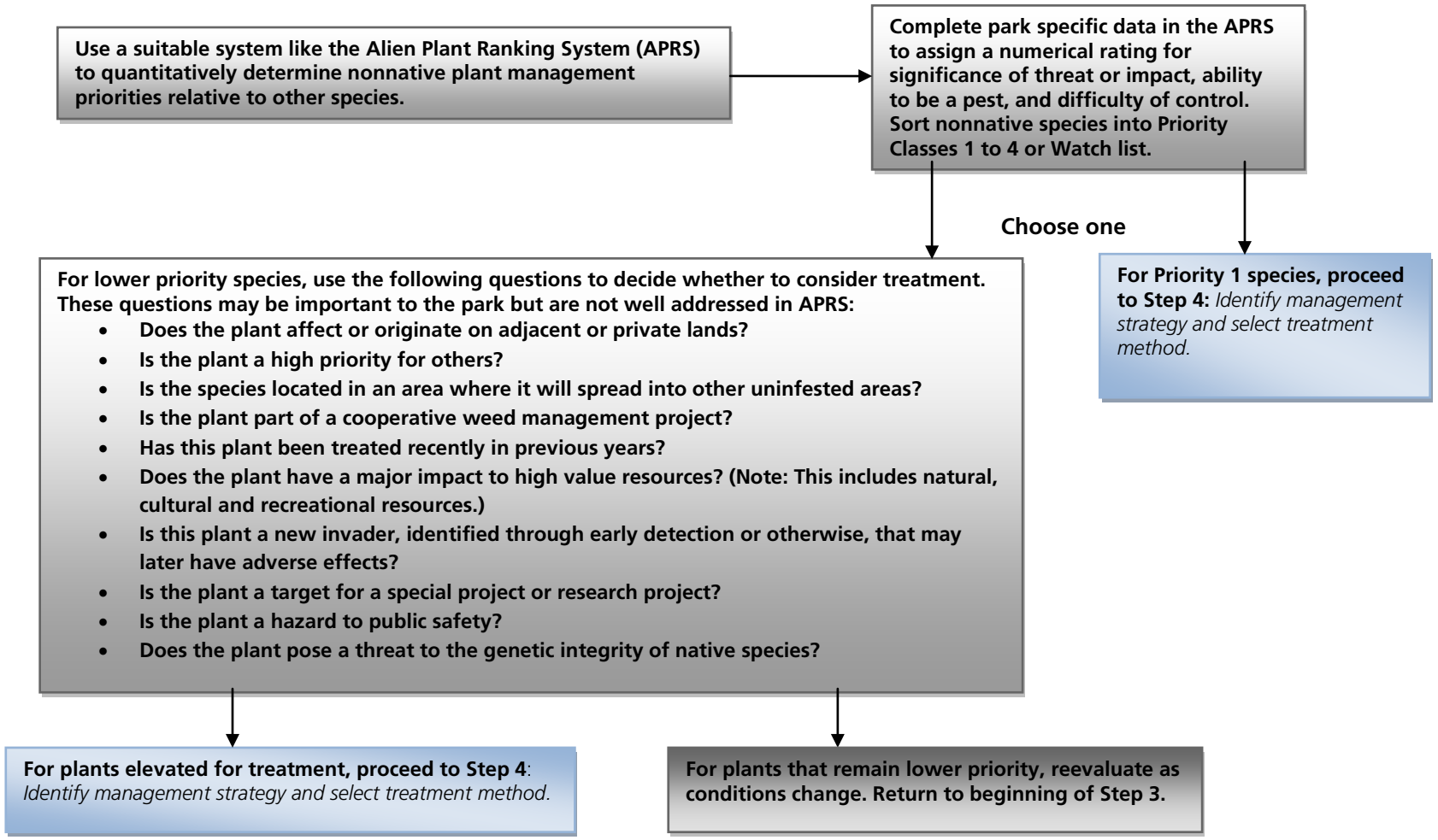


Step 2a: Monitor to determine whether the nonnative species is invasive.

This monitoring is to assess the effect of nonnative species on the surrounding vegetation and ecosystem. A nonnative invasive plant that has high impact in one area may not have high impact in another, based on differences in the plant communities, climate, soil type, etc. If a species is not having a high impact, resources would be better spent focusing on other invasive plants. The key to monitoring for impact is that it has to be done over time—one assessment is not sufficient. Data from only one year can be confounded by annual variation in weather or an unusual disturbance event such as a spike in an insect population.

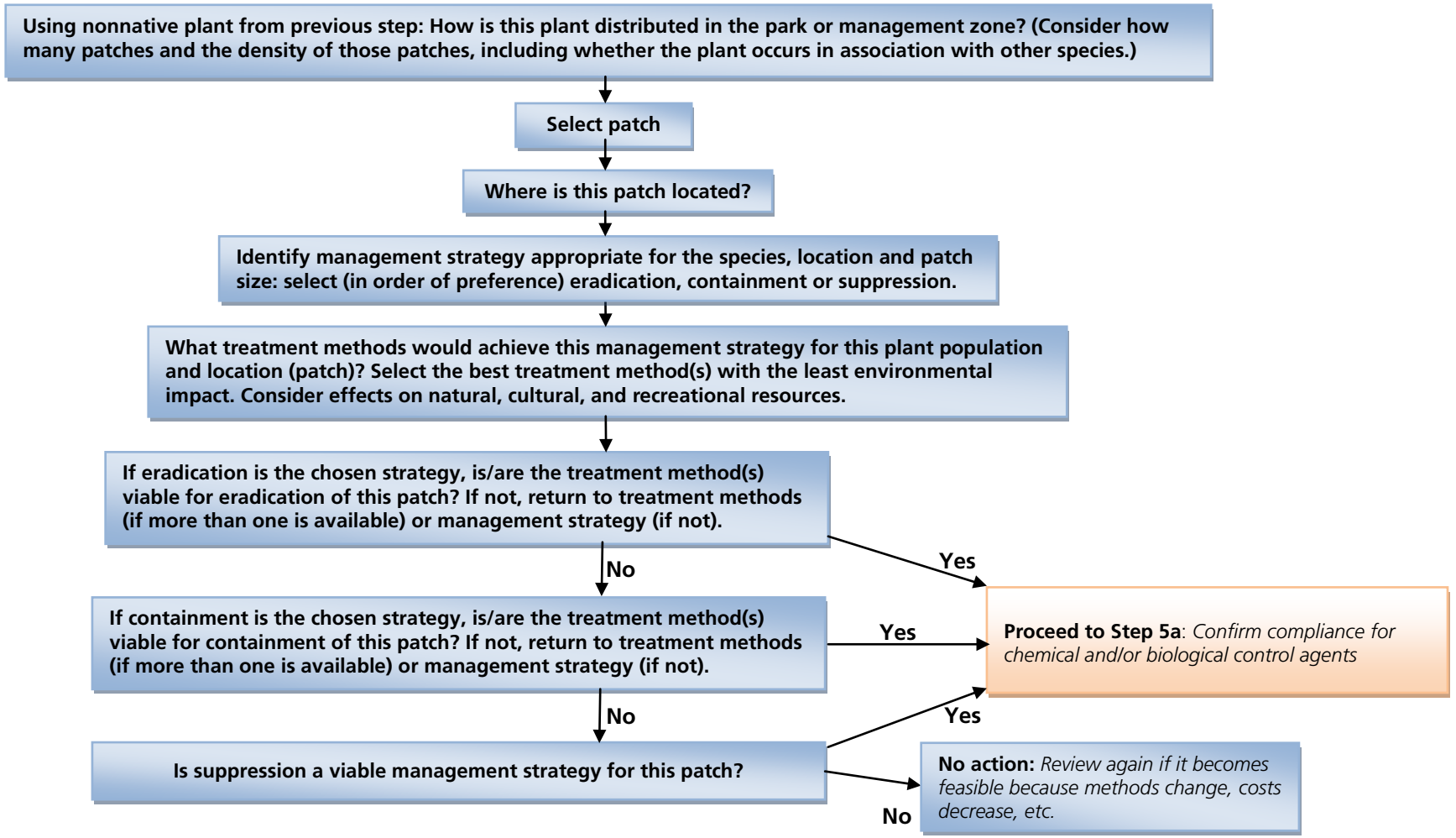
Step 3: Identify management priorities for invasive species.

The highest priority is to manage nonnative plants that have had or could have a substantial impact on park resources, and can be reasonably expected to be controlled. Lower priority is given to innocuous nonnative plants that have almost no impact on park resources or are unlikely to be successfully controlled.

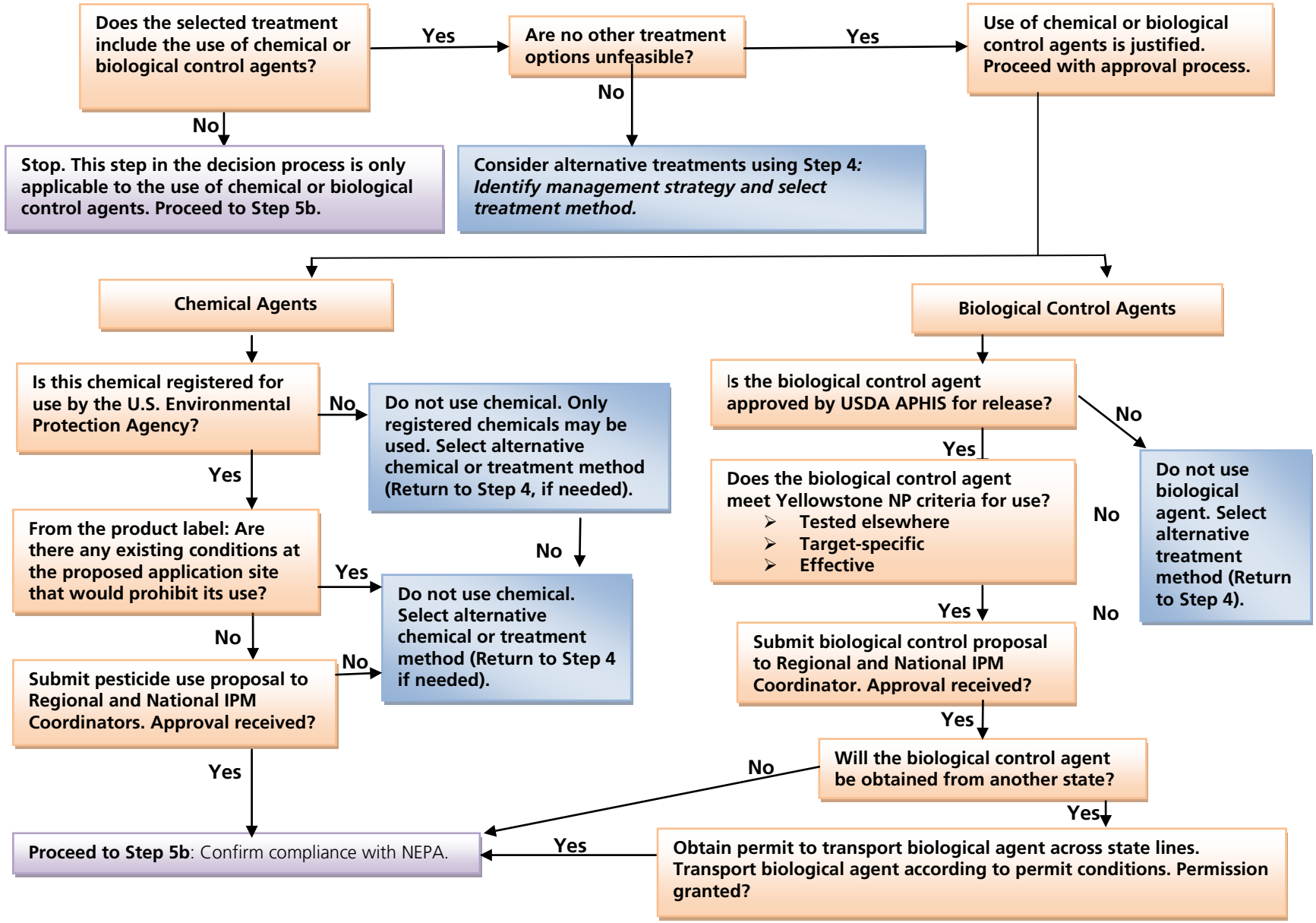


Step 4: Identify management strategy and select treatment method.

For Step 4, treatment options must meet management objectives and be feasible, given potential costs, available resources, potential impacts, effectiveness, and applicable regulations and policies. Because the goal is always eradication, treatments that start as suppression or containment will eventually also revert to eradication once it becomes feasible and affordable. Managers may have to repeat Step 4 many times to determine treatment techniques, management goals and methods for treating the same species in different areas. Step 4 should also be repeated if variables change (e.g. patch size changes, additional resources become available or success has been achieved for management strategy).

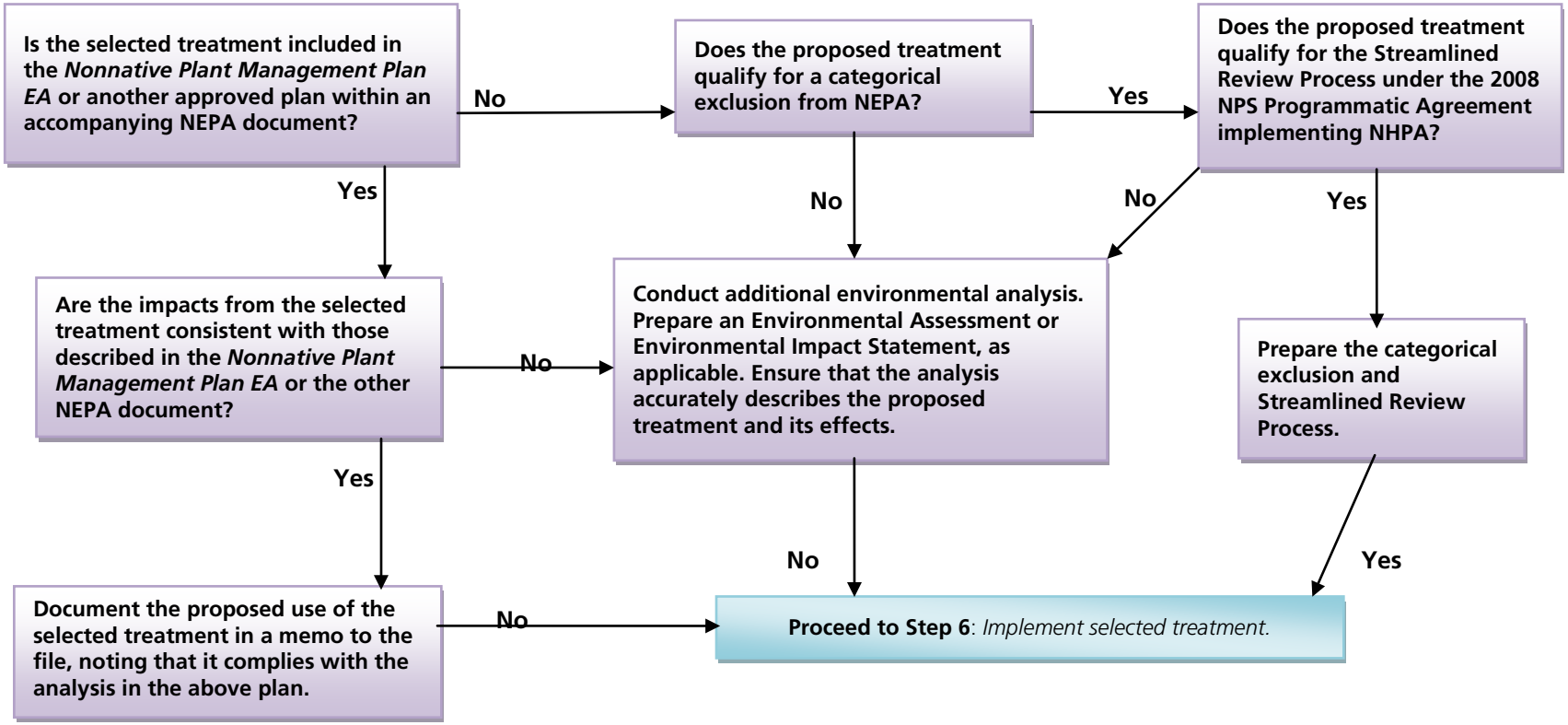


Step 5a: Confirm compliance for chemical and/or biological control agents.

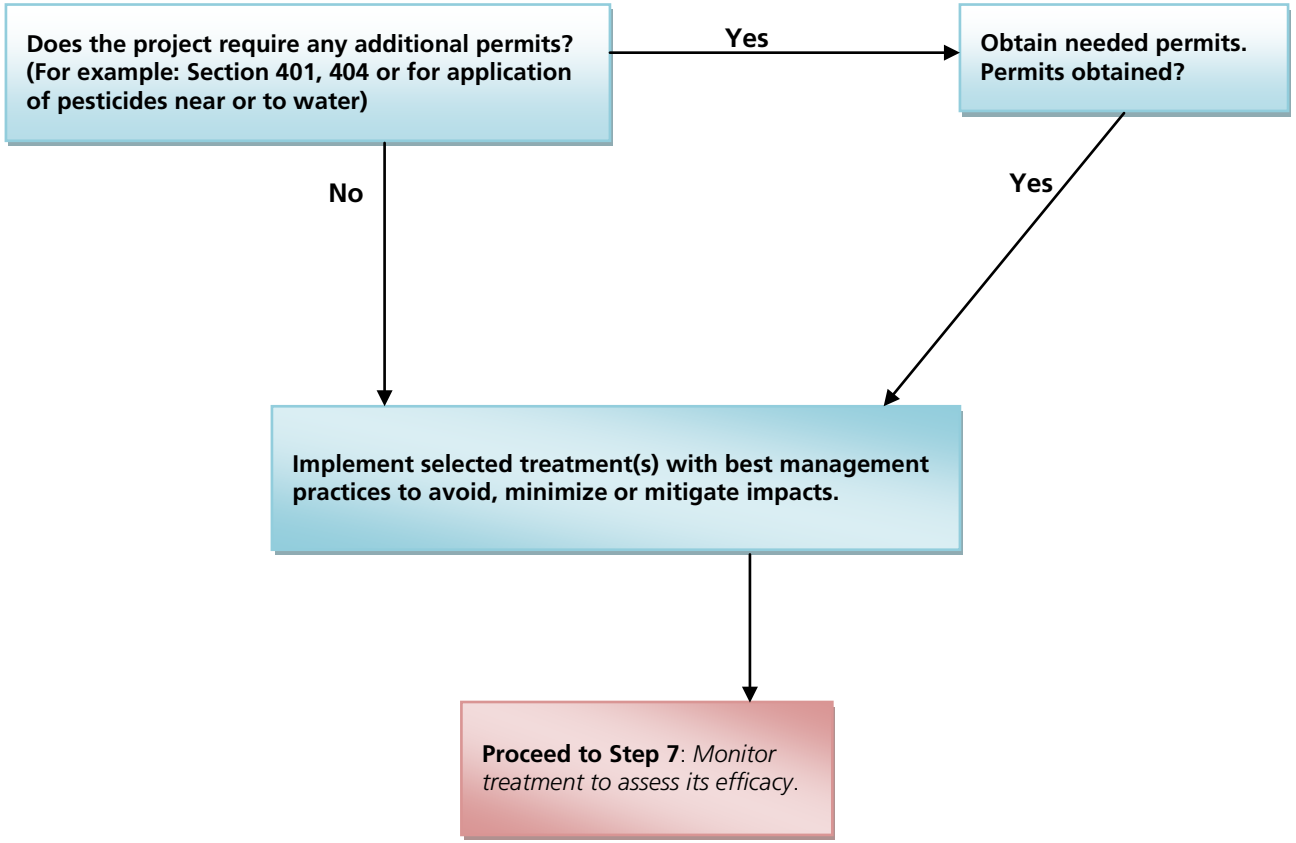


Step 5b: Confirm compliance with NEPA.

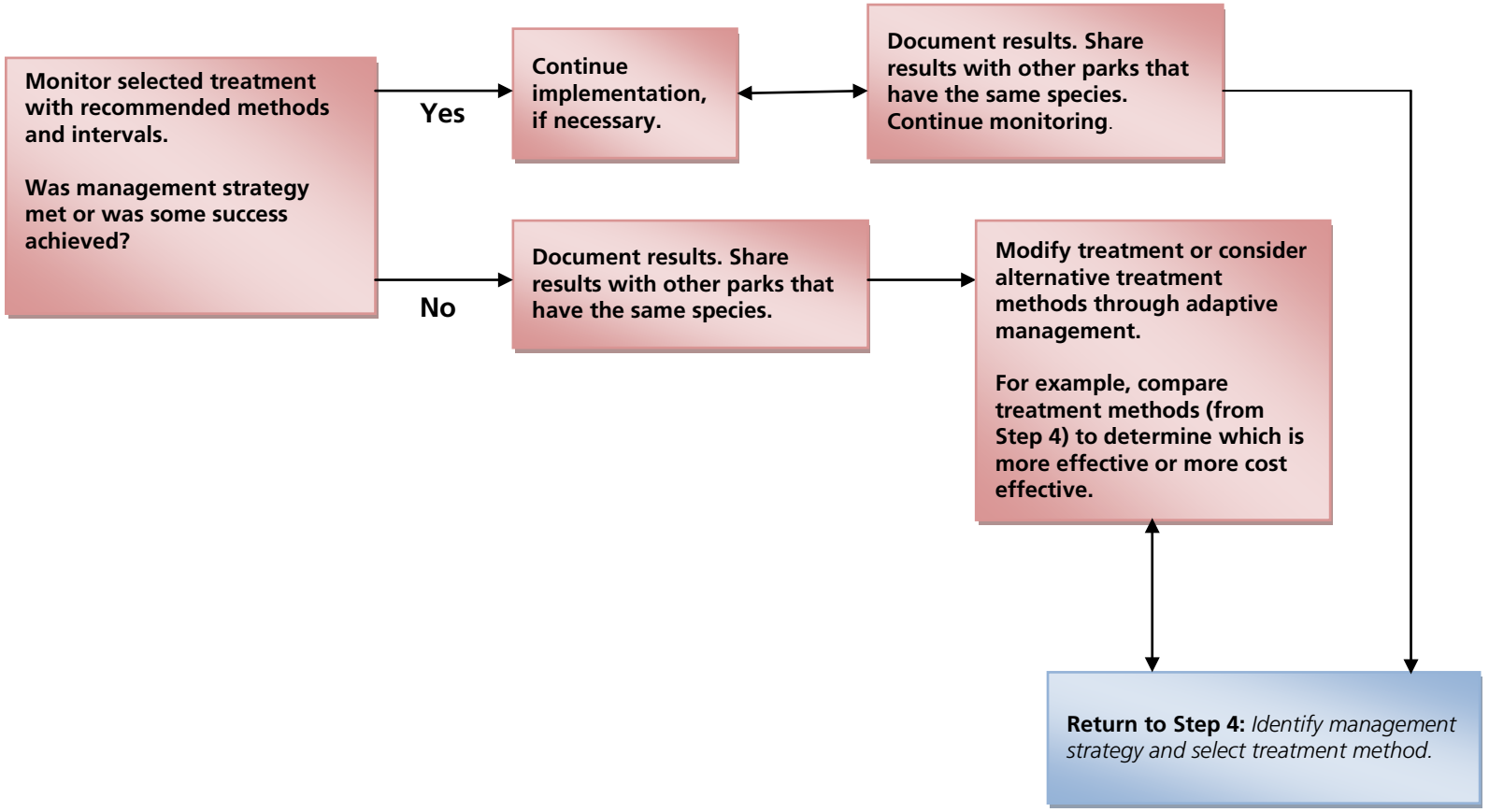
Prior to implementing the selected treatment, confirm that the selected treatment method has the necessary compliance with NEPA.



Step 6: Implement selected treatment.



Step 7: Monitor treatment to assess its efficacy.



Appendix 5

CERTIFICATION OF SAND AND GRAVEL PIT INSPECTION
Greater Yellowstone Area

Pit inspection history
_____1st year
_____2nd year
_____3rd year
_____4 or more years (specify)

Inspection Date _____

STATE PERMIT #_____

This certifies that the gravel pit described herein, has been inspected according to Greater Yellowstone Area certification standards. The objective of the program is to help prevent and slow the speed of invasive plants by providing gravel/borrow material that is free* of the potential for transport and dispersal of listed weed species.

Pit Name_____Operator _____ Phone_____ County_____

Address_____ City_____State_____Zip_____

Pit Location_____Acres inspected_____

Level of certification:

A._____APPROVED: Exceeds requirements of Greater Yellowstone Area certification standards and contains only the specified gravel/borrow material with no nonnative plants noted.

B._____APPROVED: Meets requirements of Greater Yellowstone Area certification standards. Gravel/borrow material contain no tri-state (WY,MT,ID), regional or YNP listed weeds and only limited amounts of annual weeds and/or other weeds not listed as prohibited or noxious.

Weeds noted:

C._____APPROVED: Complies with MINIMUM requirements of Greater Yellowstone Area certification standards. *This gravel/borrow material contains variable amounts of prohibited or noxious weed species which were immature (no viable seed) when treated to prevent seed formation. These plant parts, although not usually desirable in the gravel/borrow material, are not considered able to begin new infestations.

Weeds noted:

D._____FAILED Explanation_____

Weeds noted:

Additional comments:
_____

REQUIREMENTS
Gravel/borrow material must be certified to Greater Yellowstone Area's certification standards and inspected by proper officials. Inspection shall include, but not limited to, surrounding ditches, topsoil piles, gravel/sand piles, fence rows, roads, easement, rights-of-way, working areas, storage areas and the buffer zone surrounding the area.
Certification shall be based on a reasonable and prudent visual inspection. Weed location map is attached.

Certified by: Title: Date:

This document shall terminate on _____.

Disclaimer: Certified gravel/borrow material may have viable seeds from previous years. Plant seed can't be killed by registered pesticides. Certification shall be a prudent and visual inspection for that year (s) certification for this pit. Previous years may have had seed drop that can still be viable.

Appendix 6

Safety

There are many safety concerns associated with management of exotic plants. Operational procedures help prevent and mitigate these issues.

Supervision and Planning

Supervisors may utilize Operational/Mission Risk Assessments (GARs) to rate the overall risk involved in a task. GARs employ a rating system denoted by colors: Green is low risk 0-35; Amber is higher risk 36-60; Red is very high risk 61-80. Categories are rated individually and the total score is used to indicate the overall risk. Supervisors may designate experienced, knowledgeable and qualified personnel as work site leaders responsible for field operations. Team orientation and various group and individual training occur throughout the season. Attention is given to cross-training staff members on every aspect of exotic plant management and chemical handling. Safety tailgate sessions are conducted prior to each treatment with emphasis on the dangers inherent to that site. Job Hazard Analyses (JHAs) are utilized as safety guidelines for staff training and reference. JHAs address the potential hazards associated with a particular task, mitigation measures and the types of personal protective equipment necessary to perform the task safely.

Environment

Due to the hazardous nature of roadside exotic plant management work, standard operating procedures have been put in place to ensure a safer atmosphere. For these types of operations, controlled work zones or stretches of road are established. Competent staff perform traffic control within the work zone. Proper and adequate signage is put in place to alert drivers to use caution and to slow traffic prior to entering the work zone. Orange cones may be used in addition to signs. Crew vehicles using flashers and/or emergency lights may escort staff treating exotic plants on road shoulders and especially through areas with blind curves. Law enforcement staff are notified when working in their respective areas especially when Utility Terrain Vehicles (UTVs) are in use for roadside spraying. Exotic plant treatments are often conducted in rough terrain and, in some cases, adjacent to thermal areas. Safety and situational awareness is a priority for everyone involved. Staff is trained in radio use, CPR and Basic First Aid and all vehicles are equipped with a First Aid Kit. Planned treatments or surveys may be rescheduled if the weather conditions are poor or if warranted by other safety concerns.

Pesticide Use, Handling, and Storage

Park staff that apply herbicides are required to attend training that includes instruction on safe herbicide mixing and handling techniques as well as sprayer calibration. Designated staff maintain pesticide applicator's state certification. All staff members are required to read and become familiar with all herbicide labels and material safety data sheets (MSDS) prior to handling or using herbicides. In addition, product labels and MSDSs are readily available during operations for staff and visitor reference.

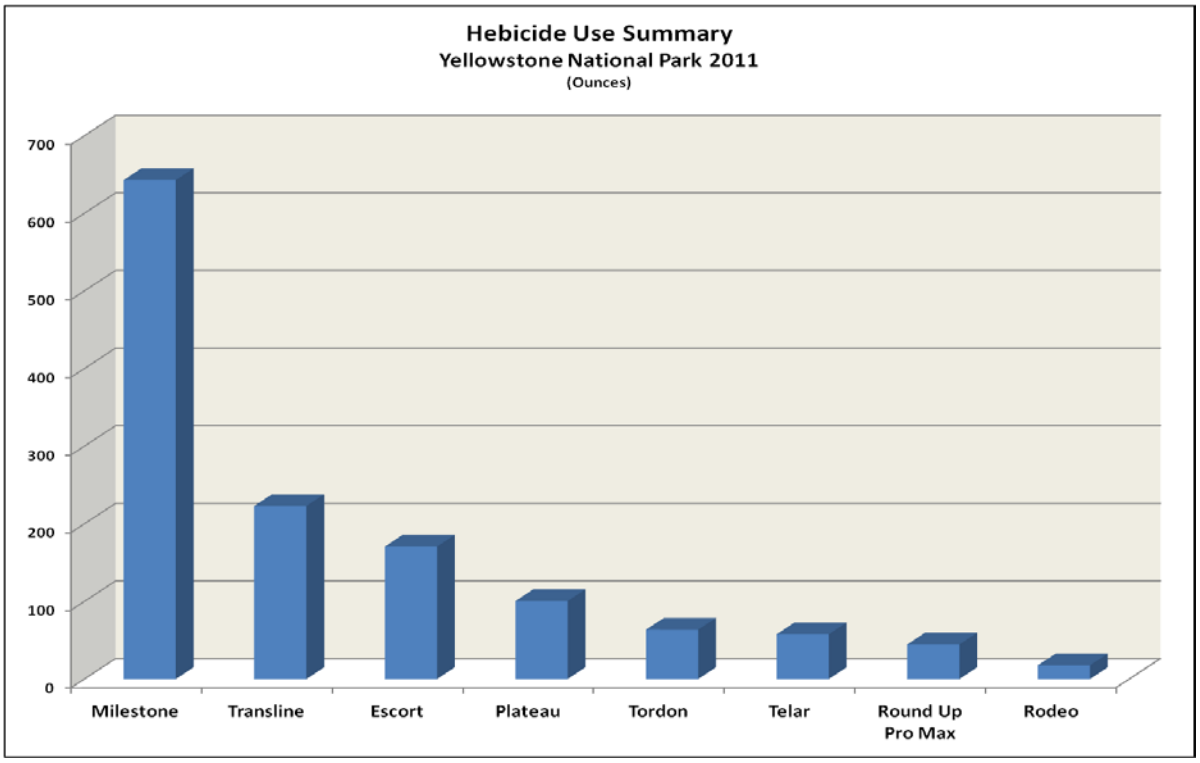
Containers of concentrated and diluted herbicides are labeled and stored properly. Spill kits are stored and readily available in each vehicle and inside the herbicide storage building. A Standard Operating Procedure is in place outlining how to handle and contain spills.

Appendix 7

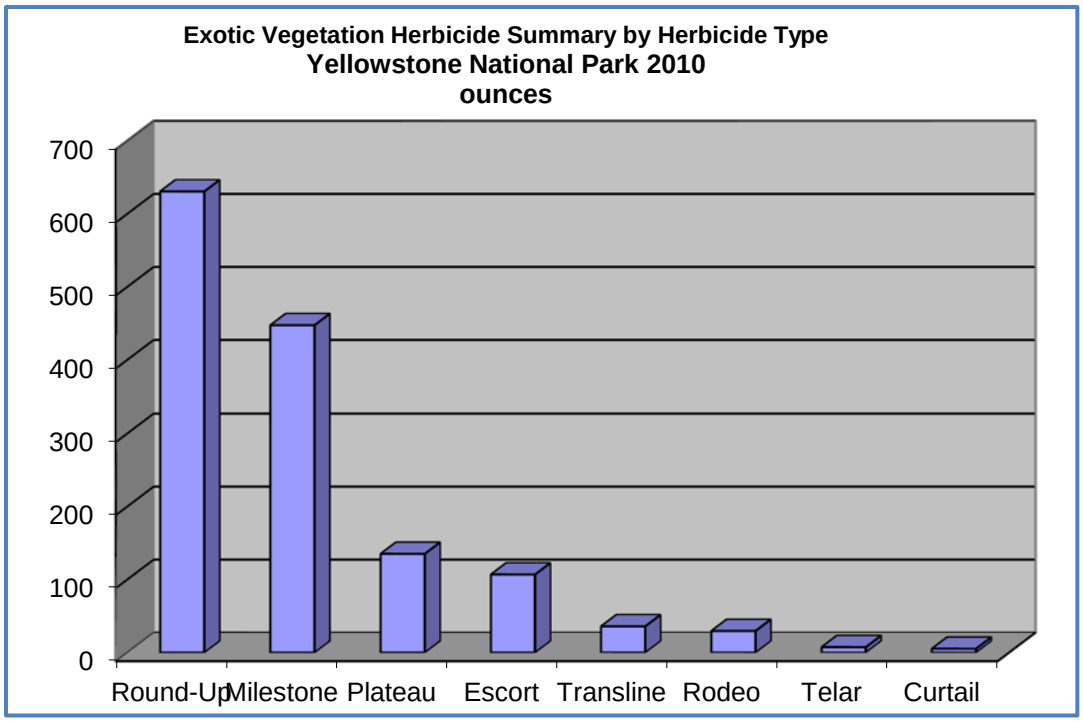
Herbicides Used in Yellowstone National Park

Herbicide selection in YNP undergoes an established review process that is consistent and rigorous. The National Park Service uses a nation-wide approach in overseeing herbicide approvals. National and Regional Coordinators are specialists in pesticide uses in national parks and work closely with designated park staff that coordinate and oversee pesticides usage within their park. The review and approval process is founded on principles in Integrated Pest Management, which places the use of herbicides as a last resort in pest management. Park staff is required to seek approval for specific herbicides through an internet-based Pesticide Use Proposal System, or PUPS. Regional and/or national Coordinators carefully review and evaluate the proposals using various criteria. These include such factors as potential environmental impacts, human safety, and effectiveness and applicability of active ingredients and formulations for specific applications and targeted species. A standard in the approval process is to use chemicals that pose the lowest risk and in the smallest quantities necessary to get the job done.

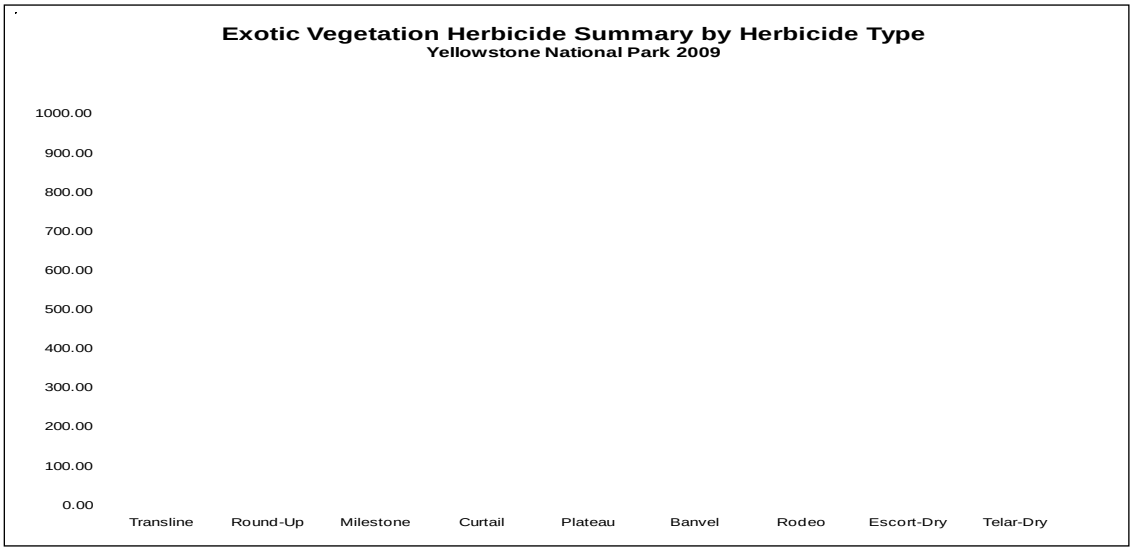
Pesticide approval is a dynamic process. Some herbicides are used for many years, while other herbicides used historically may be replaced with more effective and safer versions. The graph below illustrates this; *Milestone*, a relatively new, low-risk herbicide was widely used in 2010 and 2011 due to its effectiveness on high priority weed species and applicability for YNP environments.



Herbicides used in 2011 and their comparable amounts applied in concentrated form.



Herbicides used in 2010 and their comparable amounts applied in concentrated form.



Herbicides used in 2009 and their comparable amounts applied in concentrated form.

The table below is typical of herbicides applied in a given year (in this case 2010) in which formulations of selected chemicals are applied to targeted species for the maximum possible result.

Herbicide Use in Ounces by Species, 2010									
Species	**Curtail**	**Milestone**	**Rodeo**	**Round-Up**	**Escort**	**Telar**	**Plateau**	**Transline**	**Total**
Cheatgrass	0.000	0.555	0.000	464.160	0.184	0.000	0.000	0.000	464.899
Spotted Knapweed	0.000	150.445	0.000	0.000	42.181	3.179	0.000	0.000	195.806
Crested Wheatgrass	0.000	0.000	0.000	166.530	0.000	0.000	0.000	0.000	166.530
Dalmatian Toadflax	0.000	8.120	10.000	0.000	2.600	0.100	127.160	0.000	147.980
Houndstongue	0.000	69.148	0.000	0.000	21.964	1.130	0.000	0.000	92.242
Canada Thistle	0.000	36.132	0.000	0.000	5.128	0.103	0.000	30.950	72.312
Berteroa	0.000	35.836	0.000	0.000	5.794	0.148	0.000	0.000	41.778
Ox-eye Daisy	4.764	28.801	0.000	0.000	4.389	0.042	0.000	0.000	37.996
Yellow Sweetclover	0.000	27.159	0.000	0.000	6.493	1.711	0.000	0.000	35.363
Yellow Toadflax	0.000	3.535	16.250	0.000	2.369	0.000	4.730	0.000	26.885
Bull Thistle	0.000	11.267	0.600	0.000	1.958	0.188	0.000	5.000	19.012
St. John's wort	0.000	14.054	1.250	0.000	2.264	0.000	0.000	0.000	17.568
Wooly Mullein	0.000	7.692	0.000	0.000	1.841	0.633	0.000	0.000	10.165
Yellow Hawkweed	0.000	9.780	0.000	0.000	0.081	0.000	0.000	0.000	9.861
White Top	0.000	7.285	0.000	0.000	2.474	0.000	0.000	0.000	9.759
Tumble Mustard	0.000	6.615	0.000	0.000	2.106	0.100	0.000	0.000	8.821
Whiplash Hawkweed	0.000	7.015	0.000	0.000	0.000	0.000	0.000	0.000	7.015
White Campion	0.000	4.843	0.000	0.000	1.497	0.030	0.000	0.000	6.370
Orange Hawkweed	0.000	4.668	0.000	0.000	0.684	0.000	0.000	0.000	5.352
Musk Thistle	0.000	3.268	0.000	0.000	1.018	0.000	0.000	0.000	4.286
Black Medic	0.000	3.121	0.000	0.000	0.429	0.000	0.000	0.000	3.550
Leafy Spurge	0.000	0.001	0.000	0.000	0.000	0.000	3.300	0.000	3.301
Tall Buttercup	0.404	1.322	1.000	0.000	0.054	0.000	0.000	0.000	2.779
Field Bindweed	0.000	2.083	0.000	0.000	0.614	0.000	0.000	0.000	2.697
Goatsbeard	0.000	1.037	0.000	0.000	0.335	0.000	0.000	0.000	1.372
Curly Dock	0.000	1.319	0.000	0.000	0.000	0.000	0.000	0.000	1.319
Lambsquarters	0.000	0.750	0.000	0.000	0.120	0.000	0.000	0.000	0.870
Russian Knapweed	0.000	0.575	0.000	0.000	0.092	0.000	0.000	0.000	0.667
Sulfur Cinquefoil	0.000	0.379	0.000	0.000	0.127	0.000	0.000	0.000	0.505
Tansy Aster	0.000	0.001	0.500	0.000	0.000	0.000	0.000	0.000	0.501
Bladder Campion	0.125	0.000	0.025	0.000	0.000	0.008	0.000	0.000	0.158
Diffuse Knapweed	0.000	0.100	0.000	0.000	0.034	0.000	0.000	0.000	0.134
Red Clover	0.000	0.115	0.000	0.000	0.000	0.000	0.000	0.000	0.115
Flixweed	0.000	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.075
Black Henbane	0.000	0.051	0.000	0.000	0.017	0.000	0.000	0.000	0.067
Sticktight	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.017
Sowthistle	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.010
Alfalfa	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Totals	5.293	447.172	29.625	630.690	106.848	7.372	135.190	35.950	1398.139

*Many of the herbicides listed above were applied as a mixture to improve efficiency and efficacy.

In assessing the risks, the NPS and YNP use information from multiple sources in addition to consulting with experts and experienced land managers. Basic information is taken from the herbicide label and Material Safety Data Sheets (MSDSs), which provide laboratory and field research findings that satisfy the registration process established under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and which have been reviewed by the Environmental Protection Agency. The USDA Forest Service (USFS) completed risk assessments for many herbicides that use information from independent research in addition to the label/MSDS information. They

base their quantitative assessments of potential environmental and human health risk on the "worst case scenario" supposing the maximum application rate allowed annually, as well as the maximum potential acute exposure and the lowest known thresholds for species effects. These risk assessments for the herbicide currently used in YNP are summarized below; the full assessments can be found at http://www.fs.fed.us/foresthealth/pesticide/risk/shtml. The Health Department of Thurston County, Washington conducted extremely thorough reviews for the majority of the herbicides used by YNP (H. Parkinson *in* "Northern Rocky Mountains Exotic Plant Management Plan and Environmental Assessment for Ten Small Parks" 2011).

Herbicide Information Sheets

2,4-D Information Sheet

2,4-D, the common term for (2,4-dichlorophenoxy)acetic acid, in the phenoxy family of herbicides. It has been in wide use for many years and its properties, environmental chemistry and toxicology are well-studied. There are numerous herbicide formulations available that include salts, esters, or a combination of both. YNP uses the brand **Curtail®**, which contains triisopropanolamine salt of 2,4-D mixed with clopyralid (Information sheet follows). In YNP, the most common application method is spot spraying using backpack sprayers. Use of this chemical is being eliminated in YNP. The safest way to dispose of herbicides is often to judiciously use them. Once current stocks of 2,4-D are gone, it will not be restocked.

Mode of Action. 2,4-D is an auxin mimic. It binds to auxin receptors on plant cells, disrupting growth. Auxins are plant hormones that control plant stem and root growth; they are not present in animals. 2,4-D is a selective herbicide used to control broadleaf weeds in grasslands. It is primarily used in YNP when the plants are close to maturity and producing seeds because most other herbicides do not affect seeds.

Human Health and Safety. There are some small human health hazards associated with 2,4-D at high exposures. It seems to be toxic to the immune system and developing immune system because it disrupts the cell membrane and cellular metabolic processes. Proper personal protection equipment for workers is essential and public access to areas that have been recently sprayed should be prevented. As a result, YNP does not use 2,4-D on lawns or in heavily used areas of the park.

Environmental Fates and Effects

- *Soil:* 2,4-D adheres very poorly to soil and is moderately soluble in water. Therefore, it has a high potential for leaching and moving through soil to non-target plants. It is considered to have low to moderate persistence (half-life up to 30 days in soil).
- *Water:* The combination of 2,4-D and clopyralid may be toxic to fish and aquatic invertebrates. It has the potential to leach through soil into groundwater, especially in permeable and/or shallow soils. Therefore, it is limited to use in small quantities in areas where contamination of aquifers is minimal.
- *Native Plants:* 2,4-D and Curtail are effective herbicides that are mobile in soil. Therefore, there is potential for mortality or damage to native non-target vegetation. However, in small, careful applications, such non-target damage can be minimized.
- *Wildlife:* Single-dose toxicity tests indicate that 2,4-D is moderately toxic to mammals and birds and practically non-toxic to bees, frogs, and aquatic organisms. It does not seem to bio-accumulate.

Aminopyralid

Aminopyralid is of the chemical class pyridine carboxylic acid (chemical formula 4-amino-3,6 dichloropyridine-2-carboxylic acid or 2-pyridinecarboxylic acid, 4-amin-3,6-dichloro-). This class also contains clopyralid, picloram and triclopyr. This is a relatively new chemical under patent to Dow AgroSciences and marketed under the brand name of Milestone®. The formulations of aminopyralid found in Milestone® contain triisopropanolammonium salt of aminopyralid. Neither Milestone® nor Milestone VM® contains inert ingredients other than water and triisopropanolamine (SERA 2007).

The EPA's finding that aminopyralid appears to be a "reduced risk" is supported by the USFS Risk Assessment (USFS 2007). Because it is a new herbicide, there is little information beyond that submitted by Dow AgroSciences in support of its registration under FIFRA. It is not labeled for use in water. In YNP, it is applied as a spot spray along roadsides and in open areas to control spotted knapweed, houndstongue, Canada and other thistles, berteroa, ox-eye daisy, hawkweeds and other broadleaf weeds.

Mode of Action. Aminopyralid is an auxin-like growth regulator. Auxins are plant hormones that control plant stem and root growth; they are not present in animals. Auxin mimics like aminopyralid disrupt or alter plant growth by binding to receptor sites on cells, thus preventing the plant's auxins from binding. This leads to mortality or decreased vigor.

Milestone is a semi-selective herbicide especially effective against sunflower/composite (Asteraceae), pea/legume (Poaceae) and nightshade (Solonaceae) families. Grasses (Poaceae family) are less affected by this chemical. At sufficient concentrations, it kills most vegetation with which it comes into contact. At label rates, it is a selective herbicide and can be effective at lower application rates than clopyralid, picloram and triclopyr. It is usually applied to foliage; however, it can act as a pre-emergent control of target species by inhibiting seeds from sprouting.

Human Health and Safety. Auxins are plant hormones that are not present in animals except as ingested in food. Animal cells do not have auxin-binding sites; therefore, auxin mimics have no impact on animal hormonal processes. According to the "U.S. Forest Service Human Health and Environmental Risk Assessment for Aminopyralid" (2007), the risk characterization for aminopyralid for both workers and members of the general public is reasonably simple and unambiguous: based on a generally conservative and protective set of assumptions regarding both the toxicity of aminopyralid and potential exposures to aminopyralid, there is no basis for suggesting that adverse effects are likely in either workers or members of the general public even at the maximum application rate that might be used in Forest Service or NPS programs.

More than 96% of orally ingested aminopyralid passes through the digestive system unchanged. In animal testing, it is found to be non-mutagenic, unlikely to cause cancer, has a low acute oral toxicity, and is not thought to bio-accumulate.

Environmental Fates and Effects

- *Soil:* Aminopyralid adheres poorly to soil particles and is highly soluble in water. Therefore, it has a high mobility and leaching potential in soil. It is stable in soil in the absence of air. It degrades mostly by microbial metabolism in aerobic conditions, breaking down into carbon dioxide, non-extractable residues and small amounts of acidic volatiles (EPA 2005a). It remains intact for 6 to 533.2 days (average half-life 103.2 days), depending on the soil content and texture. It breaks down very quickly in light, whether on the soil surface or in water.

- *Water:* Aminopyralid is stable in water and submerged sediments, except in the presence of sunlight. It is toxic to aquatic plants and algae. Therefore, this chemical is not labeled for use in or near open water.
- *Native Plants:* Aminopyralid is an effective herbicide that is soil active. As such, there is a potential for it to damage or kill native plants with which it comes into contact. Plants may also absorb it from the soil. For that reason, it is not sprayed within the drip line of desirable plants and it is used at the lowest possible rates that are effective for the target species.
- *Wildlife:* According to the "U.S. Forest Service Human and Environmental Risk Assessment on Aminopyralid" (2007), the level of concern was not approached and there were no significant effects on soil microorganisms, fish, amphibians, terrestrial or aquatic invertebrates, or large or small mammals. However, "the risk characterization for birds is similar to that of mammals in that no hazard quotients exceed the level of concern (1.0)." In water, aminopyralid was shown to be toxic to aquatic vascular plants and algae, and slightly toxic to some species of oysters, fathead minnow (*Pimphales promelas*), and midges (*Chiromus riparus*). It tested as virtually non-toxic to all other species freshwater and marine fish that were tested), amphibians, marine invertebrates, and marine algae (EPA 2005a; PMRA 2007).

Chlorsulfuron

Chlorsulfuron (chemical formula 2-Chloro-N-[4-methoxy-6-methyl-1,3,5-traizon-2-yl) aminocerbonyl] benzenesulfonamide) is in the sulfonylurea class of herbicides. Chlorsulfuron is a relatively new herbicide that controls many broadleaf species that are more difficult to control with other chemicals. Common herbicide brands that contain chlorpyralid include Telar, Glean, Corsair, Perspective, Cimarron, Landmark, and many others. YNP is currently using Telar®.

Mode of Action. Chlorsulfuron is an acetolactate synthesis inhibitor; It stops cell division in plant roots and shoots, which in turn causes plants to stop growing. It is absorbed through roots and foliage, moving rapidly through the plant to inhibit cell division in roots and shoots.

Chlorsulfuron is a selective herbicide used for the treatment of broadleaf weeds in pastures and wildlands. It is effective as a pre-emergent herbicide or post-emergent foliar spray whose selectivity depends largely on the rate at which it is used the higher the concentration, the more species of plants it will damage or kill. It may be used to treat weeds in non-cropland sites that have temporary surface water (equipment ruts or other human-created depressions) and after when no water is present in wetlands. It may not be used in open water such as lakes, streams, etc. In YNP, it is primarily used to control toadflax and yellow sweet clover.

Human Health and Safety. Chlorsulfuron does not appear to cause cancer, genetic mutation, reproductive issues or birth defects, although it may cause weight loss at extreme doses. There is no clear basis for suggesting that the effects on humans are likely or would be substantial.

Environmental Fates and Effects

- *Soil:* Chlorsulfuron adheres poorly to soil particles. The persistence of chlorsulfuron in soil varies widely, breaking down in acidic soils much faster than in more alkaline soils (half-life 10 -180 days, in field trials, 11-70 days). It is highly water soluble, making Soil microorganisms and moisture break chlorsulfuron down to nontoxic, non-herbicidal chemicals in the absence of oxygen. It is generally soil active, and is easily absorbed by plant roots and seeds.

- *Water:* Chlorsulfuron has the potential to contaminate groundwater, but current application rates and use patterns are not likely to cause significant contamination.
- *Native Plants:* Chlorsulfuron is an effective herbicide. Because it is mobile in soil, can be taken up by roots and works on almost any plant species, there is potential *for higher no*n-target plant mortality than some other chemicals. It should be carefully applied in small quantities in areas where the soil is not highly permeable and water tables are not shallow. Potential damage to aquatic plants is likely to be less substantial than for terrestrial plants. Aquatic algae do not as sensitive to chlorsulfuron.
- *Wildlife:* Chlorsulfuron has low toxicity for mammals, birds, and bees, and it is practically non-toxic to fish and aquatic organisms. It does not seem to bio-accumulate.

Clopyralid

Clopyralid is a chemical in the pyridine carboxylic acid class (chemical formula 3,6-dichloro-2-pyridinecarboxylic acid, monoethanolamine salt), which also contains aminopyralid, picloram and triclopyr. Some brand names include Transline, Stinger, Reclaim and Curtail (in which it is mixed with 2,4-D). Transline® and Curtail® have been used in YNP. Clopyralid has been used in YNP to treat Canada thistle. Its use is being phased out in favor of Milestone (aminopyralid) which is as effective against thistles and has fewer environmental issues.

Mode of Action. Clopyralid is another auxin mimic which binds to receptors on cells to disrupt plant growth. Clopyralid is a selective herbicide used for control of broadleaf weeds, especially thistles and clovers. It is more selective than many other auxin-mimic herbicides. In YNP, it is spot sprayed using backpack sprayers or small powered sprayers with nozzles.

Human Health and Safety. Clopyralid may cause mild respiratory, eye or skin irritation to workers chronically exposed to doses larger than expected. It does not appear to cause cancer, genetic mutation, or reproductive issues. It has a low probability of causing birth defects.

Environmental Fates and Effects

- *Soil:* Clopyralid adheres poorly to soil particles and is highly soluble, has moderate persistence in the soil (half-life 15-287 days) and very high soil mobility. It is not readily decomposed in soils.
- *Water:* With high soil mobility, clopyralid has the potential to contaminate groundwater. Therefore, it is not applied where soils are highly permeable and the water table is shallow.
- *Native Plants:* Clopyralid is an effective herbicide on selected plant families. Because it is mobile in soil and can be taken up by roots, there is potential for more non-target plant mortality than some other chemicals. Clopyralid should be carefully applied in small quantities in areas where the soil is not highly permeable.
- *Wildlife:* Clopyralid seems to have low toxicity to fish and aquatic invertebrates, mammals and birds. It is not toxic to bees. It does not seem to bio-accumulate.

Glyphosate

Glyphosate is an isopropylamine salt of N-(phosphonomethyl) glycine. Originally developed by Monsanto, it is now off patent and used in many brand names of herbicides. Some, like Rodeo®, Pondmaster® and Aquamaster® are safe to use in or near water and on aquatic weeds. Many others, including the most well know (Roundup), have added ingredients known as surfactants that can only be used on dry land. Surfactants are addressed specifically later in this Appendix, and

discussed specifically in terms of being applicable to multiple brand formulations. Glyphosate is one of the most widely used herbicides in the United States, with a long, well-documented history of use in agriculture and home gardening, as well as natural area applications. In YNP, **Roundup PRO®** is only used in dry, terrestrial settings for controlling grasses, and **Rodeo®** is used for many species when they are near or in water or wetlands.

Mode of Action. Glyphosate works by inhibiting the synthesis of key amino acids necessary for protein synthesis and growth. Although microorganisms have the same amino acid pathway, research suggests glyphosate has no effect or slight enhancement to microorganisms in soil (SERA 2003a; Powell, Kerby, and Rowell 1991; Haney, Senseman, and Hons 2002; Busse, Ratcliff, and Shestak 2001). This amino acid metabolic pathway does not occur in humans and other animals (SERA 2003a).

Glyphosate is a broad-spectrum, non-selective systemic herbicide used primarily for controlling grasses, broadleaf weeds and some woody plants.

Human Health and Safety. Glyphosate has not shown signs of causing neurotoxicity and has the lowest risk of carcinogenicity (EPA 1993a) and has not been shown to bio-accumulate (SERA 2003a). According to the U.S. Forest Service's "Glyphosate Human Health and Ecological Risk Assessment Final Report" (2003a), "The risk characterizations for both workers and members of the general public are reasonably consistent and unambiguous. For both groups, there is very little indication of any potential risk at the typical application rate of 2 lbs per acre. Even at the upper range of plausible exposures in workers, most hazard quotients are below the level of concern." Chronic or subchronic exposure to glyphosate tends to cause loss of body weight. And skin, eye or lung irritation can occur in workers exposed to the chemical.

Environmental Fates and Effects

- *Soil:* Glyphosate is not mobile through soil because it quickly and strongly adheres to soil particles and is no longer available to plants. This strong adsorption limits the transport of glyphosate or its metabolites to groundwater or surface water. The persistence of glyphosate in soil is usually rapid, but it varies depending on the soil's organic matter, moisture, pH, and temperature. Both bound and unbound chemical degrade with half the chemical metabolizing within 1 to 197 days. Its metabolites also break bind to soil and break down further to carbon dioxide, ammonium and phosphate.
- *Water:* Glyphosate preferentially bonds to organic matter (soil particles) in water as well, reducing the amount of glyphosate in solution in the water. It biodegrades within 2 14 days.
- *Native Plants:* Glyphosate is a broad-spectrum herbicide likely to damage or kill any plant it touches while still active. However, because it does not move from the plant or soil particle on which it dries, it is possible to minimize non-target mortality by careful application techniques.
- *Wildlife:* According to the U.S. Forest Service's "Glyphosate Human Health and Ecological Risk Assessment" (2003), "The current risk assessment for glyphosate generally supports the conclusions reached by U.S. EPA. Based on the current data, it has been determined that effects to birds, mammals, fish and invertebrates are minimal."

Imazapic

Imazapic is in the imidazolidinone class of herbicides (chemical formula (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid). Some common

brand names are Cadre, Plateau Eco-Paks and **Plateau®**, which is used in YNP to control toadflax and may be used to control invasive grasses.

Mode of Action. Imazapic inhibits the enzyme acetohydroxyacid synthase (AHAS), preventing amino acids from being formed in the plant. This enzyme is not present in animals. It is a systemic, selective herbicide used most often as a pre-emergent or post-emergent control for annual and perennial grasses and aquatic weeds. In YNP, it is used on Dalmatian toadflax.

Human Health and Safety. For workers and the general public, no exposure scenarios, acute or chronic, exceed the level of concern, except for accidental spill of a large amount of imazapic into a very small pond. In practice, mild, temporary eye irritation is likely to be the only overt effects as a consequence of mishandling this chemical.

Environmental Fates and Effects

- *Soil:* Imazapic binds to different soils at different rates, but does not seem to move through soil easily. It remains in the soil a moderately long time; it has a half-life of 120 days. It is degraded mostly by soil microbes. Off-site movement from erosion is unlikely and it is not likely to contaminate groundwater.
- *Water:* Sunlight rapidly degrades imazapic in water. It does not move laterally with surface water.
- *Native Plants:* As a pre-and post-emergent herbicide, there is some potential for damage to non-target plants. Sensitive plants species may be damaged by off-site drift and there is some potential for damage from runoff. As a pre-emergent, that risk seems to be relatively low. In the pre-emergent study, there was no noticeable effects of emergence of non-target species.
- *Wildlife:* Studies indicate that at the exposure levels expected from regular use, there is little risk to mammals, birds or other wildlife. However, larger mammals, such as dogs and rabbits, may be more sensitive to imazapic than smaller mammals, such as mice. In dogs, this chemical has been associated with effects on the muscle, blood, and liver after long (2-year) exposure to high doses. Aquatic animals seems to be relatively insensitive to this chemical. No toxicity studies have been located on the effects of imazapic on amphibians or microorganisms.

Metsulfuron Methyl

Metsulfuron methyl (chemical formula methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]-carbonyl]amino]sulfonyl]benzoate) is in the sulfonylurea class of herbicides. Some common brand names are Escort, Ally and Cimarron. Escort® has been used in YNP to control many weeds. However, it may be phased out as new herbicides become available that are ecologically safer and more effective.

Mode of Action. Metsulfuron inhibits acetolactate synthase, blocking amino acid synthesis. It is absorbed through roots and foliage, moving rapidly through the plant to inhibit cell division in roots and shoots. Metsulfuron is a selective herbicide used for the treatment of woody plants, annual and perennial broadleaf weeds and annual grasses. It is most effective when sprayed on foliage; however, it also has effective pre-emergent activity.

Human Health and Safety. Metsulfuron does not appear to cause cancer, genetic mutation, reproductive issues or birth defects, although it caused weight loss in test animals at high doses.

This effect might be related to saccharin, which is one of the chemicals remaining after metsulfuron metabolizes. Typical exposure by workers or the general public should not lead to toxic effects.

Environmental Fates and Effects

- *Soil:* The persistence of metsulfuron methyl in soil varies widely, depending on the soil's organic matter, moisture, pH, and temperature (half-life 13.4 -180 days). Soil microorganisms and moisture break metsulfuron down to nontoxic, non-herbicidal chemicals in the absence of oxygen. It is generally soil active, and is easily absorbed by plant roots.
- *Water:* Metsulfuron is highly mobile in water and can leach through silt loam and sand soils to endanger groundwater at low concentrations. It breaks down in water in one to eight days. Surface water contamination can occur if it is applied directly to open water or wetlands.
- *Native Plants:* Metsulfuron is an effective herbicide. Because it is mobile in soil, can be taken up by roots, and works on almost any plant species, non-target plant mortality may be higher than with some other chemicals. It should be carefully applied in small quantities in areas where erosion, highly permeable soil, or high water tables may move it easily. Potential for damage to aquatic plants seems to be small and aquatic algae appear to be relatively resistant to it.
- *Wildlife:* Metsulfuron has relatively low toxicity for mammals, birds, bees and worms, although toxicity is moderate for fish and aquatic organisms. It does not seem to bio-accumulate.

Appendix 8

Potential Use of Biological Control in Yellowstone National Park Invasive Vegetation Management

Biological control (biocontrol) is the deliberate use of living organisms to limit the abundance of a target species. In many situations, both the biocontrol agent and the targeted species are nonnative to the system where control is desired. Biological control is a strategy used by many western states for control of nonnative plant species and is used by many of Yellowstone National Park's (YNP) neighbors in Greater Yellowstone Area (GYA) National Forests and Counties. Yellowstone National Park itself has unsuccessfully used very limited agents in earlier years as an attempted means of controlling nonnative *Linaria* plant species. Although often touted as a safer means than use of chemicals for controlling nonnative species, only 20% of biocontrol programs have shown significant success at reducing host density (Williamson and Fitter 1996). It is not necessarily preferable to chemical control or appropriate if the agent has low efficacy or direct and indirect non-target effects.

Classical biocontrol is based on the enemy release hypothesis (Pearson and Callaway 2005). This theory is a strong top down approach that assumes once free from natural herbivore enemies that suppressed them in their native range, pests are able to grow unchecked in their new environments (Crawley 1997; Maron and Vila 2001; Keane and Crawley 2002). However this hypothesis has not been critically tested. Many plants are capable of being a dominant in their native range despite high herbivory (Maron and Vila 2001).

Most controversy, however, exists over ecological risks in classical biocontrol (Louda et al. 2003). Biocontrol operates under the assumption that highly host-specific biological control agents are safe and effective (Pearson and Callaway 2005). But with any successful introduction of an alien organism, it must be recognized that ecological consequences will occur. Ecological risks that have been identified include: 1) discrepancies between predicted host specificity, based on controlled host preference tests, and observed host use in the field (Louda and O'Brien 2002; Pearson and Callaway 2003, 2005); 2) self-replicating, self-dispersing, and irretrievable successfully-introduced biological agents, often viewed as a beneficial quality by biocontrol practitioners (Simberloff and Stiling 1996; Louda and Stiling 2004); 3) host damage, but not control, resulting in an increased competitive advantage of the nonnative targeted host and decreasing the biomass/productivity of desired native grass species (e.g., Callaway et al. 1999). Pearson and Callaway (2003, 2005) coined the term compensatory responses" of the target nonnative host to describe such outcomes; 4) failure of the introduced agent to control the host plant, yet increasing to superabundant levels and subsidizing native seed predators, illustrating food web interactions (Pearson and Callaway 2003, 2005); and 5) successful control of the targeted host, but resulting in increased response of other nonnative plant species rather than desired native plants (e.g., Butler and Wacker 2010) or the inability of native plant species to quickly recolonize and restore the ecological function that native vertebrate/invertebrate species have come to depend, illustrating "ecological replacement" (Pearson and Callaway 2003, 2005). Such ecological risk factors are complex and illustrate the difficulty in predicting outcomes, interactions, and cascading effects of introducing nonnative biocontrols, a process not fully required as part of the assessment, approval, and release of weed biocontrol agents (Lockwood, 1997; Louda et al. 2003; Delfosse 2005; Maron et al. 2010). Such analyses of ecological risk are often realized following either establishment of the nonnative host species (e.g., Sing et al. 2005; Sing and Peterson 2011) or the release and establishment of the

biocontrol agent (e.g.,Louda and O'Brien 2002; Louda et al. 2005; Wacker and Butler 2006; Breiter and Seastedt 2007; Butler and Wacker, 2010).

Ecological risk may be of a lesser concern in agricultural or some rangeland settings, but assumes a greater degree of ecological or ethical scrutiny for natural areas managed for their intrinsic biocentric values (Lockwood 2001). In places like Yellowstone, maintenance of native biodiversity and control of nonnative species permeates management issues, philosophy, and actions across the full spectrum of life forms—from higher-order vertebrates (e.g., mountain goats *Oreamnos americanus*) to lower-order fungi (e.g., white pine blister rust *Cronartium ribicola*)—and is the fundamental basis for the prevention and control of nonnative vegetation. Purposeful introduction of nonindigenous species contributes to conservation issues surrounding "biotic homogenization" (Olden et al. 2004, 2005; Olden 2006; Olden and Rooney 2006) and the maintenance of biological distinctiveness, values for which places like YNP are formally recognized as World Heritage Sites. The wisdom of using nonindigenous insects to control nonindigenous plants should not be taken lightly, especially considering that insects as a taxon are a poorly recognized and understood component of the park's fauna. The absence of information on adverse environmental impacts of biocontrol introductions does not necessarily equate to absence of effect. The real issue is whether purposeful introduction of additional alien species is worth the risk, justified only by the likelihood of preventing greater damage by the target pest species.

Based on these concerns, the YNP Interdisciplinary Weed Team identified criteria that would need to be met for the park to release biocontrol agents:

- Peer-reviewed published literature clearly demonstrates a quantifiable measure of agent success under field conditions on the targeted weed species in similar habitats, resulting in the proliferation of native plant species.
- Host specificity has been successfully demonstrated under field conditions to the targeted species in similar habitats. Research into pre-approval or early releases of minimally field tested biological controls would not be permitted in the park, particularly if there are adequate research sites available on non-park lands.
- Research indicates that the introduced biological control would not harm other native organisms, including populations of species similar to it.
- Other treatment options have proven ineffective or demonstrate unacceptable potential impacts.
- The threat to the park of continued spread of the targeted nonnative plants outweighs the risk of introducing a nonnative biocontrol species into the park.
- External and internal reviews have been conducted and compliance requirements have been met.

Quantification of ecological risks associated with introduced biocontrols "is still a scientific frontier" (Louda et al. 2005), but will be evaluated by the YNP Interdisciplinary Weed Team by: 1) gathering information on the life cycle and habits of both the targeted weed species and biocontrol agent under consideration; 2) conducting a search of peer-reviewed scientific literature of laboratory, greenhouse, and field studies relevant to the biocontrol agent and its effects, with emphasis on data and interpretations drawn from field studies; and 3) acknowledging if and where applicable information gaps may exist to make the most informed decision. The resulting evaluation, weighed against the expected and potential outcomes, will determine whether to proceed with purposeful introduction of a given agent. The process recognizes the burden of proof lies with evidence available in the scientific literature, and not with anecdotal or qualitative information.

Implementation of biocontrol is best suited to large, dense aggressive nonnative infestations where eradication is impractical or in remotely accessed locations. While some species meet this condition (e.g., timothy, *Phleum pretense),* they are not candidates for biocontrol because they are not considered noxious nor is there a biocontrol method currently available for them.

The plant species most likely for Yellowstone National Park to consider biocontrol are:

- Dalmatian toadflax (*Linaria dalmatica*), widely distributed throughout the sagebrush-steppe vegetation in the northern third of the park (Rew et al. 2005a,b) and to a lesser extent along the west-central park boundary;
- Perhaps spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), found in low densities but throughout the park along road corridors and in some developed areas (Olliff et al. 2001); and
- Perhaps in the near future, leafy spurge (*Euphorbia esula*) which is currently found and controlled in a very few locations in the park but is encroaching on the park from all directions, particularly from the southwest.

The use of biocontrols in relation to these plant species is undertaken as follows, omitting information from step 1 above for the sake of brevity, but including information relevant for YNP. General weed and biocontrol information is available elsewhere and familiar to the YNP Interdisciplinary Weed Team.

Dalmatian Toadflax (*Linaria dalmatica Mill*)

First collected in the 1950s in Mammoth, although reported in 1947, Dalmatian toadflax quickly spread from 70 acres in 1962 to 800 acres in 1967. Its aggressive spread prompted the need for the park's first nonnative plant suppression crews in 1967 (YNP Archives; Browning 2010) and over the next few decades the park launched a suppression effort that included mechanical, chemical and biocontrol efforts. From 1969-71, YNP became the first park to introduce a biocontrol agent, the defoliating moth *Calophasia lunula*, for the control of Dalmatian toadflax (YNP Archives; Olliff et al. 2001; Browning 2010). Further attempts to rear *C. lunula* under laboratory conditions occurred through 1974 (YNP Archives; Olliff et al. 2001) with the hopes of supplanting herbicides as the primary control strategy for Dalmatian toadflax (YNP Archives). Both field releases and efforts to rear-and-release *C. lunula* were discontinued after 1974 apparently because of unsuccessful field establishment and poor rearing success/insufficient brood stock (Olliff et al. 2001). Incidental observations of biocontrol agents, apparently from stocks released outside the park, have been observed inside park boundaries (Olliff et al. 2001). Ovary-feeding beetles (*Brachypterolus pulicarius)* were collected from both Dalmatian and yellow toadflax from the west-central boundary of the park ca. 1991 (R. Renkin, personal communication), and in 1992 a capsule-feeding weevil (*Rhinusa antirrhini*) was collected from Dalmatian toadflax at Heart Lake in the south-central region of the park (R. Renkin, personal communication). Moreover, unauthorized releases of *Gymanetron antirrhini* and *Brachypterolus pulicarius* occurred at 6 sites in the north and west-central areas of the park in 1997-1998 for the control of *Linaria* species. There was no permanent establishment of the released or identified agents.

Browning (2010) reported that the release of Dalmatian toadflax agents (primarily the stem-feeding weevil *Mecinus janthinus,* but sympatric with *B. pulicarius* at one site) over the past 7-8 years in areas around the South Fork of the Shoshone River (Park County, Wyoming) resulted in a reduction in infestations of the weed. Qualitative descriptors ranging from "little evidence of herbivory of insects" to "unthrifty (plants) often contained weevil larva or feeding damage" and "toadflax populations are on their way down" were used to describe the results. In perhaps the most relevant

study to date given quantitative assessment of *M. janthinus* from field release sites adjacent to the park near the gateway community of Gardiner, MT, Schat (2008) reported limited agent establishment, high overwinter winter mortality, and no effect of agent damage on the cover or density of Dalmatian toadflax over the 3-4 year study period. Apparently released agents could not sustain population growth and achieve injury threshold densities, probably because of low snow cover and insufficient plant stem diameters affecting overwinter survival and larval development, respectively (Schat 2008).

A recent survey in the northern tier of the park did not detect any feeding by previously-released agents identified above on Dalmatian toadflax (Browning 2010). The survey, however, did reveal widespread native insect presence, feeding, and damage including foliage damage by grasshoppers, leaf feeding by lepidopterus larva, leaf feeding by adult fleabeetles, and a pentatomid bug feeding on an inflorescence. A follow-up visit to plants supporting the gregarious lepidopterus larva revealed continued larval development and survival, resulting in more extensive plant damage. Moreover, widespread, and in some locations, extensive stem grazing by ungulates was observed (Browning 2010). There is still not enough research to indicate that *M. janthinus* would be successful in YNP.

An unintended consequence of the use of biocontrol agents is that geographical separation of populations of insects can result in the insect exploiting different host species. This is termed "host race" and results from ecological differentiation. Sing et al. (2005) in a review of literature over the past 50 years considers risks associated with biocontrol of Dalmatian toadflax. The research documented that a number of studies have looked at host race concerns on Dalmatian toadflax and yellow toadflax (Groppe 1992; Harris and Gassmann 2004; Hering 2002; Nowierski 1995; Smith 1959) and found evidence for host race in *R. antirrhini* and *B. pulicarius*. It was used to support the petition of the release of these biocontrol agents. As a result two biocontrol host race agents have been accidentally introduced to North America.

Ecological studies have shown that defoliation of plants such as that due to agent *C. lunula* have little effect on established weed infestations (Cousens and Mortimer 1995; Myers and Bazely 2003; Pearson et al. 2005). Dalmatian toadflax can reproduce both sexually and asexually, a physiology that is particularly resilient to biomass reduction (Burdon et al. 1980; Burdon and Marshall 1981; Lajeuness et al. 1993; Pearson et al. 2005). Since Dalmatian toadflax can survive biomass reductions, the most promising agent is *M. janthinus*, a stem boring weevil (Breiter and Seastedt 2007) that elicits a different physiological response than defoliation from the moth, *C. lunula*.

One concern is that YNP has many native species in the same family as Dalmatian toadflax. Recently this family has undergone taxonomic revision, resulting in some native species being identified as potential hosts for Dalmatian toadflax biocontrol agents, a problem that was not anticipated at the time of their approval for release. Breiter and Seastedt (2007) looked at the effects of *M. janthinus* on native species, some of which are found in YNP (3 of 7 species tested), related to Dalmatian toadflax. In greenhouse choice and no-choice studies they found that at most low-level use of native plants may occur. The greenhouse studies included paintbrush (*Castilleja* spp.), yellow monkeyflower (*Mimulus guttatus* DC), purple monkeyflower (*Mimulus lewisii* Pursh), all found in YNP, and Texas toadflax (*Nuttallanthus texanus* (Scheele) DA Sutton), bearded sidebells penstemon (*Penstemon secundiflorus* Benth.), beardless sidebells penstemon (*Penstemon virgatus* Gray), and low beard tongue (*Penstemon virens* Pennell ex. Rydb)—none of which are present in YNP. They also conducted no-choice experiments in the field in Colorado on Texas toadflax, low beard tongue, and bearded sidebells penstemon and feeding and reproductive use was not observed on any except the Texas toadflax. Their study suggested that non-target herbivory on native Scrophulariaceae would be none to minimal in the study area.

Evaluation of the available literature reveals six insects have been approved for release in the United States as biocontrol agents for Dalmatian toadflax (Jacobs and Sing 2006): a flower-feeding beetle (*B. pulicarius)*, a foliage-feeding moth (*C. lunula*), a root-feeding moth (*Eteobalia intermediella*), and weevils that feed on roots (*Rhinusa linariae*), seeds (*Rhinusa antirrhini*), or stems (*M. janthinus*). Four of these agents have been found in the park, due either to intentional releases in the park or incidental migrants from release sites outside the park. None have established, let alone demonstrated some degree of control of Dalmatian toadflax. Both the flower beetle and seed capsule weevil have proven ineffective in controlling Dalmatian toadflax in field studies elsewhere, and no information on the effectiveness of root-feeding agents is available, mostly because of the cryptic lifestyle of these agents (Jacobs and Sing 2006). Of the USDA-approved agents for release to control Dalmatian toadflax, the stem weevil *M. janthinus* currently appears the most promising for control given reported decreases in plant vigor and density in areas of southern British Columbia and northern Washington. Yet repeated releases of *M. janthinus* adjacent to the park failed to demonstrate meaningful establishment or control of Dalmatian toadflax. While quantitative information on efficacy remains scarce, there is little field research to address whether successful biocontrol results in proliferation of desired native plant species, or the degree to which known and potential ecological risk factors (identified above) are mitigated. As Sing et al. (2005) emphasize, such risk factors should not be discounted. Consequently, the use of approved, available biocontrols in YNP for management of Dalmatian toadflax, particularly with reference to the agent *M. janthinus,* will not be considered at this time because: 1) field and laboratory measures of plant fitness under the influence of biocontrol have not translated into quantifiable reductions of Dalmatian toadflax in the field; 2) no research demonstrates the proliferation of desirable native plant species results from successful control of Dalmatian toadflax; 3) limited assessment of ecological risk suggests: a) host specificity testing to date is compromised by the taxonomic uncertainty of the figwort family Scrophulariaceae, and b) host damage, but not control, facilitates competitive advantage without decreasing plant biomass or size; and 4) the anticipated effects of introduced biocontrol agents are already being realized with a suite of native insects and grazers acting on established Dalmatian toadflax populations. There is insufficient information to demonstrate that introduced biocontrol agents, particularly *M. janthinus,* would be "successful" in YNP.

Spotted Knapweed (*Centaurea stoebe* L. subsp. *micranthos* (Gmeliln ex Gugler) Hayek)

Spotted knapweed was first observed in the park in the late 1970s and first collected in 1973; suppression efforts started in earnest in 1982. There are currently twelve biocontrol agents available in North America for knapweed suppression (Story et al. 2006). The galls of one such agent, *Urophora* spp., were observed on seed heads of spotted knapweed ca. 1992 along the west-central boundary of the park (R. Renkin, personal communication), apparently from introductions outside park boundaries. No establishment of the agent has been demonstrated. Knapweed provides a good example of non-target effects that may occur due to the use of biocontrols.

Callaway et al. (1999) showed that the biocontrol agent *Agapeta zoegana*, a root moth, may elicit a compensatory competitive response in knapweed making it an even better competitor. They further showed an increase in the negative effects of knapweed on neighboring native Idaho fescue (*Festuca idahoensis*), a common plant also native to YNP. Several others have found similar results (Ridenour & Callaway 2003; Newingham and Callaway 2006; Newingham et al. 2007).

Story et al. (2006) found that over an eleven-year period on sites in western Montana, knapweed declined with use of the root weevil *Cyphocleonus achates* biocontrol agent, but two major annual nonnative species (one of which was cheatgrass (*Bromus tectorum*)) became significant

components of the plant community, making the overall invasive species problem worse rather than better. Jacobs et al. (2006) also looked at knapweed control with the use of biocontrol agent *C. achates* and found only insignificant declines in knapweed. Story et al. (2006) suggested that the agent might be successful in reducing knapweed when competitive native grasses are present.

Research on another agent has shown non-target food-web interactions with the introduction of *Urophora* spp., a highly host specific biocontrol agent introduced to control spotted knapweed by attacking the flowers. Native deer mice eat the *Urophora* spp., significantly altering deer mice diets and thus potentially elevating the mice populations in knapweed habitats (Pearson et al. 2000). With a subsidized diet, deer mice population increase and mice carrying hantavirus can become more than three times as abundant as before the introduction, increasing the risk of humans contracting the disease (Pearson and Callaway 2006). Besides the non-target effects of *Urophora* spp., Myers and Risley (2000) found that spotted knapweed is resilient to greatly reduced seed production. They "suggest that it is important to demonstrate that weeds are seed limited before introducing exotic herbivores whose impact is to reduce seed numbers."

Considering that spotted knapweed is largely confined to road corridors and some developed areas within the park, has been a primary target of herbicide control for more than 2 decades, and does not exist in large, dense, monocultures typical of control with biological agents, it is questionable whether biocontrols are a desired management tool. Even though a high degree of host specificity and a decrease in spotted knapweed density has been demonstrated under field conditions, there is no evidence suggesting an increase in desirable native plant species commensurate with control of spotted knapweed. Strong compensatory responses to herbivory have been demonstrated, with unpredictable indirect effects to non-target organisms showing food web interactions. For these reasons, the use of USDA-approved biocontrol agents for the management of spotted knapweed within the boundaries of YNP will not be pursued at this time.

Leafy Spurge (*Euphorbia esula* L. var. *uralensis* (Fisch. ex Link) Dorn)

Leafy spurge was first documented in the park in 1983. Early detection/rapid response and control strategies have been successful in eradicating most isolated patches, but leafy spurge is encroaching the park from all directions, particularly from the southwest. The park anticipates increasing infestations of leafy spurge in the future, and is collaborating with neighboring federal, state, and private interests in a centralized effort titled, "Hold the Line" (www.helpholdtheline.com). Efforts to stop the spread of leafy spurge and control established infestations include the release of flea beetle biocontrols (*Aphthona* spp.) adjacent to the park. It is anticipated that quantitative results from field studies will yield information relevant to the criteria adopted by the park in evaluating future potential use of these biocontrol agents.

Currently there are 10 biocontrol agents available for use on leafy spurge, the most effective of which is *Aphthona* spp. (Anderson et al. 2003; Lesica and Hanna 2004). *Aphthona* spp. are thought to be the most effective because adults feed on the leaves while the larvae feed on the roots. Butler et al. 2006 examined the use of *Aphthona* spp. or flea beetles and found that with a reduction in leafy spurge, graminoid cover increased. However, forb cover remained below levels of non-infested leafy spurge plots, suggesting leafy spurge can alter the structure of the plant community (Butler and Cogan 2004; Butler et al. 2006) even after it has been controlled. Other studies have shown an increase in other nonnative species with a decrease in leafy spurge associated with the use of biocontrols (Butler and Wacker 2010). Another study in north-central Montana over five years found that with the introduction of *Aphthona nigriscoutis* to reduce leafy spurge, vegetation cover did not show a significant increase in nonnative species (Lesica and Hanna 2004). *A. nigriscoutis* has also been shown to feed on native *Euphorbia robusta* (Baker et al. 2003).

While this plant does not occur in the park, it does occur in Fremont County, WY. Another study failed to find *Aphthona* spp. feeding on a native Great Plains species, *Euphorbia brachycera,* and thought the ability of flea beetles to host shift was low (Wacker and Butler 2006).

While current levels of leafy spurge in the park are not consistent with the use of biocontrols, the available research suggests the need for more detailed field studies addressing ecological risk if future releases are to be considered. Host specificity of *Aphthona* is inconclusive, and it appears successful control of leafy spurge with *Aphthona* does not result in proliferation of desired native plant species. While much anecdotal, qualitative information is available, there is insufficient quantitative information currently available to fully evaluate risk vs. benefit of biocontrol in YNP.

Conclusion

Biological control is the use of living organisms to limit the abundance of a target nonnative species. It is a long term management tool and will not result alone in species eradication or containment, but when used in conjunction with other methods can contribute to infestation containment. Biological Control agents have been widely used as part of an Integrated Weed Management approach to control invasive vegetation by land use agencies throughout the western U.S. and in the Greater Yellowstone Area. While limited biocontrol has been deployed in the park, there are currently no active uses of biocontrol agents. Biological control is not necessarily appropriate or preferable to chemical or other control methods if it involves introducing one nonnative species to control another, especially if the biological control organism has low efficacy in controlling the target species. Introducing a nonnative biological agent to control nonnative plant species has many associated risks (Lockwood et al., 2001; Louda and O'Brien 2002) in addition to potential benefits.

This paper looked at the use of biocontrol agents through the scientific literature for three invasive species currently found in Yellowstone National Park. Literature review of potential biocontrol agents pertinent to Yellowstone National Park nonnative plant species, shows that the biocontrol agents currently available do not meet the criteria of being demonstrably effective, are not sufficiently host-specific, and/or have negative effects to other native species. These agents therefore would not be efficacious in meeting current nonnative vegetation management objectives. Yellowstone National Park will continue to review potential biocontrol agents as part of a complete Integrated Weed Management program. If a new potential biological control agent becomes available, park vegetation and invasive plant management staff will undertake a thorough review of the label and national approval process, complete an internal review process to address potential impacts to native, plant species, and consider using it under specific criteria and review as well as appropriate compliance procedures.

In balancing the ecological risks associated with the use of biological control agents, such releases would occur when all the following conditions are met:

- Peer-reviewed published literature clearly demonstrates a quantifiable measure of agent success under field conditions on the targeted weed species in similar habitats, resulting in the proliferation of native plant species.
- Host specificity has been demonstrated under field conditions to the targeted species in similar habitats. Research into pre-approval or early releases of minimally field tested biological controls would not be permitted in the park, particularly if there are adequate research sites available on non-park lands.
- Research indicates that the introduced biological control would not harm other native organisms, including populations of species similar to it (i.e. native insects or pathogens).
- Other treatment options have proven ineffective.

- The threat to the park of continued spread of the targeted nonnative plants far outweighs the risks of introducing a nonnative biocontrol species into the park.
- Approved agent meets set criteria, external and internal review and appropriate compliance is completed.

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Appendix 9

Monitoring for Invasive Plant Control Effectiveness

Monitoring nonnative plant control allows resource managers to adapt their control methods to achieve management goals. In this case, monitoring is defined as the collection and analysis of repeated observations and/or measurements of areas where nonnative plant control treatment has occurred in order to assess whether the techniques employed were successful and native vegetation is recovering. Through monitoring, staff gather site specific information that could be used to make future decisions about the sites what modifications or additional treatments, if any, are needed. The documentation of the monitoring program also provides consistent and valuable site information for future personnel. Monitoring protocols should be designed as efficiently as possible to answer the management questions.

The questions that need to be answered to make these assessments include:

- Did the target nonnative plant population decrease or increase on this site?
- Could there be an explanation other than the treatment for these changes?
- Was there non-target damage?
- What plants are emerging following the treatment?

These questions require the collection of different information using different techniques, both qualitative and quantitative. Some questions require much more elaborate techniques than others. The causes of population changes may not always be discernible.

For the most part data should be collected annually, before (or during) any needed retreatment. The longer data is gathered, the more complete the analyses will be. In all cases, data should be recorded and maintained for at least 3-5 years. In some instances, like native plant recovery, the interval between sampling can be longer than every 3-5 years.

Permanent Photo-Points

Permanent photo-points provide a qualitative to semi-quantitative monitoring method that is used to visually document changes in the abundance or condition of nonnative plant populations. They provide a baseline from which to monitor exotic plant control efforts including treatment efficacy, non-target damage, and general vegetation trends. Photo-points can be an important ongoing management tool and are easy to establish, efficient, repeatable, and provide the park with a photographic record of change at the site by comparing photographs of the same site taken over a period of time. Photo-points should be established before initiating a control program in an area; if treatment has already occurred, this should be noted in the site history. Some plant species are easier to see in landscape-level photographs than others. Therefore, photographs should not be used alone to document change vegetation.

Equipment needed:

- Permanent stakes (rebar or galvanized pipe, 1–3 feet long)
- Metal tags
- Hammer or post driver
- Orange spray paint (for marking post)
- Compass
- GPS unit

- Camera and lens (digital): Use a quality camera with a wide-angle lens and adjustable aperture, either a 35mm, or a 3 megapixel or higher digital camera that records the date on the photograph.
- Tripod

Site selection: At least one permanent photo-point should be located in major treatment sites and at locations with similar site characteristics that will not be treated (to compare treated sites to "control" sites). Locate photo-point(s) to record a representative view of the treatment site, when the target plants can be discerned at landscape level.

Procedures:

1. Mark each photo point with a permanent stake using a hammer or post driver. Spray the permanent stake with orange paint.
2. Permanently attach to each stake a metal tag with a photo-point number and record on data sheet.
3. Determine and record the GPS location of the stake as accurately as possible.
4. Determine which azimuths will best document the site using a compass and record on data sheet.
5. Place tripod/camera over photo-point (measure and record height of camera and record on data sheet). Use a quality camera with adjustable aperture either a 35-mm or a 3 mega-pixel or higher digital camera that records the date on the photograph. Use a wide-angle lens: 28-35 mm. Standard fixed lenses rather than zoom lenses allow greater repeatability.
6. Place photo identification record frame in an upright position so that it will appear in the foreground of the photograph. Include the photo record frame, a general view of the site, and some sky in the photographs.
7. Make three or four frames of the same picture with a slightly different aperture. Record the camera settings used to take the photograph.
8. Repeat photographs at the same time each year using the above procedures. Use GPS to relocate the permanent stake. The most accurate time series of photographs will be created by using the same camera/lens, camera height, camera settings and azimuth when taking repeat photos.

Recording non-vegetation site data: A site history should be maintained for all treatment sites, with observations that help explain changes in plant species populations. These may include:

- Maps that delineate the location and boundaries of the site
- Soils on site
- Dates and times of treatments
- Weather at the time of treatments: temperature, percent cloud cover, wind speed and direction
- Unusual weather events that might affect plant growth, e.g., very wet or dry spring, extremely cold or snowy winter
- Observations of other site characteristics or changes in the site

Measuring change in target nonnative species populations: Measuring the decrease (or increase) in the target nonnative species can be accomplished by conducting annual surveys of the entire treatment area. This can be completed during actual treatment/retreatment. The area boundaries must remain the same each year. If the target species is found outside the original boundaries of the site, either consider the new population as a separate site or document that this added area had none of the target species in previous years.

Record data:

- For small populations, count stems of the species. Stems can be counted as they are being manually removed or spot-sprayed.
- For larger populations that are being sprayed with calibrated equipment, canopy cover of the plants sprayed can be estimated from the amount of herbicide solution used; e.g., if the equipment sprays 30 gallons/acre and 30 gallons of herbicide are sprayed, assume 1 acre of plants were treated. For this method to be accurate, the entire area must be treated each time.
- When surveys are conducted separately from treatment, ocular estimates of the percent cover of the treatment area will suffice.

Analyze data: Compare annual percent cover from one year to the next by site. If populations fluctuate, check other factors (e.g., weather history) to determine whether the changes might be due to other factors.

Determining non-target damage and what plants are emerging after treatment: Identifying and estimating population size for every plant in a treatment area would be costly and time consuming. Therefore, a protocol would be established to sample non-target vegetation within treated sites. These sampling data could also be used to verify the survey results from treatments, described above. An example of a relatively simple sampling protocol follows.

Sample Monitoring Program

Identify Plots

1. Identify different types of habitat within treatment sites (e.g., roadside, backcountry, riparian).
2. Randomly select three or more sampling sites from each of these types; the number of sampling sites per habitat type should be proportional to the number treatment sites in each type.
3. At each sampling site, set up three sampling frames or transects, randomly placed within the treatment area. Transects are used for woody shrubs, while 0.25, 0.5 or 1.0 square-meter plots are used for non-woody vegetation. The size of the sampling unit is based on the size of the plants and density. The unit must be large enough to capture numerous plants, but not so large that observers would be counting more than 200 plants on average per unit.

Record Data

1. Permanently mark each plot (e.g. with rebar). Establish site's GPS coordinates and include on a map to the site. Ensure directions to find plot, data sheets, directions for collecting data are written clearly so they can be used by someone unfamiliar with the project in the future.
2. Record all species present in the plot; identify whether they are native or nonnative.
3. Record stem count or percent cover of the target weed species.
4. Record stem count or percent cover of the three most abundant native species in the plot.
5. Record stem count or percent cover of two other of the most abundant nonnative species in the plot (if present).
6. Collect data at the same time of year at least three times, at one- to five-year intervals.
7. Make backup copies of the data, and make sure clear directions describe plot locations, how to collect the data, the date, and who collected the data.

Analyze Data

1. Compare number of species present over time.
2. Determine whether stems or percent cover of each plant is increasing or decreasing.

If the data are highly variable from one sampling site to another within a habitat type, assess whether there are differences among the sampling sites (some in very healthy plant communities, others in very disturbed areas). If the changes in populations are inconsistent from one sampling event to another, assess whether other factors such as weather might explain the changes.

Appendix 10

Vegetation Restoration in the Gardiner Basin

The National Park Service has proposed controlling nonnative plants and restoration of native plant communities in approximately 700 acres of former agricultural fields west of the Yellowstone River between Gardiner, Montana, and the park's northern boundary at Reese Creek (fig. 1). The work would be done in stages over many years, subject to availability of funding.

Background. To provide key low elevation winter range for elk, pronghorn, bison and deer, over 7,000 acres of land was added to the northwest corner of Yellowstone National Park through purchase and eminent domain in the 1930s. Approximately 700 acres of the addition were irrigated agricultural fields. Following acquisition, the NPS ceased irrigation and seeded the fields to crested wheatgrass (*Agropyron cristatum*), a nonnative perennial that was recommended because it was aggressive, drought resistant, would crowd out weeds, undergoes early greenup, and was (erroneously) thought to provide better forage than native plants. It thrived and for many decades was almost the only plant species present. In the past decade, however, the crested wheatgrass has been dying out, leaving large patches of unvegetated soil and areas that have been invaded by monotypic stands of a nonnative mustard, desert alyssum (*Alyssum desertorum*). Some sites have been invaded by another nonnative grass, annual wheatgrass (*Eremopyrum triticeum).* These species have spread into native vegetation communities upslope and updrainage from the Gardiner Basin. It is likely that cheat grass (*Bromus tectorum*) and various knapweeds (*Centaurea* sp.) could be the next wave of nonnative plants to invade and spread outward from the Gardiner Basin.

Various investigations and reports on the degraded vegetation communities and ungulate-habitat relationships of the area all recognize the value of restoring native plant communities to the former agricultural fields (Houston 1982; NPS 1990; YNP 1997; NPS 2002; NRC 2002). The park has attempted a variety of native revegetation experiments that have failed. In retrospect, they were too small in scale, too short term, and failed to recognize the special remedial actions needed to repair these degraded semi-arid soils so that they can again sustain the native vegetation.

The Gardiner Basin (defined as the public and private lands of the Yellowstone River valley between Yankee Jim Canyon and Gardiner, Montana) lies within the rain shadow of the Madison and Absaroka/Beartooth mountain ranges. It typically receives less than 10 inches of precipitation per year, and stays relatively free of snow. Summertime temperatures can exceed 100°F. High levels of sodium are common, affecting productivity, erosion potential, and plant communities. High clay content causes the soil to compact and "seal" when wet. During dry periods, large amounts of soil are lost through wind erosion.

Recognizing that the park staff did not have the experience in arid land restoration that was needed, the park joined with Gallatin National Forest and the Montana State University-based Center for Invasive Plant Management to convene a restoration workshop in April 2005 (NPS et al. 2005). Ten specialists in arid land restoration were invited to help Yellowstone and Gallatin National Forest (which acquired similar former agricultural lands for wildlife habitat adjacent to the park) develop recommended long-term restoration/ management plans for approximately 1,200 acres of former agricultural fields within the Park (700 acres) and Gallatin National Forest (500 acres).

The resulting management recommendations were based on fundamental ecological principles to restore functioning water, soil, and energy cycles; soil properties; and a sustainable native

sagebrush and/or grassland plant association similar to the site potential (NPS et al. 2007). Implementation would proceed in multi-year phases to allow for plant establishment under natural conditions, monitoring and refinement of methods to maximize success, and to allow wildlife access to portions of the surrounding area during the restoration work.

Twenty to fifty-plus acre plots, the number and size dependent on available funding, would be temporarily fenced to exclude ungulates while restoration efforts are underway. The sites would be treated with appropriate herbicides in the early spring to control the emerging exotics. Herbicide application would be followed by no-till drilling of a preparatory cover crop—such as barley, or a sterile cereal crop species which are drought tolerant and early spring germinators. The preparatory cover crop provides competition with undesirable exotic plants and will be left to capture moisture, prevent soil erosion, and add organic matter to the soil. Weeds will be spot-treated throughout the growing season as needed. This treatment cycle would be repeated annually for 2-4 years until satisfactory control of nonnative weeds and amendments to the soil result in conditions favorable for the germination and survival of native grass seed. The fenced exclosures would remain in place for at least 5 years after the natives are seeded to maximize establishment.

To ensure native seed availability, it will be necessary to collect native seed from adjacent communities and "grow-out" sufficient quantities to mechanically no-till drill at a rate of 8-11 lbs. per acre. It was strongly recommended to avoid irrigating the fields following native seed planting to allow for better long-term survival of established plants under natural conditions.

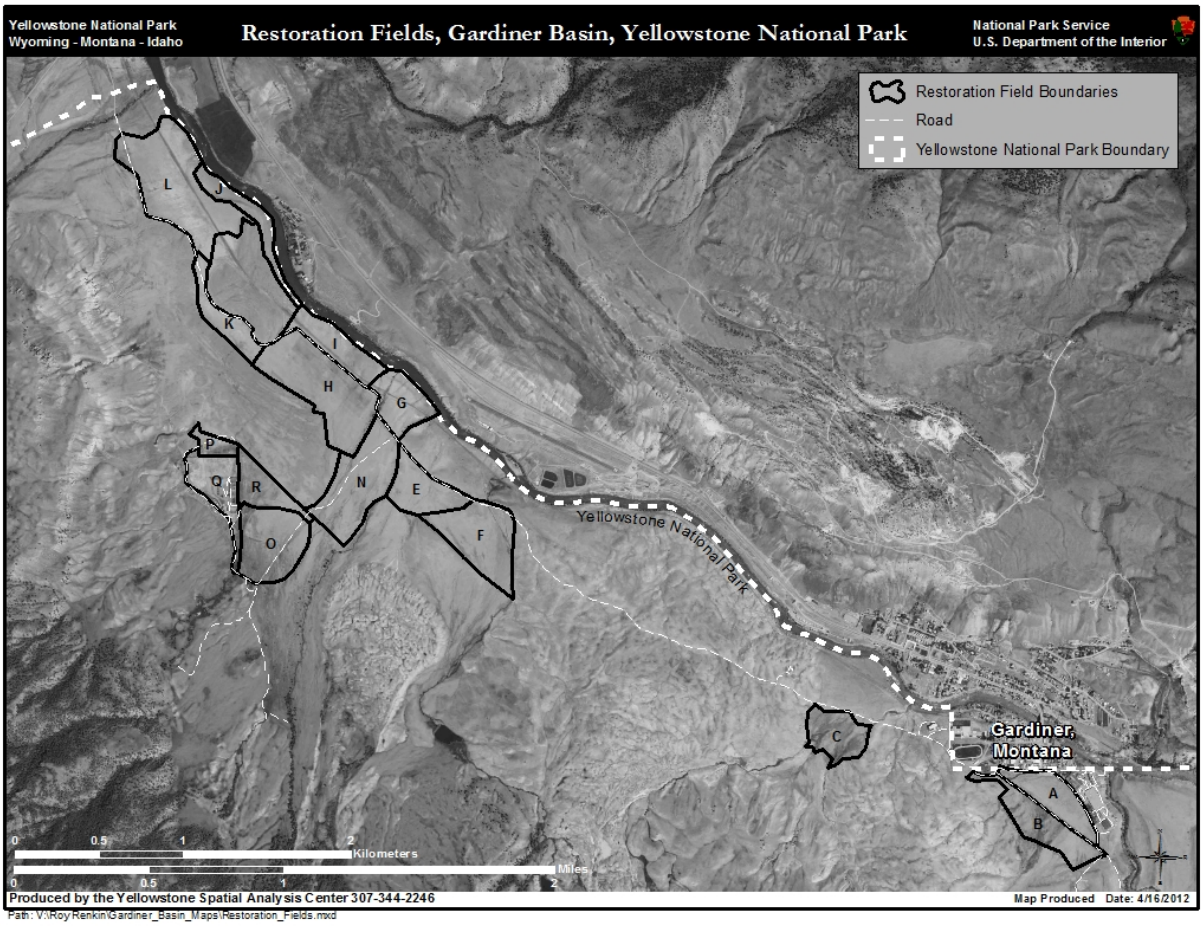

Figure 1. Gardiner Basin Vegetation Restoration Project

Accomplishments to Date: Archeological survey (Maas and MacDonald 2009) and National Historic Preservation Act determinations of eligibility on 12 documented sites within the 700-acre project area (Letter to Montana State Historic Preservation Office, 22 July, 2008; concurrence received 16 August 2008) have been completed, as has NEPA compliance (dated 4 September 2008) for a pilot project to restore <60 acres to native vegetation beginning in 2008. Three fenced exclosures totaling 50 acres were constructed (1 in 2008, Field H; 2 in 2009; Fields G and L), control actions for exotic plants implemented and ongoing, and cover crops of barley and/or winter wheat planted. Native seed collection in the area has taken place since 2008, and the growing out of native seed (3 different species) is underway via contract with two Natural Resource Conservation Service (NRCS) facilities (Bridger, MT and Aberdeen, ID Plant Material Centers). In the fall of 2011, two .1-acre test plots (one each in Field H and L) were burned in preparation for seeding; 8 native grass species were drill-seeded using a randomized complete block design with 4 seed treatments (no seed treatment, inoculants, liquid smoke, and seed coating) and 4 applications of each treatment. The seeding trials are expected to optimize the germination and establishment of native plants, and will guide future native seeding efforts. Independent research to identify changes in soil physical properties and biota due to site amendment with cover crops, and compared with reference site conditions, are underway.

Future Planned Activities: Native seed growing operations have produced sufficient amounts of 3 native species to warrant drill-seeding of two exclosures (Fields H and G) totaling 30 acres and planned for the fall of 2012. Negotiations with the NRCS facilities to extend the production of native seed through 2015, and include 2-3 additional species, are underway. The remaining 20 acres (Field L) will be drill-seeded with native seed in the fall of 2014, with spot seeding of remaining seed in the fall of 2015 across all sites. Evaluation of the 2011 native seed trials will be ongoing, and will inform native seed planting in 2014-2015. While intended only as a site preparation for mechanical planting, burning of the native seed trial plots may prove to be a highly effective weed control strategy, and could be incorporated into the overall restoration protocols. As identified in the workshop recommendations (NPS et al. 2007), exclosures are expected to remain in place for up to 5 years following native seed planting to maximize establishment. Any future expansion of the pilot effort will require additional NHPA consultation and NEPA compliance.

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