North Cascades National Park Service Complex

North Cascades National Park
Lake Chelan National Recreation Area
Ross Lake National Recreation Area

National Park Service
US Department of the Interior

Invasive Non-Native Plant Management

Environmental Assessment

November 2011

Cover Photo:

Japanese knotweed (*Polygonum cuspidatum*) near Gorge Powerhouse in Newhalem.

How to Comment on This Document

The public comment period for this Environmental Assessment will extend through January 11, 2012. We encourage you to review the document and welcome your comments. During the comment period you may submit comments on-line, through the regular mail, or hand delivery.

Using PEPC: We ask that people submit comments on-line at the NPS Planning, Environment, and Public Comment (PEPC) website (http://parkplanning.nps.gov/noca_invasives). At the PEPC website you will find the full text document, an on-line comment form, and instructions for submitting on-line comments.

By mail or hand delivery to:
Superintendent, attn: Invasive Plant Management EA
North Cascades National Park Service Complex
810 State Route 20
Sedro-Woolley, WA 98284

In addition, comments may be made in person at the upcoming public meetings in Stehekin and Sedro-Woolley.

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment, including your personal identifying information, may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

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EXECUTIVE SUMMARY

Purpose and Need

North Cascades National Park Service Complex proposes to implement an Integrated Pest Management (IPM) program to control invasive, non-native plants, restore impacted areas, and detect and prevent new infestations. The purpose of these actions is to protect natural ecosystem dynamics, including the vegetation, wildlife, and other terrestrial and aquatic resources and processes that are threatened by invasive, non-native plants. The proposed actions will also protect and restore the Stephen Mather Wilderness. Although most invasive plant populations are confined to frequently disturbed areas, including roadsides, gravel pits, transmission line corridors, and abandoned home sites, others threaten backcountry and designated wilderness. There are approximately 225 non-native plant species known to exist within the Park Complex, approximately 40 of which are deemed invasive and targeted for control under the Preferred Alternative. These actions are needed because invasive plants can alter the function of an entire ecosystem, and if taken now they will avoid further degradation of uninfested areas, especially designated wilderness where delaying action would make restoration more difficult.

The proposed IPM program includes strategies for prevention, inventorying and monitoring, control, restoration, and education. Control efforts would be centered on techniques that involve using the most effective, economical, environmentally safe, and socially acceptable methods of management. Proposed treatment methods and priorities are consistent with those currently being proposed on adjacent lands administered by the US Forest Service.

Overview of the Alternatives

This environmental assessment evaluates three alternatives, the No Action Alternative, a Preferred Alternative, plus a third alternative. A number of actions would take place regardless of which alternative is ultimately chosen for implementation. These include an Integrated Pest Management (IPM) approach, the use of Best Management Practices (BMPs), a Minimum Requirements Analysis for actions proposed in wilderness, and an annual project planning, implementation, and tracking process. A key feature of the BMPs that would be implemented includes a new requirement to use weed-free certified feed for all stock use that occurs within the Park Complex. Specifics of the three alternatives are described below.

Alternative 1, the *No Action Alternative*, continues with current management. Invasive, non-native plant management would continue into the future as it has over the last five years. The Park Complex would not be able to implement a more comprehensive invasive plant management program since action is limited under what would be categorically excluded under the National Environmental Policy Act without more comprehensive environmental analysis and public disclosure. There are 24 invasive plant species that would be considered priority for treatment. Six projects would be implemented on the East Side in the lower Stehekin Valley within Lake Chelan National Recreation Area, two of which would be limited to inventory only with no treatments occurring; and nine projects would be implemented on the West Side within portions of North Cascades National Park and Ross Lake National Recreation Area, one of which would be limited to inventory only with no treatment occurring. Control techniques would concentrate primarily on mechanical methods of controlling and containing existing populations of invasive non-native plants plus limited herbicide use. Many species that are currently not being treated would continue to go untreated and spread.

Alternative 2, Integrated Pest Management with Herbicides, is the *Preferred Alternative,* the NPS preferred course of action. Invasive, non-native plant management activities would expand to include an increase in the number of species that would be treated, the number of projects that would be undertaken, and the type and quantity of herbicides that could be used for treatment projects. A number of species and infestations that currently are not being treated under Alternative 1 would be treated under this alternative. There are 40 invasive plant species that would be considered a priority for treatment. Twenty-five proposed invasive plant projects of various sizes would be implemented in this alternative, 12 of which would be implemented on the East Side, and 13 of which would be implemented on the West Side. A new prioritization technique would also be implemented to better identify species that pose the greatest risk to park resources.

Alternative 3, Integrated Pest Management without Herbicides, is similar to Alternative 2, except that herbicide use would be discontinued. This alternative was developed in response to public comments that expressed concern about the use of herbicides. The priority species list developed in Alternative 2 would be used; however, several species (12) would not be controlled because the available methods would be ineffective at reaching the objectives. As a result, eight projects described in Alternative 2 would not occur under this alternative. Control efforts would include mechanical, cultural, and biological methods, with the goal of eradicating invasive weeds when it is a feasible option.

Environmental Analysis

The potential effects of the three alternatives are analyzed for natural, cultural, and socio-cultural resources. These resource topics were selected based on the issues identified during public and internal scoping; for each issue, the resources that could be affected were identified, forming the basis of the impact analysis. The natural resource topics include soils, hydrology, water quality, wetlands, vegetation, fish and wildlife, and special status species. Cultural resource topics include archeological resources, historic districts, and cultural landscapes, as well as isolated historic sites, structures and features. Socio-cultural resources include wilderness character, visitor use and experience, human health and safety, socioeconomics, and park and partner operations. Organized by resource topic, Chapter 3 of this document describes the existing conditions (i.e., Affected Environment) of the area that could be impacted by any of the alternatives. Chapter 4 describes the environmental impact associated with each of the alternatives.

Environmentally Preferred Alternative

The environmentally preferred alternative is “the alternative that will promote the national environmental policy expressed in NEPA (Sec. 101(b)).” Each alternative was evaluated to determine how well the goals from NEPA Section 101(b) are met. Upon full consideration of the Section 101 of NEPA, Alternative 2 was found to be the environmentally preferred alternative for the Invasive, Non-native Plant Management Plan.

1 INTRODUCTION

1.1 Purpose and Need

North Cascades National Park Service Complex (hereafter, the Park Complex) proposes to implement an Integrated Pest Management (IPM) program to control invasive, non-native plants, restore impacted areas, and detect and prevent new infestations. The purpose of these actions is to protect natural ecosystem dynamics, including the vegetation, wildlife, and other terrestrial and aquatic resources and processes that are threatened by invasive, non-native plants. The Stephen Mather Wilderness, which encompasses 94 percent of the Park Complex and is at the core of one of the largest protected areas in the lower 48 states, would be further protected by these actions. Natural conditions in wilderness would be restored where there are current infestations of invasive plants, and protected from degradation in areas that are un-infested. The natural quality of wilderness character would thus improve as restoration actions are taken. Proposed treatment methods and priorities are consistent with those currently being proposed on adjacent lands administered by the US Forest Service, providing an ecosystem-based approach to restoration.

These actions are needed because invasive plants have the capacity to alter the function of an entire ecosystem (Sheley and Petroff 1999). For example, invasive plants can displace native vegetation, resulting in the displacement of the animal populations that rely on the plants for food and shelter. They can affect water quality by reducing or depleting water levels or altering runoff patterns and increasing soil erosion. Some invasive plants, like knapweed (*Centaurea* spp.), are allelopathic-they release toxins that don't allow native plants to grow. Others, such as Scotch broom (*Cytisus scoparius*), are nitrogen-fixing, allowing other non-natives to outcompete native plants that have evolved in nutrient-poor soils. Finally, others, such as cheatgrass (*Bromus tectorum*), can alter fire regimes and drastically change a landscape by preventing native vegetation from successfully re-establishing after fire events. For these reasons, invasive, non-native plants are threatening the ecological integrity of our natural areas.

Figure 1-1. Cheatgrass Infestation within the 2006 Flick Creek Fire Perimeter (Stehekin Valley)

Unfortunately, climate change is exacerbating the impacts of invasive plants. Temperatures and the amount and seasonal distribution of precipitation are changing, resulting in conditions that often favor the establishment and spread of invasive plants (IPCC 2007). The global warming trend of 0.15°C–0.20°C per decade that began in the late 1970s continues, with the last decade being the warmest on record (Hansen et al. 2010). Land managers are now faced with the extra burden of trying to understand and respond to changes in species' ranges, both native and non-native, due to changing climatic conditions. The control or removal of ecosystem stressors, such as invasive plant species, is one way to increase ecosystem resilience; promoting ecosystem resilience is one key goal the NPS is taking to address climate change, as outlined in the NPS Climate Change Response Strategy (2010).

Within the Park Complex, over 200 non-native plant species, a subset of which have invasive characteristics, are currently known to exist (Appendix A). Although most invasive plant populations are confined to frequently disturbed areas, including roadsides, gravel pits, transmission line corridors, and abandoned home sites, others threaten backcountry and designated wilderness. Where infestations occur in wilderness, a Minimum Requirements Analysis (Appendix C) has been completed to identify, analyze, and select management actions that are the minimum necessary for wilderness administration.

Actions are needed immediately to prevent the spread of invasive species into pristine wilderness and to restore already impacted areas. The amount of time, equipment, and personnel that are needed to treat infestations are less when infestations are treated early and not allowed to grow exponentially, whereas delaying action could require more extensive treatments that are more likely to impact wilderness character.

1.2 Background

Exotic species, as defined by the NPS, include "those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities." There are a number of additional terms that are often used interchangeably to describe exotic species, such as non-native, alien, noxious, or invasive species. For the purpose of this discussion, invasive plants are non-native species that are aggressive and pose an ecological threat to the integrity of the community in which they are found. Because a non-native species did not evolve in concert with the species native to the area, it is not a natural component of the ecosystem at that place. However, not every non-native species is invasive. In fact, the majority of non-native species found within the Park Complex are not targeted for treatment because they do not have invasive characteristics.

INVASIVE PLANTS
are non-native species that are aggressive and pose an ecological threat to the integrity of the community in which they are found.

Current resources available to manage invasive plants come from both park and network employees, as well as other agencies and volunteers. Primary management responsibility, including prioritization of projects, falls under the direction of the park botanist. In 2002, the North Coast and Cascades Network (NCCN), comprised of seven Pacific Northwest parks, obtained funding for the creation and support of a network Exotic Plant Management Team (EPMT). The EPMT is designed to address invasive plant management issues that pose an imminent threat to park resources through the control and eradication of high priority invasive species in the NCCN. Each year, the park botanist, along with the six other park

EPMT: *Exotic Plant Management Team*

The EPMT is designed to address invasive plant management issues that pose an imminent threat to park resources.

units in the network, submits a request to the EPMT for invasive plant mapping and management needs. The EPMT then compiles these requests from each park and prepares a proposal to obtain funding. When funded, the EPMT mobilizes a staff of eight to 15 individuals that conduct invasive plant mapping and management throughout the summer at each park in the network.

The park botanist is responsible for completion of smaller invasive plant projects that are not managed by the EPMT. With input from other park personnel familiar with invasive plant infestations, the park botanist develops an annual work plan that prioritizes projects each year, obtains funding where necessary, and provides guidance to support the completion of invasive plant monitoring and control. Monitoring and control work is conducted by personnel working directly under the supervision of the park botanist, plant propagation personnel, or district natural resource specialists. The Stehekin District natural resource specialist is largely responsible for detecting small infestations in Lake Chelan National Recreation Area as well as their subsequent treatment if they are too small to be undertaken by the EPMT. All activities completed by park personnel or the EMPT are communicated to the park botanist to ensure data is compiled and summarized each year.

A more detailed discussion of the invasive species present, identification of those species that are considered the biggest threat to ecological integrity, and proposed actions that would address the problem can be found in Chapter 2.

Integrated Pest Management

The NPS defines IPM as, "The selection, integration, and implementation of pest management methods based on predicted economic, ecological, and sociological consequences." IPM can also be defined as a decision-making process which helps one decide if a treatment is necessary and appropriate, where the treatment should be administered, when a treatment should be applied, and what strategies should be integrated for immediate and long-term results. The keys to a successful IPM program are sustained effort, constant evaluation, and the adoption of improved strategies (Sheley and Petroff 1999). IPM is a form of adaptive management in the National Park Service. In adaptive management, information about the resources managed, in this case, invasive plants, is continuously developed, and used to adjust management approaches. Following an IPM program will allow the Park Complex to manage invasive plants in the most effective and efficient way.

The proposed IPM program includes strategies for prevention, inventorying and monitoring, control, restoration, and education. Control efforts would be centered on techniques that involve using the most effective, economical, environmentally safe, and socially acceptable methods of management. The major components of IPM are described in Chapter 2.

1.3 Goals and Objectives

Goals and objectives for this planning effort are based on national strategic goals for invasive plant management as identified by the National Invasive Species Council (NISC 2008). Long-range strategic planning is necessary to address complex invasive species issues. Tiering off of the 2008 NISC Plan, five strategic goals were developed to focus park invasive plant management efforts. Specific objectives were then tied to each strategic goal. These goals and objectives apply equally to designated wilderness and non-wilderness portions of the Park Complex given that the impacts of invasive species and the threat that they pose to ecosystem function are not related to such administrative/legal boundaries. By having goals and objectives that are consistent with those of adjacent US Forest Service lands, broad ecosystem protection and restoration can be achieved. The goals and objectives for invasive plant management at North Cascades National Park Service Complex include:

GOAL 1 – Prevention and Early Detection: The invasive, non-native plant management program should emphasize 1) Prevention of new invasive species from entering and establishing within the Park Complex, and 2) Prevention of the spread of existing invasive species within the Park Complex.

Objectives:

- Identify major pathways upon which new and existing invasive species enter the Park Complex, as well as how they spread once established
- Work to minimize establishment and spread of invasive species using targeted surveys of the major pathways and quick treatment of new infestations
- Incorporate Best Management Practices (BMPs) for park and partner operations

GOAL 2 – Inventorying and Monitoring: Initiate a comprehensive and systematic inventory of both sensitive native and invasive non-native plant populations to establish a baseline, and monitor known populations.

Objectives:

- Document the abundance and distribution of invasive and sensitive plant species within the Park Complex
- Monitor change in abundance, distribution, and species composition over time in order to evaluate the effectiveness of control techniques, and adapt as necessary

GOAL 3 – Prioritization and Control: Develop a clear set of invasive plant management priorities based on the degree to which invasive species or populations affect natural systems, and treat those species or populations using IPM techniques.

Objectives:

- Develop a decision tool that can be used to prioritize invasive species for control
- Periodically review and revise priority rankings
- Eradicate existing populations of invasive species in the Park Complex where there is a reasonable chance of success
- Contain existing populations of invasive species that are too widespread to be eradicated

GOAL 4 – Restoration: Restore disturbed and/or treated areas as soon as possible to prevent infestations.

Objectives:

- Develop a revegetation / restoration plan that clearly outlines the steps necessary to restore a site after treatment has taken place
- Quickly revegetate areas disturbed by park and partner operations, and in some instances consider revegetation after natural disturbance events in order to prevent the establishment of invasive species at disturbed sites

GOAL 5 – Outreach, Education, and Cooperation: Foster an understanding about prevention and control of invasive, non-native plants.

Objectives:

- Use outreach and education to prevent the spread of invasive plants within the Park Complex
- Work with adjacent landowners, agencies, and partners when needed to pool resources, such as sharing knowledge and working together on control projects

1.4 Decision to be Made

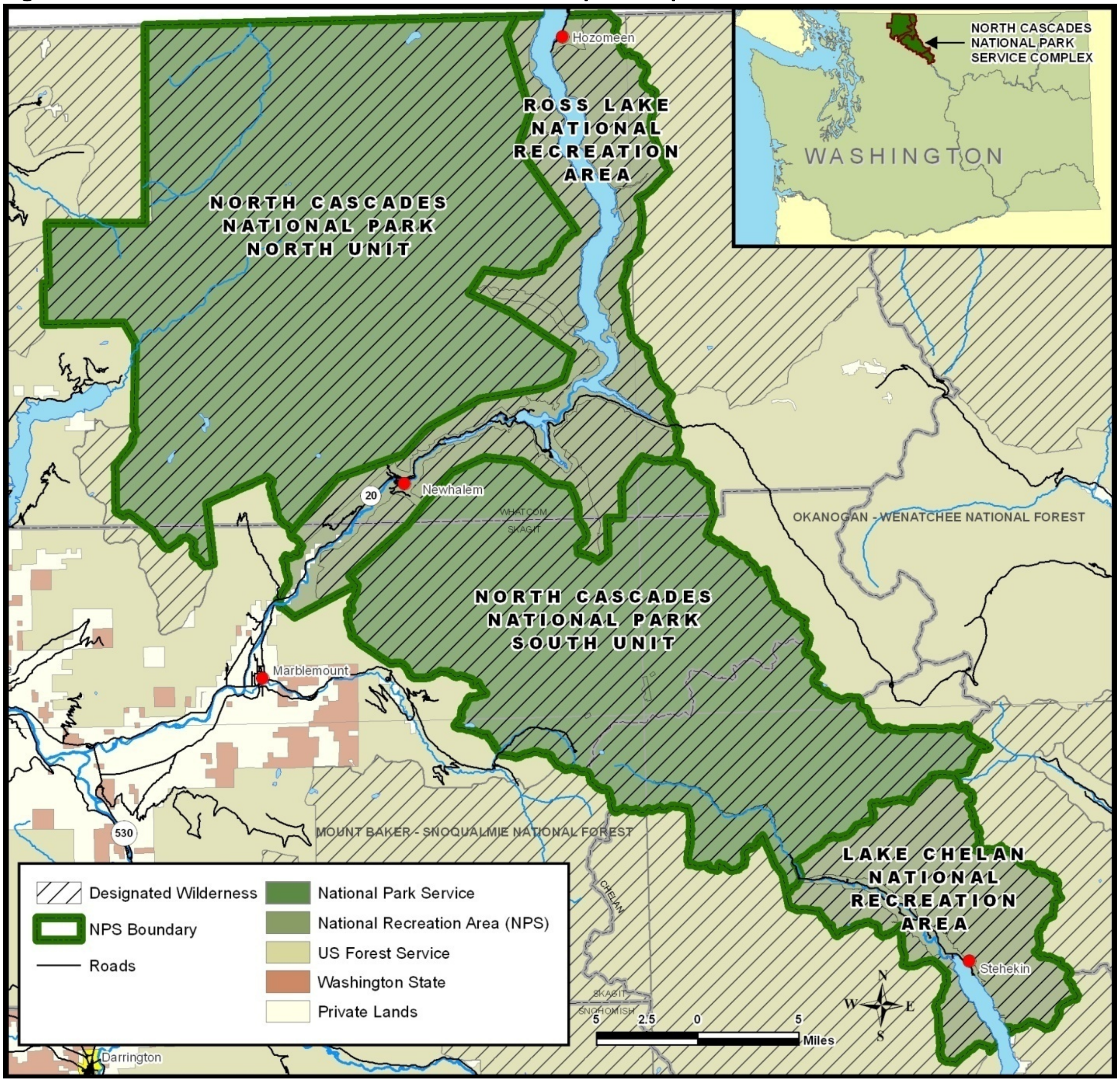
This environmental assessment (EA) presents several alternatives for management of invasive non-native plants within the Park Complex. The decision to be made involves selecting an alternative that best meets the purpose, need, goals, and objectives of this proposed action. One of the three alternatives as presented in the EA will be chosen, or a modified version of one of the alternatives will be chosen based upon review and input from the public or other agencies. The decision may also include additional mitigation measures or other conditions to minimize environmental impacts or risks. The deciding official is the regional director of the NPS Pacific West Region, who, based on the recommendation from the park superintendent, will be responsible for approval of the final plan.

The selected alternative will become the Invasive Plant Management Plan for all invasive plant management activities over the next five to 10 years. New infestations requiring treatments outside the current scope of this environmental analysis would require further assessment before implementation.

1.5 Project Area

The scope of the proposed action covers the entire Park Complex, which includes North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. Over 94 percent of the Park Complex is designated as the Stephen Mather Wilderness (see Figure 1). The majority of invasive plant populations occur within the six percent of the Park Complex that is non-wilderness. Where infestations occur within wilderness, a Minimum Requirements Analysis (Appendix C) has been completed to identify, analyze, and select management actions that are the minimum necessary for wilderness administration.

Figure 1-2. North Cascades National Park Service Complex Map



1.6 Relevant Issues

Public scoping for this project has taken place on two different occasions, first in 2002 and again in 2008. A total of 15 comments were received during the two scoping periods; four from 2002 and 11 from 2008 (see Chapter 5 for a more detailed discussion of public comments). NPS staff members have also met on numerous occasions to discuss the purpose, need, issue statements, alternatives, and impact topics during internal scoping meetings. Comments from all sources have been used to identify key issues, which were then used to determine the scope of analysis in this EA. For each issue, the resources (also known as "impact topics"), that could be affected are identified. Key issues and their associated impact topics are summarized below.

1. **Impacts as a result of continued management (no treatment).** A number of invasive plant infestations are currently not being treated, and have the potential to cause impacts of various intensities

to most natural resources, such as displacing native vegetation, altering soil chemistry, changing fire regimes, and impacting wildlife habitat and forage (including threatened and endangered species habitat), thus threatening the ecological integrity of Park resources.

Impact topics include: soils, hydrology, water quality, wetlands, native vegetation, and fish and wildlife, including rare or sensitive species.

2. **Herbicide use and non-target impacts.** Proposed herbicides have the potential to impact a number of natural resources through spilling, drift, overspray, volatilization, and run-off. Some Stehekin residents use the Stehekin River as a source for drinking water and other domestic uses such as watering gardens. Although no direct herbicide applications to water are proposed, there is the potential for small amounts of dilute herbicide solutions to reach surface water during foliar applications near open water. Primary risk of acute exposure to people applying herbicides occurs during herbicide and surfactant mixing and loading and through potential chronic exposure to these dilute mixed solutions.

   Impact topics include: soils, water quality, wetlands, native vegetation, fish and wildlife, (including rare or sensitive species), human health and safety.

3. **Mechanized/motorized equipment use.** The use of equipment such as ATVs (all-terrain vehicles) and tractors for herbicide application or mechanical removal may impact cultural and natural resources through trampling or more extensive ground disturbance, especially when used for mechanical removal of invasive species. Native vegetation could be damaged or killed, and archeological resources could also be damaged. If activity takes place in a wet area, siltation of nearby waterways could occur. Motorized equipment use can also impact natural soundscapes, and when used in wilderness, can impact the undeveloped quality of wilderness character as well as opportunities for solitude.

   Impact topics include: soils, water quality, wetlands, native vegetation, fish and wildlife, (including rare or sensitive species), natural soundscapes, cultural resources, wilderness character

4. **Wilderness degradation.** The spread of invasive plants in the Stephen Mather Wilderness has impacted naturalness, a key quality of wilderness character. The act of treating invasive plants in wilderness in order to restore natural conditions temporarily impacts another quality of wilderness character, untrammeled (or *wildness*.) Park managers must weigh the relative risks and benefits of taking action (restoring naturalness) versus not taking action (maintaining wildness).

   Impact topic includes: wilderness character

5. **Cultural resources.** Methods of invasive plant removal have the potential to impact cultural resources in two ways 1) chemical contamination of organic and non-organic artifacts and remains (from herbicide use), and 2) physical disturbance of site sedimentary matrices that contain artifacts and other cultural remains (from mechanical extraction of plants). Invasive plant removal also has the potential to impact historic character by removing significant species at a site. Cultural landscapes can serve as sources of invasive plants that spread to un-infested areas. Several proposed projects take place within National Historic Districts and have the potential to impact these sites as well as other cultural resource sites.

   Impact topic includes: cultural resources

6. **Operations can exacerbate invasive plant problems.** Human-caused disturbance, such as regular trail and road maintenance, construction, and prescribed burning, can exacerbate current invasive plant infestations, as well as create new infestations.

Impact topic includes: soils, water quality, wetlands, native vegetation, fish and wildlife, (including rare or sensitive species), park and partner operations

7. **Developed areas as sources**. Developed areas within the Park Complex can serve as significant sources that contribute to the spread of invasive plants to less developed areas, including wilderness. For example, roads (SR 20, Cascade River Road, and Stehekin roads), gravel pits, the Stehekin Airstrip, and the town sites of Diablo and Newhalem, among other developed areas, serve as sources of invasive plants.

   Impact topics include: soils, water quality, wetlands, native vegetation, fish and wildlife, (including rare or sensitive species), cultural resources, park and partner operations

8. **Visitor use and experience**. The presence of invasive plants within the Park Complex can impact the experiences of some visitors as well as how they use the area. Removal of invasive plants can also impact visitor use and experience.

   Impact topics include: visitor use and experience

9. **Weed-free feed requirements.** Requiring the use of weed-free feed is a Best Management Practice that could adversely impact stock users that enter the Park Complex.

   Impact topics include: visitor use and experience, socioeconomics

1.7 Issues Considered but not Further Addressed

Air Quality

Air quality was an issue considered but not further addressed in this document. None of the alternatives would have more than a negligible impact on air quality. Dust generation from the removal of invasive plants and subsequent restoration of any site would be minimal to non-existent. Impacts from spray drift of herbicides would be extremely local and would be mitigated by having crews cease spraying if wind exceeds 10 miles per hour for backpack applications and five miles per hour for powered applications.

Wild and Scenic Rivers

Impacts to Wild and Scenic Rivers was also an issue considered but not further addressed. Several creeks and rivers within the Park Complex are listed in the Nationwide Rivers Inventory (NRI), a register of river segments that potentially qualify as national wild, scenic or recreational river areas. Federal agencies are required to avoid or mitigate adverse effects on rivers identified in the NRI. The following creeks or rivers have segments that are listed in the NRI: Agnes Creek, Baker River, Big Beaver Creek, Bridge Creek, Canyon Creek, Chilliwack River, Fisher Creek, Granite Creek, Ruby Creek, Silesia Creek, Skagit River, Stehekin River, and Thunder Creek. The Skagit is currently designated as a Scenic River below Bacon Creek (outside of NPS boundaries), and one of its tributaries, the Cascade River, is also listed as Scenic. The segment of the Skagit River from below Gorge Powerhouse to Bacon Creek, along with Goodell and Newhalem creeks, were recently found eligible and suitable for inclusion in the Wild and Scenic River System as part of the Draft Ross Lake National Recreation Area General Management Plan. The Stehekin River was found eligible for designation as Recreational in 2002. This issue was considered but dismissed because none of the alternatives would adversely affect the values that render any of the creeks or rivers suitable for designation, nor preclude future eligibility or Congressional classification of the creeks or rivers under the Act.

1.8 Relevant Laws, Regulations, and Policies

Various laws, regulations, and policies limit the nature and scope of management actions that are acceptable in the national park, recreation areas, and designated wilderness. Relevant portions are described in this section.

Federal Authorities

The following federal laws, executive orders (issued by the president), regulations, and policies provide the basis and authority for this plan:

- Plant Protection Act of 2000
- Federal Noxious Weed Act of 1974
- Executive Order 13112 of February 3, 1999 – Invasive Species
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, as amended
- Federal Water Pollution Control Act (Clean Water Act) of 1972, as amended
- Endangered Species Act of 1973
- Occupational Health and Safety Act (OSHA) of 1970
- National Environmental Policy Act (NEPA) of 1969, as amended
- National Historic Preservation Act (NHPA) of 1966, as amended
- Archaeological Resources Protection Act (ARPA) of 1979, as amended
- Native American Graves and Repatriation Act (NAGPRA) of 1990
- American Indian Religious Freedom Act (AIRFA) of 1978, as amended
- Wilderness Act of 1964
- Department of the Interior (DOI) Policies
- National Park Service Policies (2006)
- Agreements with Other Agencies

Plant Protection Act of 2000 *(supersedes the Federal Noxious Weed Act of 1974, except Sec. 2814)*
The Plant Protection Act of 2000 provides the US Department of Agriculture's Animal and Plant Health Inspection Service (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 within the US. Once a target exotic plant and biological control agent are identified, the PPQ goes through extensive host-specificity testing. This testing is designed to ensure that introduced biological weed control agents are limited in host range and do not threaten endangered, native, or crop plants.

Federal Noxious Weed Act of 1974 *(superseded by the Plant Protection Act of 2000, except Sec. 2814)*
Section 2814 of the Federal Noxious Weed Act requires federal agencies to develop and fund an exotic plant management program to control noxious weeds on federal lands, complete and implement cooperative agreements with State agencies regarding the management of exotic plant species on Federal lands under the agency's jurisdiction, and establish integrated management systems to control or contain exotic plant species targeted under cooperative agreements.

Executive Order 13112 – Invasive Species
Section 2 of E.O. 13112 on Invasive Species, signed February 1999, directs federal agencies to identify actions that may affect the status of invasive species and to take action to:

- Prevent the introduction of invasive species
- Detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner
- Monitor invasive species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded
- Conduct research on invasive species and develop technologies to prevent introduction
- Provide for environmentally sound control of invasive species, and
- Promote public education on invasive species and the means to address them

E.O. 13112 also established the National Invasive Species Council and authorized the Council to develop and implement a National Management Plan (NMP) for Invasive Species. The first edition of this plan was finalized in 2001, and the 2008–2012 National Invasive Species Management Plan is its first revision. The plan serves as a blueprint for all federal action on invasive species, providing five strategic goals to direct federal agencies in their efforts: prevention, early detection and rapid response, control and management, restoration, and organizational collaboration. The strategic goals outlined in the plan were used to frame the action alternatives in this environmental assessment.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, as amended

SEC. 303. Integrated Pest Management states: “Federal agencies shall use Integrated Pest Management techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies and other activities.”

FIFRA and the regulations established by the EPA act as primary guidance governing pesticide registration, pesticide usage, the training and certification of pesticide applicators, and the criminal and civil penalties associated with misuse of pesticides. *Herbicides* are a type of pesticide that control unwanted plants. Selective herbicides control certain target plants while allowing the desired plants to survive. In this document, herbicides are the only class of pesticides that would be used to chemically treat invasive, non-native plants.

The EPA is the agency responsible for registration of pesticides. Pesticide registration is the process through which the EPA examines the ingredients of a pesticide; the site or crop on which it is to be used; the amount, frequency and timing of its use; and storage and disposal practices. The EPA evaluates the pesticide to ensure that it will not have unreasonable adverse effects on humans, the environment, and non-target species. Except for a small number of low-toxicity active ingredients that have been exempted, a pesticide cannot be legally used if it has not been registered with the EPA’s Office of Pesticide Programs. Once registered, a label is developed for each pesticide. Pesticide labels include directions for the protection of workers who apply the pesticide, directions for reducing exposure to non-applicators, and reducing potential impacts to the environment. Violations of pesticide label directions constitute a violation of FIFRA. The storage and disposal of most pesticides is also regulated under FIFRA, with specific direction provided on pesticide labels. Under FIFRA, enforcement of the act is delegated to individual states. Because labels contain important application, safety, and storage and disposal information, labels must be kept with the product.

Federal Water Pollution Control Act (Clean Water Act) of 1972, as amended

Section 402 of the Clean Water Act (CWA) established the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges of pollutants into waters of the United States. An NPDES permit sets specific discharge limits for point sources discharging pollutants into waters of the United States and establishes monitoring and reporting requirements, as well as special conditions. The Environmental Protection Agency (EPA) is charged with administering the NPDES permit program, but can authorize states to assume many of the permitting, administrative, and enforcement responsibilities of the NPDES permit program. The National Park Service will continue to monitor the status of EPA's NDPES permit system, and conform to all applicable laws and regulations as they are issued.

Endangered Species Act of 1973

Section 7 of the Endangered Species Act (ESA) charges federal agencies to aid in the conservation of listed species and requires federal agencies to ensure that their activities will not jeopardize the continued existence of listed species or adversely modify designated critical habitats. The provision under section 7 that is most often associated with the US Fish and Wildlife Service (USFWS) and other federal agencies is section 7(a)(2). It requires federal agencies to consult with the USFWS to ensure that actions they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify designated critical habitats.

Occupational Health and Safety Act (OSHA) of 1970

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 also required to maintain Material Safety Data Sheets (MSDSs) about these substances and to provide the employee with a copy of the sheets if they are requested. Park personnel must maintain a current set of MSDSs for any pesticides used within NPS boundaries. Maintaining a copy of the label with the MSDS is encouraged.

National Environmental Policy Act of 1969, as amended

The National Environmental Policy Act (NEPA) requires all federal agencies to study the impacts of proposed actions on the environment of federal lands, to analyze alternatives to the actions, and to inform and seek input from the public on the actions. Environmental consequences of the proposed action and alternatives to the proposed action are analyzed in detail to provide managers and the public adequate information in order to provide input and to make informed decisions. Compliance with the National Environmental Policy Act (NEPA) is satisfied by this environmental assessment.

National Historic Preservation Act of 1966, as amended

Federal agencies must consider the effects of their activities on historic properties. Section 106 of the National Historic Preservation Act directs federal agencies to consider the effects of undertakings on historic or archeological properties that are listed in or eligible for listing in the National Register of Historic Places. Similarly, Section 110 requires that Federal agencies identify and protect historic properties (both listed and presumed eligible for the National Register) and avoid unnecessary damage to them. Unless addressed by stipulations in 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" (2008), the National Park Service must consult with the State Historic Preservation Officer (SHPO) and may consult with the Advisory Council on Historic Preservation, an independent federal agency that advises the President and the Congress on matters pertaining to preservation of historic architectural, archeological, and cultural properties. The Advisory Council may comment on how the project affects significant properties. In most cases, agreement on how a project will be carried out with the least harm to important properties is written into a Memorandum of Agreement which is signed by the National Park Service and the SHPO, and may be signed by the Advisory Council.

Archaeological Resources Protection Act of 1979, as amended
The purpose of this act is to protect archaeological resources on public and Indian lands from unlawful excavation, removal, damage, alteration or defacement and from unlawful sale, purchase or exchange. This act also governs the lawful excavation of archaeological sites on federal and Indian lands, (via permit process) and the removal and disposition of archaeological collections from those sites.

Native American Graves and Repatriation Act (NAGPRA) of 1990
This act requires that federal agencies and institutions that receive federal funding return certain Native American cultural items and human remains to groups demonstrating affiliation. Cultural items include funerary objects, sacred objects, and objects of cultural patrimony. In addition, it authorizes a program of federal grants to assist in the repatriation process.

American Indian Religious Freedom Act (AIRFA) of 1978, as amended
The American Indian Religious Freedom Act eliminates interference with the free exercise of Native religion, as per the First Amendment. This act protects and preserves the traditional religious rights and cultural practices of American Indians, Eskimos, Aleuts, and Native Hawaiians. These rights include, but are not limited to, access to sacred sites, freedom to worship through ceremonial and traditional rights, and use and possession of objects considered sacred. Through this act, government agencies accommodate access to and use of religious sites to the extent that the use is practicable and not inconsistent with the agency's essential functions.

Wilderness Act of 1964
Federal agencies administering designated wilderness are responsible for preserving the wilderness character of the area. Wilderness areas are devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use. Prohibited uses include the following: there shall be no commercial enterprise and no permanent road within any wilderness area and, except as necessary to meet minimum requirements for the administration of the area (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area. A Minimum Requirements Analysis is conducted for all proposed administrative actions in designated wilderness in order to determine whether it meets the minimum requirement for administering the area, and if so, what minimum tools should be used to complete the action (The Minimum Requirements Analysis for this program is located in Appendix C).

Department of Interior Policies and Guidelines

Departmental Manual (DM) 517 Integrated Pest Management Policy
The Department's policy is to manage pests and use IPM principles in a manner that reduces risks from both the pests and associated pest management activities. IPM is a science-based, decision-making process. IPM incorporates management goals, consensus building, research, pest biology, environmental factors, pest detection, monitoring, and the selection of the best available technology to prevent unacceptable levels of pest damage. Bureaus will accomplish pest management through cost-effective means that pose the least risk to humans, natural and cultural resources, and the environment. Further, it is the Department's policy to:

- Conduct all pest management activities in full compliance with applicable laws and other authorities including the National Environmental Policy Act; the Endangered Species Act; Migratory Bird Treaty Act; Federal Insecticide, Fungicide, and Rodenticide Act; Food Quality Protection Act; and the National Historic Preservation Act. Bureaus will complete the necessary environmental documentation before conducting pest management activities.
- Give full consideration at all times to the safety and protection of humans and other non-target organisms and resources.
- Establish site management objectives and then choose the lowest risk, most effective approach that is feasible for each pest management project. The methods can include, but are not limited to, one or more of the following: no action, cultural, physical, biological, and chemical management. Bureau planning will incorporate IPM methods into short and long term planning documents to establish methods for implementing low risk, effective pest management practices. While management costs are important, they are not the primary deciding factor in selecting a management approach. At times, it may be appropriate to select a more expensive management approach if that method is effective and reduces risks to humans and other non-target resources.
- Conserve and promote beneficial organisms and natural processes that would inherently suppress potential pest populations.
- Design and maintain the stability of structures, developed landscapes, and natural areas to prevent and reduce conditions conducive to pests.
- Utilize and promote pest management research, methods, education, and technical and financial assistance programs to develop, support, and implement IPM strategies.
- Conduct appropriate and applicable pest detection, environmental surveillance, and monitoring before, during, and after any management activity to determine whether pest management goals are achieved and whether the activity caused any significant unanticipated effects.
- Incorporate this policy into procurement activities, contracts, leases, and agreements to ensure compliance by bureaus, offices, and outside parties conducting activities such as farming, construction, habitat management, grazing, forestry, operation and maintenance of irrigation systems and dams, concessions management, roads, rights-of-way, public health, and animal and vegetation management on Departmental properties.

Departmental Manual (DM) 609 Weed Control Program

It is DOI's policy to control undesirable plants on the lands, waters, or facilities under its jurisdiction, to the extent economically practicable and as needed for resource/environmental protection and enhancement, as well as the accomplishment of resource management objectives and the protection of human health.

Programs for the control of undesirable plants on DOI lands, waters, and facilities will incorporate Integrated Pest Management (IPM) concepts and practices. Consistent with their missions and authorities, Departmental offices and bureaus having land and water resource management responsibilities are to conduct or sponsor appropriate research, technology transfer, cooperative agreements, public education, and technical assistance programs to develop and encourage the use of environmentally safe and effective IPM programs for the control of undesirable plants.

Interior offices and bureaus will coordinate their IPM activities concerning weed control operations, research, and technology transfer with related programs and goals of private, local, state, and other federal agencies where such cooperation is feasible and mutually advantageous. All IPM programs and activities relating to the control of undesirable plants on DOI lands will be carried out pursuant to applicable statutes, directives, and Departmental policies pertaining to protection of the environment and human health.

National Park Service Policies and Guidelines

The NPS has a strong and clear policy on managing invasive (also referred to as exotic) plants in the parks. Parks are guided by three primary internal documents to manage invasive plants, which are listed below. Invasive plant management actions in designated wilderness are further guided by Director's Order 41: Wilderness Stewardship.

- NPS Management Policies 2006
- Director's Order 77-7 (DO 77-7): Integrated Pest Management
- Park-specific Management Plans

NPS Management Policies 2006
General policies for management of invasive plants are provided in *NPS Management Policies* 2006. The most relevant sections are summarized below.

Section 4.4.4 - Management of Exotic Species
NPS units are required to manage exotic species to prevent the displacement of native species. This section states, "Exotic species will not be allowed to displace native species if displacement can be prevented." Management of exotic species within park units is allowed given the following conditions: "All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed - up to and including eradication - if (1) control is prudent and feasible, and (2) the exotic species:

- interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or
- disrupts the genetic integrity of native species, or
- disrupts the accurate presentation of a cultural landscape, or
- damages cultural resources, or
- significantly hampers the management of park or adjacent lands, or
- poses a public health hazard as advised by the US Public Health Service (which includes the Centers for Disease Control and the NPS public health program), or
- creates a hazard to public safety.

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.

Programs to manage exotic species will be designed to avoid causing significant damage to native species, natural ecological communities, natural ecological processes, cultural resources, and human health and safety

Section 4.4.5.2 Integrated Pest Management Program
The NPS is required to use an Integrated Pest Management approach to address pest issues (including invasive plants). All pesticide use on NPS lands must be reported annually.

Section 4.4.5.3 Pesticide Use
All prospective users of pesticides in park units must submit pesticide use requests, which are reviewed on a case-by-case basis, taking into account environmental effects, cost and staffing, and other relevant considerations. The decision to incorporate a chemical, biological, or bioengineered pesticide into a management strategy will be based on a determination by a designated IPM specialist that it is necessary and other available options are either not acceptable or not feasible. Pesticide applications will only be performed by or under the supervision of certified or registered applicators licensed under the procedures of a federal or state certification system.

Section 4.4.5.4 Biological Control Agents
The application or release of any bio-control agent or bioengineered product relating to pest management activities must be reviewed by designated IPM specialists in accordance with Director's Order #77-7 and conform to the exotic species policies in Section 4.4.4.

Section 4.4.5.5 Pesticide Purchase and Storage
Pesticides must not be stockpiled. No pesticides may be purchased unless they are authorized and expected to be used within one year from the date of purchase. Pesticide storage, transport, and disposal will comply with procedures established by (1) the Environmental Protection Agency; (2) the individual states in which parks are located; and (3) Director's Order #30A: Hazardous and Solid Waste Management, Director's Order #77-1: Wetland Protection, and Director's Order 77-7: Integrated Pest Management.

Section 6.3.7 Natural Resources Management (Wilderness)
The principle of nondegradation will be applied to wilderness management, and each wilderness area's condition will be measured and assessed against its own unimpaired standard. Natural processes will be allowed, insofar as possible, to shape and control wilderness ecosystems. Management should seek to sustain the natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries.

Management actions, including the restoration of extirpated native species, the alteration of natural fire regimes, the control of invasive alien species, the management of endangered species, and the protection of air and water quality, should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals.

Director's Order 77-7 (DO 77-7): Integrated Pest Management
The NPS is developing *Director's Order 77-7 (DO 77-7): Integrated Pest Management (IPM)*. The purpose of DO 77-7 is to supplement and clarify existing NPS policies on IPM. The NPS Associate Director for Natural Resources Stewardship and Science will also develop and issue Reference Manual 77-7 (RM 77-7). RM 77-7 will provide parks with additional information and procedures for carrying out NPS responsibilities included in NPS-77, DO 77-7, and Management Policies 2006. Once formalized, policy and guidance included in DO 77-7 and RM 77-7 would apply to any actions taken under the proposed plan. Since DO 77-7 has not been approved, this EA was developed based on existing policy included in NPS-77 and

Management Policies 2006. However, some concepts that are included in draft versions of DO 77-7 were incorporated into the EA to provide additional guidance, where appropriate.

Review and Approval to Use Pesticides
NPS-77 provides guidance on the review and approval process for pesticides, biological control, and other treatments. The natural resource manager at the park can approve treatments that do not involve the use of pesticides or biological control. However, if pesticides or biological control treatments will be used, a use proposal must be sent to the Regional IPM Coordinator. The Regional IPM Coordinator may then forward requests to the National IPM Coordinator in Washington D.C., as necessary. Parks that propose the use of pesticides or biological control agents must also follow established state and federal regulations.

Pesticides must be reviewed and approved prior to use if they:

- Are applied to any lands, waters, or structures that are owned, managed, or regulated by the NPS; or
- Are purchased by NPS or cooperating association funds; or
- Are used on privately owned lands or lands managed by another government agency and are located within a park boundary, and NPS approval is required under the terms of a legally binding agreement between the park and the landowner; or
- Are purchased by the park for employees (e.g., insect repellants and bear deterrents).

To obtain approval for pesticide use, each park is required to prepare a pesticide use proposal. Except as noted below, Regional IPM coordinators review pesticide use proposals and either approve them, approve them with conditions, or deny them (and provide alternative methods). Currently, the following pesticide use proposals also require a second level of review by the National IPM Coordinator:

- Pesticide uses that involve aquatic applications or situations in which the applied pesticide could reasonably be expected to get into waters or wetlands;
- Pesticide uses that may negatively affect rare, threatened, or endangered species or associated critical habitat;
- Pesticide use involving aerial application; and
- Restricted-use pesticides as defined by the EPA.

In the future, broadcast applications over a specified acreage may also require approval from the National IPM Coordinator under DO 77-7. While not yet formally approved, the National IPM Coordinator has indicated that, in practice, approval should be obtained from the National IPM Coordinator for any chemical treatment of 400 or more contiguous acres.

Reporting Pesticide Use
Under NPS-77, parks are required to maintain records of pesticide use, including pesticide use reports, during the year.

Review and Approval to Use Biological Control Agents
Any park unit proposing to release a biological control agent must receive approval from the Regional or National IPM Coordinator. Biological control use requests are first submitted to the Regional IPM Coordinator. The Regional IPM Coordinator may deny the proposal, modify the proposal in cooperation with the park and forward the modified request, or forward the request (without modification) to the Na-

tional IPM Coordinator for review and approval. State permitting may also be required prior to the release of a biological control agent.

Exotic Species Management
NPS-77 provides guidance on a number of exotic species management topics that were used in the formulation of this plan. These topics include prevention of exotic species invasions, management of established exotic species, biological control, and environmental compliance and planning documents.

Director's Order 41 (DO 41): Wilderness Stewardship
DO 41 states that the goal of wilderness stewardship is to keep NPS wilderness areas as natural and wild as possible in the face of competing purposes and impacts brought on by activities that take place elsewhere in the park and beyond park boundaries. It requires parks to have a documented process for applying the minimum requirements concept, and the concept must be applied to all administrative activities that could potentially affect wilderness character, including activities that are not specifically prohibited by section 4(c) of the Wilderness Act (16 USC 1133 (c)). In regards to climate change, it calls for parks to be leaders in efforts to increase landscape connectivity and improve ecosystem resilience through the reduction of the influence and negative impact of humans on the ecosystem.

Park-specific Guidance and Agreements

Several North Cascades National Park Service Complex planning documents provide further guidance on the management of invasive plants. The 1988 General Management Plan states that the NPS will evaluate, monitor, and mitigate environmental impacts, including invasions by exotic species (NPS 1988). The 1995 LACH General Management Plan states that the NPS will monitor and attempt to protect incoming gravel, soil, and firewood from non-native plants, and would control selected non-native species (e.g., knapweed, common mullein (*Verbascum thapsus*), knotweed (*Polygonum spp.*), rush skeletonweed (*Chondrilla juncea*)) that threaten to spread and adversely affect national recreation area resources (NPS 1995). The draft ROLA General Management Plan and EIS states that the NPS will prioritize according to the ecological threat posed by invasive species and/or threats to high quality and high value habitats; eradicate invasive non-native species where feasible, and use containment strategies when eradication is infeasible; and collaborate with adjacent landowners and jurisdictions on cooperative weed management, such as working with the Washington State Department of Transportation to replace invasive non-native species with native species (NPS 2010).

The 1999 Resource Management Plan calls for the continued treatment of priority species, including rush skeletonweed, knapweed, Scotch broom, and Japanese knotweed. The plan calls for the infestations to be mapped, monitored, and restored, as well as continued monitoring for invasive plants in wilderness (NPS 1999). The plan also calls for the creation of a comprehensive management plan for invasive plant control at the Stehekin Airstrip. The Wilderness Management Plan, approved in March of 1989, serves as the primary guidance for management of the Stephen Mather Wilderness. Although the plan does not specifically identify actions related to invasive plant management, it calls to manage indigenous plant and animal communities to sustain natural processes, assuring that levels of human use are compatible rather than detrimental, with emphasis on preserving endangered and threatened species (NPS 1989).

Settlement Agreement on Recreation and Aesthetics, April 1991
This agreement was entered into by Seattle City Light (SCL), the National Park Service, and several other intervenors as part of the Skagit River Hydroelectric Project No. 553 license issued by the Federal Energy

Regulatory Commission (City of Seattle 1991). It established SCL's obligations relating to recreation in the Project area and the visual quality of the Project facilities, including vegetation management. SCL right-of-way fee title within NPS boundaries is held by the United States and managed by the NPS. Within these areas SCL is to manage vegetation to "conform to the greatest extent possible with the natural character of the landscape." Prior to any pesticide use, SCL is to consult with NPS and obtain necessary permits.

Lake Chelan Project Settlement Agreement, October 2003
This agreement was entered into by Public Utility District No. 1 of Chelan County, the National Park Service, and several other intervenors as part of the Lake Chelan Project No. 637 license issued by the Federal Energy Regulatory Commission. The Agreement also provides for erosion control measures, the placement of large woody debris, measures to control dust at the head of Lake Chelan in the community of Stehekin, the replacement of survey monuments, tributary barrier removal, fish stocking, a revised lake level regime, wildlife habitat restoration, historic properties and cultural resources protection, recreational resources, a means of addressing unforeseen resource needs, and other measures and requirements. Among other tasks, Article 4, Stehekin Area Plan, states that Chelan PUD and NPS will attempt to reduce the current abundance, distribution, and cover of reed canarygrass, and control the spread of other non-native plants along the shoreline, and monitor native plants and wildlife for species richness, abundance, and distribution, to measure the success of these measures.

State and Local Regulatory Measures

In recognition of the economic and ecological threats caused by invasive, non-native plants, Washington State has enacted laws to control the introduction and spread of noxious weeds. The original goal was to limit Washington's economic loss due to noxious weeds in and around agricultural areas. In 1987, this law was revised to incorporate noxious weed control in all natural areas, since the ecological impacts of noxious weeds are so closely tied with Washington's economy.

Chapter 17.10 RCW - Noxious Weeds - Control Boards.
This is the primary noxious weed law, and it holds landowners responsible for controlling noxious weeds on their property. Landowners are required to eradicate all class A noxious weeds and to control and prevent the spread of all class B and class C noxious weeds (See Appendix D for all Washington State listed species). It also establishes a program for administering the noxious weed law, which is carried out by three groups:

- Washington State Noxious Weed Control Board
- Washington Department of Agriculture
- County and District Noxious Weed Control Boards

Chapter 17.10 RCW

Noxious Weeds

The primary Washington State noxious weed law, it holds landowners responsible for controlling noxious weeds on their property

The Pacific Northwest Region of the NPS has signed a Memorandum of Understanding with the Washington State Department of Agriculture and the Washington State Noxious Weed Control Board, to, "coordinate the management of exotic plant species listed as 'noxious weeds' on National Park Service lands and adjoining state and private lands in Washington."

Invasive plant management within the Park Complex will conform to applicable state and local laws. It is the NPS's general policy to comply with more stringent state requirements, where applicable. All herbicide application will be conducted by or under the supervision of a certified pesticide applicator in accordance with state laws. All NPS employees that apply or have pesticide application as a significant element of their job descriptions are encouraged to obtain state certification for pesticide application.

MOU between NPS / WSDA / WS Noxious Weed Control Board

"coordinate the management of exotic plant species listed as 'noxious weeds' on National Park Service lands and adjoining state and private lands in Washington."

2 ALTERNATIVES

This chapter describes the alternatives developed to achieve the goal of controlling invasive, non-native plants. Included in the alternatives is the *No Action* alternative (Alternative 1), as required by the National Environmental Policy Act (NEPA). The *No Action* alternative is used as a baseline from which to measure the impacts of the other *Action* alternatives. In other words, the *No Action* alternative is a measure of what would happen if management of invasive plants continues "as is." There are two *Action* alternatives in this EA, one of which is the Preferred Alternative, or the NPS-preferred course of action (Alternative 2). In this alternative, the number of species and infestations proposed for treatment increases compared to Alternative 1. Both Alternatives 1 and 2 include the use of herbicides as a treatment option. The other *Action* alternative (Alternative 3) is different from the other alternatives in that it excludes the use of herbicides. All of the alternatives are based on the concept of Integrated Pest Management (IPM), and they are all designed to meet the goals and objectives that are based on national strategic goals for invasive plant management, as described in Chapter 1: Prevention and Early Detection, Inventorying and Monitoring, Prioritization and Control, Restoration, and Outreach, Education, and Cooperation.

2.1 Organization of This Chapter

Chapter 2 begins with a section that describes the techniques commonly used to treat invasive, non-native plants. These techniques will be referred to throughout the alternatives, and there are differences in the frequency with which the techniques are used between the alternatives. Next is a section that describes the elements common to all of the alternatives (Section 2.3); this means that no matter which alternative is chosen for implementation, the elements described in 2.3 would also be implemented. The next three subsections (2.4-2.6) describe the three alternatives that are being considered in this process:

2.4 Alternative 1 – Continue with Current Management (No Action)
2.5 Alternative 2 – Integrated Pest Management with Herbicides (Preferred)
2.6 Alternative 3 – Integrated Pest Management without Herbicides

Section 2.7 describes additional alternatives that were initially considered but subsequently rejected. In Section 2.8, the Environmentally Preferred Alternative is described along with the process by which it was identified. Finally, tables that summarize all of the alternatives are found in Section 2.9.

2.2 Techniques Used in Invasive Plant Management

There are four different management techniques that are often used in combination to control invasive plants. The techniques include cultural, manual / mechanical, biological, and chemical. These techniques are described below.

Invasive Plant Management Techniques			
Cultural	Manual/Mechanical	Biological	Chemical

Cultural Treatments

Cultural treatments are practices that promote the growth of desirable plants and reduce the opportunities for invasive plants to grow. Treatments involve manipulating areas to present invasive plants with effective native competitors. Examples include shading, seeding or planting of native plant species, fertilizing for desired plants, mulching, watering to change moisture regimes, flooding or drawdown to manipulate riparian areas, prescribed burning, and grazing.

Unless native plants are re-established, the removal of one invasive plant may result in the establishment of another undesirable invasive plant. Seeding and/or planting native plants can help prevent the establishment of invasive plants. Native shrubs or trees can be replanted after invasive plants are removed to help restore habitat structure and to shade out new invasive plants. Seeding and/or planting may not be necessary in areas where native plant diversity is good within and surrounding treated invasive plant infestations. Irrigation may be used on a limited basis to help native vegetation become established during dry periods. Prescribed burning involves planning, setting, and managing fires to accomplish resource management objectives. This method works best when the targeted invasive species is much more susceptible to the effects of burning than the non-target native species in the area.

The use of goats or other domestic ruminants can be used to control invasive plants by allowing the animals to graze in infested areas. This technique will not be used to manage invasive plants within the Park Complex (See Section 2.7 for a description of alternatives considered but rejected).

Manual / Mechanical Treatments

Manual and mechanical treatments involve physically damaging or removing part or all of the plant. Examples of this type of treatment include hand pulling, mowing, cutting, tilling, and radiant heat. A variety of tools can be used to remove or damage plants, including cutting or digging tools (clippers, trowels, and shovels), pulling tools (such as weed wrenches™), and power tools (such as weed whips, chainsaws, ATV-pulled mowers, or tractors). Both manual and mechanical treatments are used to treat individual plants or specific treatment areas. Some methods are more selective for individual plants than others. Manual or mechanical treatments may need to be performed several times during a season and are often used in concert with other treatment methods. For example, manual or mechanical treatments may be used in conjunction with herbicide application or prescribed fire to treat re-sprouts and new seedlings.

Manual treatment is most effective in controlling annual and biennial species. It is conducted by removing as much of the root as possible while minimizing soil disturbance. Manual pulling of deep-rooted species may require repeated treatment to effectively deplete the root system since portions of roots can break off, remain in the soil, and regenerate. Another treatment option for removing deep-rooted plants is the use of pulling tools. These can be used to control small infestations, such as when an invasive plant is first identified in an area. These tools grip the weed stem and remove the root by providing leverage.

Figure 2-1. NPS and Seattle City Light workers manually and mechanically remove Scotch broom

Use of hand tools, such as trowels, shovels, and pulaskis are simple forms of mechanical treatments. These tools can be used to remove a larger portion of the root system or to sever the plant's taproot below the point where nutrients are stored. Hand cutting or the use of power tools is a treatment option for removing the aboveground portions of annual or biennial plants. These methods are useful for controlling annual plants before they set seed and for reducing plant growth. Weed whips can be used to treat small to large infestations at sites that are inaccessible or are too rocky to be mowed. Mowers work best in large, relatively flat treatment areas that do not include sensitive environmental resources. Power tools can also be used along with other treatments, such as herbicides or prescribed fire, to treat perennial invasive plants.

Biological Treatments

Biological treatments are commonly referred to as biological control, or biocontrol. These treatments involve the use of "natural enemies," such as insects, microorganisms, and naturally occurring pathogens to reduce the abundance of an invasive plant population by limiting its growth or reproduction. Natural enemies are imported from areas where the target invasive plant occurs as a native plant and are deliberately released into areas where the plant is invasive. Before a biological control agent is released into the United States, it undergoes a series of host (plant)-specific feeding tests generally conducted by independent researchers under permit from the United States Department of Agriculture's Animal Plant Health and Inspection Service (USDA-APHIS). These tests are initially conducted in the agent's country of origin, followed by laboratory quarantine in the United States, and then quarantined field studies. During this time, but prior to widespread release of an agent, USDA-APHIS completes NEPA compliance that addresses the effect this agent should have were it to spread naturally throughout the continental United States. A USDA-APHIS Plant Protection and Quarantine permit (PPQ 526) is required for the interstate transport and release of biological control agents, however, once an agent is released within a state, it may be transported (and is expected to move) freely within its boundaries. Examples of biological control agents include plant-feeding insects such as flea beetles (*Aphthona lacertosa*) for leafy spurge (*Euphorbia esula*) and leaf beetles (*Galerucella* spp.) for purple loosestrife (*Lythrum salacaria)*.

Biocontrol may be a long-term solution for controlling some invasive species that are too widespread for control by other means or that are readily invading the Park Complex. Biocontrol is best suited for infestations of a single, dominant invasive plant species which is not closely related to other native plant species.

Chemical Treatments

Using chemical treatments involves applying herbicides, as prescribed by their labels, to invasive plants. Herbicides can be used to treat small patches of invasive plants where hand pulling or cutting is not feasible or effective, for treating large monocultures of a single invasive plant species in areas where desirable native plants are scarce or absent, for selectively treating target plants based on their physiology and the timing of application, and/or where other control methods are not successful (i.e., for some species such as Japanese knotweed and other rhizomatous plants, mechanical control can make the problem worse). Application methods can include wicking, injection, cut stump, foliar spot application, and foliar broadcast application. Portable equipment may include wick applicators, injectors, backpack sprayers and hand-held pump sprayers. Broadcast methods typically utilize ATV-mounted or truck-mounted power sprayers.

Herbicide application methods are described below:

Wick applicator: herbicides are applied directly to target vegetation, by utilizing a wick, sponge or brush.

Injection / Frill and girdle: concentrated herbicide is delivered either by means of a syringe to interstitial cavities (e.g., in bamboo or knotweed) or applied directly to cuts or holes made in the bark of woody species, and translocated throughout the plant.

Cut Stump: an herbicide solution is applied directly to the cambium and bark of trees, shrubs, or vines directly after cutting down the plant. The herbicide penetrates the stump and is absorbed via capillary action into the root system.

Basal Bark: an herbicide solution is applied in an 8 – 16" band around the base of trees, shrubs, or vines less than 6" in diameter. The herbicide solution penetrates the bark, and is then moved by capillary action throughout the plant.

Foliar Spot Application: a dilute herbicide solution is delivered to the foliage of target plants by means of a manually pressurized backpack or hand-held sprayer. In some cases, this treatment may also be made to the soil of infested areas prior to seed germination.

Foliar Broadcast Application: a dilute herbicide solution is delivered to the foliage of target plants by means of an electrically driven or internal combustion powered sprayer, mounted on either an ATV or truck. Applications are either selective or non-selective, depending on the area to be treated and the species of concern. Herbicide is delivered by means of either a calibrated high pressure gun, or a series of nozzles calibrated to give an even coverage of target species while delivering herbicide solutions at a species specific application rate.

Figure 2-2. Foliar spot application of reed canarygrass

Adjuvants. An adjuvant is a substance added to an herbicide to aid its action, but which has no herbicide action by itself. Some herbicides require the addition of an adjuvant to work safely and effectively. Surfactants are adjuvants used in conjunction with herbicides to increase absorption by plant tissue, reduce run-off, and create larger spray droplets to minimize drift. A surfactant lowers the surface tension of the solution in which it is dissolved or the tension between two immiscible liquids (i.e., liquids that will not mix together). Safety procedures must be followed and MSDSs (Materials Safety Data Sheets) must be kept on site for all adjuvants used for invasive plant management.

All herbicides used by the NPS must be approved by the Regional IPM Coordinator, and in some cases the National IPM Coordinator. See Section 1.8 for more details about the approval process. Best Management Practices for the use of herbicides in the Park Complex are described in Appendix E.

2.3 Elements Common to All Alternatives

All of the elements described in this section would be implemented regardless of which alternative is ultimately chosen. The elements include an Integrated Pest Management (IPM) approach, the use of Best Management Practices (BMPs), a Minimum Requirements Analysis (MRA), and an annual project planning, implementation, and tracking process.

Integrated Pest Management Approach

Under all alternatives, the NPS will use an IPM approach as required by law (Title 7 USC 136r-1 FIFRA) and NPS policy. IPM is a decision-making process that supports the NPS mission by coordinating knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage. IPM uses environmentally sound, cost-effective management strategies that pose the least possible risk to people, park resources, and the environment. This process helps resource managers determine whether the treatment is necessary and appropriate, where treatment should be administered, when treatment should be applied, and what strategies should be used for immediate and long-term results. IPM is done on a case-by-case basis, so that treatment strategies are tailored to local conditions. Each invasive plant's natural history is also evaluated before developing treatment strategies. The goal of IPM for this program, therefore, is to manage invasive, non-native plants and the environment to balance costs, benefits, public health, and environmental quality.

IPM: *Integrated Pest Management*

A decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, resources, and the environment.

IPM is considered a form of adaptive management. Adaptive management is a system of management practices based on clearly identified outcomes, monitoring to determine if management practices are meeting outcomes, and if they are not, facilitating management changes that would best ensure that outcomes are met. An adaptive management strategy allows land managers to describe and evaluate the consequences of changing invasive plant infestations and treatment.

IPM employs multiple integrated management practices rather than a single solution wherever technically and economically feasible. An integrated approach is often more effective than a single type of treatment. For example, combining prevention, various control methods, and restoration will likely result in smaller subsequent infestations and less time and effort needed for follow-up treatments. The goals and objectives that are outlined in Chapter 1 (Prevention and Early Detection, Inventorying and Monitoring, Prioritization and Control, Restoration, and Outreach, Education, and Cooperation) reflect the integrated management practices that will be implemented upon completion of this planning process. These practices are described more thoroughly below, along with specific actions that will be taken to reach each goal.

Prevention and Early Detection

Preventing weed invasions is the first line of defense in protecting ecosystems. By placing a priority on preserving and protecting un-infested lands, those areas will be spared from further degradation. Key to prevention is education and early detection/eradication. The following actions will be taken to achieve the goal of prevention and early detection:

Actions:

- Follow Best Management Practices (BMPs) to prevent the introduction and spread of invasive species into the Park Complex. Additionally, park partners and contractors will follow these BMPs. (See Appendix E)
- Establish early detection / eradication protocol for new potentially invasive species, and newly discovered populations of known invaders. Under this protocol, annual surveys of susceptible points of introduction (roads, trailheads, riparian areas, disturbance zones) paired with an employee education program will be instituted to identify and attempt eradication of 1) Newly discovered satellite populations of known invasive species, and 2) Previously uncollected/unidentified species possessing invasive characteristics. Populations identified and treated under this protocol will be monitored and re-treated annually until either the target populations are eradicated or an acceptable level of maintenance control is achieved in lieu of successful eradication.
- Specify responsibilities for non-native plant management in permits and contracts
- Devote portions of invasive plant management budget to education and other forms of prevention (See Education, Outreach, and Cooperation for examples).

Inventorying and Monitoring

The park IPM program should have at its disposal a complete inventory of known populations of both invasive and sensitive species. This will aid in the development of management priorities and treatment types based on the most current information available. Regular monitoring of treated areas will take place in order to follow-up with additional treatments or restoration if necessary, and to determine whether invasive plant management activities are effective in meeting management objectives. Record keeping will be used to document activities and to provide information that can be used to justify future invasive plant management activities. The following actions will be taken to establish an effective inventory and monitor program:

Actions:

- Inventory Park Complex for non-native and sensitive plants every five years
- Regularly monitor known non-native and sensitive plant populations every year
- Produce annual reports that summarize management activities for the year

- Produce progress reports that analyze program effectiveness and outline appropriate courses of action to meet management objectives if they are not being met every five years

Prioritization and Control

A well-rounded IPM program is essential to the control of invasive species as it offers the ability to combine management tools where appropriate to increase the effectiveness of control and eradication efforts. For each priority species, treatment methods would be selected that meet management objectives and are feasible given potential costs, available resources, potential impacts and effectiveness, and applicable regulations and policies. In general, control would focus on small, expanding satellite populations, eventually working toward the control or eradication of the densest areas of infestation.

Actions:

- Establish weed management priorities
- Eradicate infestations when they are small to minimize resource losses and reduce costs
- Stop the advancing perimeter before controlling the interior of an extensive infestation
- Attempt to remove seeds from plants that are being contained
- Repeat control efforts and monitor treated areas for effectiveness until the seed bank is depleted, or rhizomatous plants have been completely controlled, and re-sprouts no longer occur

Additional actions unique to each alternative are described under the “Prioritization and Control” section of each alternative.

Restoration

Restoration is a critical component of invasive plant management because healthy native plant communities are effective at protecting sites from re-invasion. Techniques usually involve some cultural treatments, including seeding, planting, and occasionally irrigation. In addition to occupying space that could otherwise be taken by opportunistic invasive species, the organic matter from sprouted seeds helps to improve site characteristics and soil properties by providing shade and increasing moisture retention--conditions that often favor the establishment of native species. Examples of restoration projects include a seed increase program and native plantings at several sites. Seed increase has been undertaken to provide a native seed source to re-vegetate disturbed areas along the SR 20 corridor and to be used as a cover crop to restore construction sites in Stehekin. Native plantings in conjunction with erosion control activities and reed canarygrass (*Phalaris arundinacea*) removal have occurred for several project areas along Ross Lake. Limited planting has occurred along SR 20, at the Diablo Lake Overlook, and at Gorge Overlook.

Actions:

- Develop a revegetation / restoration plan for every weed infestation (See Appendix F for an example)
- Following, or sometimes in conjunction with eradication, restoration efforts will be undertaken
- Survey site and determine what native plants will be used
- Collect seeds and/or propagate native plants (or seeds through a seed increase program) in native plant nursery
- After invasive plants have been controlled, restore disturbed areas

Outreach, Education, and Cooperation

An important element of an effective invasive plant management program is outreach, education, and cooperation with park employees, contractors, concessioners, park partners, visitors, private property inholders, and gateway communities. Visitor and staff education and awareness activities provide general information on specific invasive plant management issues and strategies for controlling individual invasive plants. Examples of existing visitor awareness and public education programs include interpretive talks, posters, handouts, and invasive plant identification cards. Examples of staff education include a recent (September 2009) workshop on developing Best Management Practices to prevent the invasion and spread of invasive, non-native plants and dissemination of pocket weed identification cards.

Actions:

- Educate NPS employees, contractors, partners, concessioners, and the public about how to identify and prevent spreading weeds. Provide weed identification training during fire refresher training and for maintenance staff each spring. In addition provide information, training, and appropriate weed identification materials to contract employees and permittees. Distribute Washington State weed pamphlet and/or provide park specific weed cards for field staff
- Create large format posters displaying color photographs of high priority weeds and their distribution throughout the Park Complex; post during annual park training and encourage participants to add their knowledge by marking new observation locations. In addition, post weed awareness messages and prevention practices at strategic locations, such as break rooms or common areas
- Collaborate with invasive plant management experts to keep informed about the latest invasive plant management technologies available and to share and learn from invasive plant management successes and challenges
- Promote research within the Park Complex to inform invasive plant management
- Interpret and communicate the results of the latest research on invasive plants to resource managers, interpreters, maintenance personnel, and others
- Encourage public support through volunteer invasive plant management projects and activities. Continue ‘bakery bucks’ program in Stehekin, and develop a similar program in the Skagit District
- Provide information sheets for horseback riders and packers, including where to obtain weed-free hay or other forage
- Enhance existing management partnerships with groups such as the Skagit Cooperative Weed Management Area Working Group, neighboring US Forest Service Ranger Districts, and concerned citizens (such as those who reside in Stehekin), in order to foster relationships between the public, private landowners, conservation groups, and county weed superintendents
- Cooperate with partners whose actions have the potential to exacerbate invasive plant infestations, especially Seattle City Light and Washington State Department of Transportation. Work together on improving prevention efforts, adhering to BMPs, and clarifying roles and responsibilities for invasive plant management
- Consider establishing cooperative agreements with other landholders and land management agencies (private, county, state, and federal lands) under the Consolidated Natural Resource Act of 2008[1] to conduct invasive plant management activities on lands within or adjacent to the Park Complex. An example of an agreement can be found in Appendix G.

[1] According to this act (Pub. L 110-229, Title III, Section 301), the NPS may enter into cooperative agreements with State, local, or tribal governments, other Federal agencies, other public entities, educational institutions, private nonprofit organizations, or participating private landowners for the purpose of protecting natural resources of units of the National Park System through collaborative efforts on land inside and outside of National Park System units. A cooperative agreement shall provide clear and direct benefits to park natural resources and provide for

Best Management Practices

Mitigation involves taking steps to avoid or minimize environmental impacts. Implementing best management practices (BMPs) is one form of mitigation that is commonly used to minimize impacts of activities that could create or exacerbate an invasive plant problem. BMPs are also used by park personnel during the treatment of invasive plant populations to minimize the environmental impacts of the treatment method. Common BMPs used for minimizing the spread of invasive plants include cleaning equipment, such as tires or tracks, after working in an infested area, or cleaning shoes and shoelaces of any seeds that may have lodged in or on shoes. Common BMPs used during the treatment of invasive plants to minimize environmental impacts of the treatment method include restricting herbicide application when it is windy to minimize spray drift, or cutting certain species at the base of their stems rather than uprooting them to minimize ground disturbance. A complete list of BMPs that will be adopted by the Park Complex as a result of this planning effort can be found in Appendix E.

Minimum Requirements Analysis

A programmatic level Minimum Requirements Analysis (MRA) was completed for invasive plant management actions within designated wilderness. Although the number of projects that would take place within wilderness varies by alternative, the same process was used to determine the minimum requirement regardless of alternative. Based on the MRA, the NPS concluded that treatment of invasive plants within wilderness is a necessary action, and therefore meets the minimum requirement for administration of the area as wilderness. A copy of the analysis and description of the process is included in Appendix C.

Step 2 of the MRA involves an analysis of potential “tools” to accomplish invasive plant management within wilderness. A combination of *Option D: Mechanical/herbicide treatments using human/stock transport and motorized equipment* and *Option E: Mechanical/herbicide treatments using helicopter transport and motorized equipment*, reflects proposed actions in Alternative 2; these options were chosen as the minimum tool. Note: because Alternatives 1 and 3 only propose manual removal of selected species within wilderness, with no herbicide use or motorized equipment proposed, the minimum tools that would be used under these alternatives would include mechanical removal with human and/or stock support.

Project Planning, Implementation, and Tracking

In addition to BMPs, the Park Complex will implement several other measures that will assist with annual project planning. First, the park botanist will hold an annual vegetation management meeting with park personnel, including the EPMT, who either work directly with native and/or non-native vegetation, or whose job duties may involve activities that have the potential to spread invasive plants. During each meeting, the past year’s accomplishments will be reviewed and a work plan will be developed for the coming year based on priorities for control. Project proposals will be developed for submittal to the EPMT, and a list of remaining smaller projects to be completed by park personnel will be prioritized and assigned to appropriate staff members. Actions taken (or not taken) to prevent invasive plant infestations will be reviewed and the group will work to improve prevention efforts.

preventing, controlling, or eradicating invasive exotic species that are within a unit of the National Park System or adjacent to a unit of the National Park System.

Second, prior to any project approval, the lists of EPMT and smaller park projects to be completed that year will be presented to the park Inter-Disciplinary Team (IDT) in order to evaluate if proposed projects are covered under this EA, whether more environmental compliance is needed, and to coordinate treatment projects among staff members. Projects confirmed by the committee to proceed will be subject to one final step if they involve herbicide application or biocontrol use: regional or national IPM Coordinator approval. Each year the park IPM Coordinator will submit Pesticide Use Proposals (PUPs) to the Regional IPM Coordinator, who must approve all herbicide use within parks. Additionally, projects involving a single herbicide application in excess of 400 acres or the release of biological control agents need approval by the National IPM Coordinator.

Finally, all invasive plant control and restoration projects, whether completed by the EPMT or park personnel, will be reported to the park botanist on an annual or more frequent basis. This documentation will aid in annual monitoring efforts to determine if current methods are effective.

2.4 Alternative 1 – Continue with Current Management (No Action Alternative)

Under Alternative 1, invasive plant management activities within North Cascades National Park Service Complex would continue on a limited basis. Resource managers would be limited to those projects and treatment options that can be categorically excluded under Director's Order (DO) 12 and in compliance with NEPA. According to DO-12, the only invasive plant management activities that can be categorically excluded involve:

> "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."

The Park Complex would not be able to implement a more comprehensive invasive plant management program since action is limited under what would be categorically excluded without more comprehensive environmental analysis and public disclosure. Management would be based on IPM principles, which include prevention and early detection, inventorying and monitoring, prioritization and control, restoration, and outreach, education, and cooperation. Control techniques would concentrate primarily on mechanical methods of controlling and containing existing populations of invasive non-native plants plus limited herbicide use at locations such as the Stehekin Airstrip, West Side gravel pits, the SR 20 Corridor, Ross Lake Reed Canarygrass, and Skagit River knotweed.

Prevention and Early Detection

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to achieve the goal of prevention and early detection.

Inventorying and Monitoring

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to establish an effective inventory and monitor program.

Prioritization and Control

See "Elements Common to All Alternatives" for a description of some basic prioritization and control actions that are common to all alternatives. The difference between prioritization and control actions in this alternative and those described in Alternative 2 is in the way in which species are prioritized as well as the frequency with which some of the control methods are used. This alternative describes current prioritization and control methods used within the Park Complex that would continue into the future if the *No Action* Alternative was implemented.

Priority species are currently determined using the best judgment of park staff with consideration for the amount of time and effort required for treatment. Control efforts have focused on the 24 species listed in Table 2-1. For each priority species, current control methods are identified along with its corresponding Washington State Noxious Weed Control Board rating. The State of Washington classifies invasive non-native species into three categories: Class A, B, and C. Class A species are limited in distribution in Washington. Preventing new infestations and eradicating existing populations is the highest priority. State law requires that these species be eradicated. Class B species are limited to portions of the state, and designated for control in regions where they are not widespread. Preventing new infestations in these areas is a high priority. In regions where Class B species are already abundant, control is determined at the local level, with containment as the primary goal. Class C species are widespread. Local programs of suppression and control are a county option, depending on local threats and the feasibility of control in local areas. The NPS uses the list to help determine management priorities for those species that exist within park boundaries. Refer to Appendix D for the 2010 Washington State Noxious Weed List along with further explanation of the process used by the State to determine the ratings.

Table 2-1. Priority Species Currently Being Treated (Alternative 1)

Species	**Control Method**[1]	**Washington State Weed Board Listing**
Bull thistle *Cirsium vulgare*	Chemical, Mechanical	Class C
Canada thistle *Cirsium arvense*	Chemical	Class C
Common tansy *Tanacetum vulgare*	Chemical, Mechanical	Class C
Dalmatian toadflax *Linaria dalmatica*	Biological, Chemical	Class B
English holly *Ilex aquafolium*	Chemical (Basal Bark[2], Cut Stump[3])	No rating
Evergreen (sweet)pea *Lathyrus latifolius*	Chemical	No rating
Hawkweed species (meadow, mouse-ear, & yellow) *Hieracium spp.*	Chemical	Class A (meadow) Class B (mouse-ear, & yellow)
Herb Robert *Geranium robertianum*	Chemical, Mechanical	Class B

Species	Control Method[1]	Washington State Weed Board Listing
Knapweed species (diffuse & spotted) *Centaurea spp.*	Chemical, Mechanical	Class B
Knotweed species (Bohemian, giant, & Japanese) *Polygonum spp.*	Chemical	Class B
Oxeye daisy *Leucanthemum vulgare*	Biological, Chemical, Mechanical	Class B
Periwinkle *Vinca major*	Chemical	No rating
Reed canarygrass *Phalaris arundinaceae*	Chemical	Class C
Rush skeletonweed *Chondrilla juncea*	Chemical	Class B
Scotch broom *Cytisus scoparius*	Chemical (Cut Stump[3]), Mechanical	Class B
St. Johnswort *Hypericum perforatum*	Biological, Chemical	Class C
Sulfur cinquefoil *Potentilla recta*	Chemical, Mechanical	Class B
White sweetclover *Melilotus alba*	Chemical, Mechanical	No rating
Yellow toadflax (butter-and-eggs) *Linaria vulgaris*	Chemical, Mechanical	Class C
[1] Unless otherwise stated, chemical treatments are foliar spot applications		
[2] Basal bark: a concentrated herbicide solution is applied in a band around the trunk		
[3] Cut stump: a concentrated herbicide solution is applied to the freshly cut stump		

Control efforts are largely conducted by the EPMT but are supplemented by occasional volunteer and park personnel efforts. Over the last three years, the EPMT has spent an average of 50 days mapping and/or treating invasive plants within the Park Complex. Under this alternative, the same amount of time would be spent within the Park Complex by the EPMT each year. The following is a summary of the types and extent of treatments that are currently being used, and would continue to be used under this alternative.

Cultural Control

The Park Complex currently implements seeding, planting, irrigation, mulching, and shading as cultural treatments. Seeding and planting are used in a variety of project areas to encourage the re-establishment of native plants and to prevent the establishment of exotic plants. Irrigation is used on a limited basis to help native vegetation establish during dry periods at the Stehekin Airstrip. Heavy mulching with hay was used to control knapweed along SR 20, but was unsuccessful. Shading with black plastic has been used to control knotweed in the Goodell gravel pit and knapweed and rush skeletonweed at the Stehekin airstrip, but both attempts only worked to reduce density rather than eradicate the infestation.

Manual and Mechanical Control

The Park Complex currently uses the following types of manual or mechanical treatments to control invasive plants: hand pulling and removal with small hand tools, shovels, and weed wrenches; and cutting with weed whips, mowers, tractor- or ATV-pulled mowers, chainsaws, and brush cutters. Some mechanical treatments are used in concert with herbicides, such as treating the stumps of woody species after removal by chainsaw or brush-cutter. The Park Complex has successfully reduced the density of plants such as Scotch broom, diffuse and spotted knapweed and herb Robert along road corridors, trailheads, and campgrounds with repeated manual or mechanical control. However, repeated manual control efforts to remove perennial species such as St. Johnswort (*Hypericum perforatum*), oxeye daisy (*Leucanthemum vulgare*), meadow hawkweed (*Hieracium caespitosum*), and Japanese knotweed have been largely unsuccessful. Under this alternative, these unsuccessful efforts would no longer continue. Up to 150 gross infested acres would be treated each year using mechanical methods.

Biological Control

Biological control agents have been released in the past (1989) by the Park Complex to reduce the density of knapweed. Additionally, many of the other biological control agents found within the boundaries of the Park Complex are already well distributed throughout the rest of Washington State, having been previously released by other federal, state, or county land managers. For many of the species listed below, it is unknown when they were released or by whom. Under this alternative, the NPS would continue to abide by USDA-APHIS regulatory statues for the interstate transport and release of biological control agents; however, no releases are proposed at this time. Biological control agents that are currently known to exist within NPS boundaries are summarized in Table 2-2.

Table 2-2. Biocontrol Agents Known to Exist within NPS Boundaries

Biocontrol Agent	Used to Control	Year Released	Released by
Seed head gall flies, *Urophora quadrifasciata and U. affinis,*	Knapweed	1989	NPS
Spotted knapweed seed head moth, *Metzneria paucipunctella*	Knapweed	1989	NPS
Broom seed weevils	Scotch broom	1999	Skagit County, Seattle City Light
Gall fly (*Urophora cardi*), Seed head stem boring weevil (*Ceutorhyncus litura*)	Canada thistle, bull thistle	Unknown	Unknown; (widespread)
Klamath weed beetle (*Chrysolina quadrigemina)*	St. Johnswort	Unknown	Unknown; (widespread)
Stem boring weevil (*Mecinus janthinus*)	Dalmatian toadflax, yellow toadflax	Unknown	Washington State Department of Agriculture; (widespread)
Gall mite (*Eriophyes chondrillae*)	Rush skeletonweed	Unknown	Unknown
Gall mite (*Aceria chondrillae*)	Rush skeletonweed	Unknown	Unknown

Chemical Control

The Park Complex is currently using seven herbicides to treat invasive plants on a limited basis. Application methods have included cut stump, basal bark, foliar spot, and foliar broadcast applications. The area treated using chemical methods has ranged from 25 to 100 gross infested acres each year, and has consisted of treatments along the SR 20 corridor, Skagit River knotweed, Ross Lake Reed Canarygrass, West Side gravel pits, and the Stehekin Airstrip. Herbicide use in and adjacent to riparian and wetland environments would continue to be limited to foliar spot applications of herbicides registered for use in aquatic environments to populations of knotweed along the Skagit River, and discrete populations of reed canarygrass along the shoreline of Ross Lake. Foliar treatment of remaining knotweed populations may result in minute amounts of dilute herbicide solution reaching the soil or surface waters during applications. Treatments along Ross Lake would be carried out in seasonally dry wetlands during the drawdown of the reservoir, when little or no surface water is present, and as a result there would be little opportunity to contaminate surface waters with herbicide applications. Some terrestrial applications along the SR 20 corridor would be conducted adjacent to the Skagit River, and within its floodplain. Additionally, spot applications conducted along other park roads may be made adjacent to small surface streams that intersect these roads.

Under this alternative herbicides would continue to be used at these sites to treat a limited number of species. A summary of herbicides currently used within the Park Complex is provided in Table 2-3.

Table 2-3. Herbicides Currently used within the Park Complex (Alternative 1)

Common Name	Trade Name(s)	Species Treated
Aminopyralid	Milestone	Canada and bull thistle, common tansy, hawkweed, herb Robert, knapweed, oxeye daisy, rush skeletonweed, Scotch broom, St. Johnswort, sulfur cinquefoil, white sweet-clover
2, 4-D	Weedar 64, Curtail	Herb Robert
Clopyralid	Curtail, Transline	Hawkweed, knapweed, rush skeletonweed, sulfur cinquefoil
Glyphosate	Roundup, Roundup Pro, Razor Pro, Rodeo, Glypro, Aquamaster	Herb Robert, knotweed, reed canarygrass
Imazapyr	Habitat, Polaris AQ	Knotweed
Sethoxidim	Poast	Non-native grasses
Triclopyr	Garlon 3A, Garlon 4	English holly, herb Robert, Scotch broom

In summary, the prioritization and control methods as described in this section would continue to be used under this alternative. Additional treatment information organized by project can be found in the next section.

Current Invasive Plant Projects

This section describes current invasive plant monitoring and control projects that have taken place since 2005 and would continue under Alternative 1. Only occasional manual removal of certain species along trails has occurred within designated wilderness; otherwise no other control projects have occurred within wilderness to date. Under this alternative these projects, and others similar in scope, would continue each year until maintenance control levels (a better than 90% reduction) can be reached. Many of the projects listed are ongoing and have already reached maintenance control levels. Significantly fewer follow-up treatments are now necessary to control remaining individual plants that sprout from the seed bank, from root fragments, or from previously undetected infestations.

Table 2-4 lists the current projects, the priority invasive species currently being treated or not treated, and the gross infested area of each project. Gross infested area can be defined as the outer perimeter of an infestation. It contains target species and the spaces between populations or individual plants. Therefore, the gross infested area of a project describes the furthest known extent of the infested area. Treatments generally would not be applied to the full gross infested area, but rather the fraction of the area containing individual plants or populations.

GROSS INFESTED AREA

The outer perimeter of an infestation, containing the target species as well as the spaces between populations or individual plants.

The projects are grouped into East Side (Stehekin) and West Side (Skagit). There are six projects that would be implemented in Stehekin, two of which would be limited to inventory only with no treatments occurring; and nine projects that would be implemented in the Skagit, one of which would limited to inventory only with no treatment occurring. Maps displaying project locations are found in Appendix H.

Table 2-4. Current Projects (Alternative 1)

Project Name	Priority Species Treated /Not Treated	Gross Infested Acres[1]
East Side - Stehekin Projects		
Airstrip, fairways, and other cleared areas	**Species treated:** Bull thistle, Canada thistle, Dalmatian toadflax, knapweed, rush skeletonweed, sulfur cinquefoil **Species not treated:** Cut leaf & Himalayan blackberry, oxeye daisy	57
Buckner Homestead Historic District	**Species treated:** Knapweed, rush skeletonweed **Species not treated:** Yellow toadflax	32
Company Creek gravel pit	**Species treated:** Knapweed **Species not treated:** Cheatgrass	6
Stehekin River & tributaries knotweed	**Species treated:** None-inventory and monitoring only **Species not treated:** Knotweed	456
Stehekin Valley cheatgrass	**Species treated:** None-inventory and monitoring only **Species not treated:** Cheatgrass	1,994
Stehekin Valley Scotch broom	**Species treated:** Scotch broom **Species not treated:** none	19
West Side - Skagit Projects		
Big Beaver Creek reed canarygrass	**Species treated:** None-inventory only **Species not treated:** Reed canarygrass	< 0.1
Gravel pits	**Species treated:** Common tansy, hawkweed, herb Robert, knapweed, oxeye daisy, white sweetclover **Species not treated:** none	6

Project Name	Priority Species Treated /Not Treated	Gross Infested Acres[1]
Hozomeen developed area	**Species treated:** Knapweed **Species not treated:** Oxeye daisy, St. Johnswort, white sweetclover	10
Marblemount Ranger Station	**Species treated:** Herb Robert, blackberry species **Species not treated:** Canada thistle, common tansy, English ivy, oak species, knotweed, oxeye daisy, periwinkle, reed canarygrass	4.5
Park-wide trails	**Species treated:** Common tansy, knapweed, oxeye daisy, St. Johnswort **Species not treated:** Reed canarygrass, yellow toadflax	8
Roads-SR 20 Corridor	**Species treated:** Absinth wormwood, common tansy, Dalmatian and yellow toadflax, evergreen (sweet)pea, hawkweed, herb Robert, knapweed, oxeye daisy, St. Johnswort, sulfur cinquefoil, white sweetclover **Species not treated:** none	56
Roads-Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads)	**Species treated:** Herb Robert **Species not treated:** Cheatgrass, common tansy, Himalayan blackberry, knapweed, Oxeye daisy, Scotch broom, St. Johnswort, white sweetclover	19
Ross Lake reed canarygrass	**Species treated:** Reed canarygrass **Species not treated:** none	150+
Skagit River knotweed	**Species treated:** Knotweed **Species not treated:** none	<10

[1] Gross infested acre estimates include the outer perimeter of an infestation.

EAST SIDE – STEHEKIN PROJECTS

Airstrip, Fairways, and Other Nearby Cleared Areas

This 57-acre site encompasses the airstrip and adjacent fairways. Scattered populations of diffuse and spotted knapweed, rush skeletonweed, sulfur cinquefoil (*Potentilla recta*), bull thistle (*Cirsium vulgare)*, Canada thistle (*Cirsium arvense*), Dalmatian toadflax, oxeye daisy, and Himalayan and cutleaf blackberry exist throughout these areas. Constant disturbance in these areas, such as vehicle and aircraft traffic, mowing, and helipad operations, has resulted in conditions that exacerbate the spread of existing species and has created a site where new invasive species are often first discovered. Aircraft as well as traffic from the nearby gravel pit serve as constant vectors of weed seed dispersal. Both Canada thistle and hops (*Humulus lupulus*) populations have increased substantially since a number of trees were removed in 2006 to improve landing and takeoff safety. Sulfur cinquefoil has increased in density and has expanded beyond the airstrip runway to the Stehekin River Trail.

In 1999 the Washington State Department of Transportation – Aviation Division, under agreement with NPS, began large-scale broadcast herbicide applications to reduce large populations of knapweed and rush skeletonweed. After three years the populations were reduced to levels that could be controlled by spot spraying and manual pulling. Since then, treatments in this area have consisted of a combination of manual/mechanical removal and foliar spot herbicide applications of bull and Canada thistle, toadflax, knapweed, rush skeletonweed, and sulfur cinquefoil; however, many of these infestations have increased in size and distribution, creating small monocultures once again. This is likely due to airstrip maintenance (early season mowing) that influences the growth of invasive species, reducing their visibility, and consequently, reduces the ability to control them by spot applications or mechanical removal later in the season. Under this alternative, manual and mechanical removal and spot applications would continue for the above-mentioned species, while oxeye daisy and the blackberry species would continue to be untreated.

Figure 2-3. Knapweed sprayed at the Stehekin Airstrip

Buckner Homestead Historic District

Within this 32-acre site, there is a densely concentrated, yet stable population of rush skeletonweed in the vicinity of the Stehekin River, with some individual plants also located amongst the orchard trees. Knapweed plants are interspersed sparsely throughout the orchard and pasture. In the last decade, a yellow toadflax (*Linaria vulgaris*) infestation has increased in density and expanded greatly throughout the orchard and into the administrative housing area nearby (Texas Twins). Treatments have primarily consisted of manual removal of knapweed and sporadic spot herbicide treatments for rush skeletonweed (outside the perimeter of the orchard). Additionally, mowing between the orchard trees has helped to reduce seed production of yellow toadflax; however it is still spreading through rhizomes throughout the orchard. Under this alternative control efforts would continue to focus only on manual removal of knapweed and occasional spot treatments of rush skeletonweed. No herbicide applications would occur within the orchard.

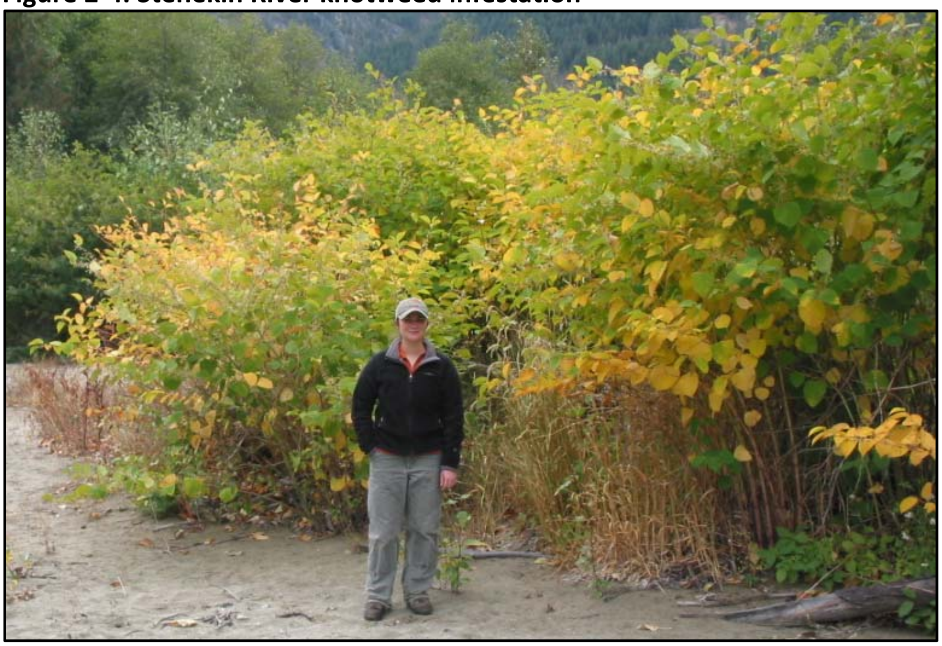
Company Creek Gravel Pit

In addition to the use of this 6-acre site as an active gravel pit (in accordance with the Sand, Rock and Gravel Plan (NPS 1995), it is also a staging area for gravel and rock materials that are imported to Stehekin from down-lake sources. The site has a small dispersed population of cheatgrass in the restored section (a revegetated area of the slope). Knapweed is often found sparsely distributed in the surrounding area, and has been manually removed on an annual basis. A species recently discovered at the site is Jerusalem oak (*Chenopodium botrys*); this species is currently the most common invasive plant at the site. Under this alternative manual removal of knapweed would continue. Cheatgrass and any new species discovered at the site which do not respond well to manual and mechanical removal would not be treated.

Stehekin River & Tributaries Knotweed

Scattered populations of Japanese knotweed ranging in density from single-stem plants to monocultures in excess of ½ acre occur from the mouth of the Stehekin River throughout its floodplain, islands, associated channels, and wetlands to a point approximately seven river miles upstream, below McGregor Meadows. A 2009 survey showed that the extent of the knotweed infestation had essentially doubled since it was first surveyed during 2004 and 2005, including a significant expansion in the floodplain near the confluence of Company Creek with the Stehekin River (see a map of this infestation in Appendix H). Although this infestation extends over more than 450 acres of floodplain (gross infested acreage), the actual surveyed canopy cover of known knotweed populations does not exceed 10 acres at this time. As mechanical treatments have been used on several sites without success, inventory and monitoring of this population would continue without additional treatments under this alternative. It is estimated that between seven and 10 percent of the knotweed infestation occurs on private property, and less than one percent occurs within designated wilderness near Weaver Point.

Figure 2-4. Stehekin River knotweed infestation



Stehekin Valley Cheatgrass

Cheatgrass populations throughout the lower valley have steadily increased over the years. Its introduction is attributed to human activities such as stock use, whereas its proliferation is primarily in association with wildfires and prescribed burns. Most populations on the valley floor are patchy and have grown slowly in size and density. However, in 2006 the Flick Creek fire burned almost 8,000 acres along south-facing slopes above Lake Chelan, and the populations burned within the fire perimeter have seen a tremendous increase in both density and area of lands infested since 2006. The species occupies all types of terrain, from very steep hillsides and rocky outcroppings to the valley floor. Infestations above the valley floor occur within designated wilderness.

In the summer of 2010, the Rainbow Bridge Fire burned over 3,600 acres from its ignition point near Rainbow Bridge Camp, across the Boulder Creek drainage, and into areas previously burned during the Flick Creek Fire. Several areas of the fire, including 204 acres of the Upper Rainbow Prescribed Contour Burn Unit were surveyed for the presence of cheatgrass in 2006. During these surveys populations of cheatgrass totaling 11.3 infested acres were identified within the boundary of the prescribed burn unit and approximately half of these populations now fall within moderate to high severity burn areas of the Rainbow Bridge Fire. An additional 280 acres of moderate to high severity burned areas along the Boulder Creek Trail adjacent to the burn unit has not been surveyed for cheatgrass, however, there is a high probability that a number of populations existed in this area prior to the Rainbow Bridge Fire. Based on existing research, and monitoring of cheatgrass populations burned during the Flick Creek Fire of 2006, increases in cheatgrass population size and density of up to 100 percent can be expected to occur in moderate to severe areas of burn intensity within one year of the fire. Additionally, a number of factors observed during field assessment of the Rainbow Bridge Fire may contribute to optimal conditions for cheatgrass expansion especially on the benches and moderate slopes along the upper portion of the Rainbow Loop and Boulder Creek trails. Should cheatgrass become widespread within areas of the Rainbow Creek Fire, there is a high probability that its presence and expansion could shorten the interval between fire cycles, resulting in frequent, low intensity fires which would prevent native vegetation from successfully re-establishing after this event. Under this alternative, inventory and monitoring of cheatgrass would continue, but treatment would not occur.

Stehekin Valley Scotch Broom

Scotch broom infestations in the Stehekin Valley are usually associated with previous or existing development (for example at the Texas Twins, Skinny Wilson's, the new school, and private property). The populations are generally small and concentrated. There is one large, dense infestation along the lakeshore trail consisting of approximately five acres that is established on a combination of private and public land. Treatments have consisted of manual and mechanical control, and have resulted in a decline in abundance of the species. Under this alternative control efforts would continue to consist of repeated manual and mechanical treatments.

WEST SIDE – SKAGIT PROJECTS

Big Beaver Creek Reed Canarygrass

This population is presumed to have established from seed carried from infestations of reed canarygrass present in the areas near campsites and associated trails around the mouth of Big Beaver Creek. A recent survey of the ponds and wetlands of the Big Beaver drainage located one small population of reed canarygrass less than a square meter in size; however, the density of native vegetation may have obscured the discovery of additional populations. The known infestation occurs within Potential Wilderness. Under this alternative, additional surveys would be conducted to determine the extent of the infestation and to determine the feasibility of control, but no treatment would be undertaken.

Gravel Pits

Both the Newhalem and Goodell gravel pits (totaling 6 acres) currently serve as significant sources of weed seed and vegetative material. Constant movement of material in and out of these pits and other areas used for storage of fill, in addition to equipment imported from outside the park to crush, sort, and deliver gravel, are continuous vectors for the establishment of invasive species. Common species include common tansy, hawkweed, herb Robert, knapweed, oxeye daisy, and white sweetclover (*Melilotus alba*). Gravel pits have received a foliar broadcast treatment using a non-selective herbicide in order to remove all vegetation present within the immediate area of pit operations in conjunction with major projects involving storage and movement of gravel. These activities would continue under this alternative.

Hozomeen Developed Area

The Hozomeen developed area includes campgrounds, a road system, NPS buildings, and administrative sites. Throughout the developed area there are sparse infestations of several weed species, including knapweed, St. Johnswort, white sweetclover, and oxeye daisy. Various other weed species are also found in lower abundance. Manual removal of knapweed species has occurred sporadically and would continue under this alternative.

Marblemount Ranger Station

The Marblemount administrative compound consists of eleven housing units and a number of administrative offices and structures, many of which are part of the Marblemount Ranger Station Historic District. Also located on the compound is a native plant nursery, stock pasture, and associated outdoor storage. Non-native vegetation at the compound was mapped and quantified during the summer of 2009. It was found that invasive species are distributed throughout approximately 4.5 acres of the compound, and they include Himalayan and cutleaf blackberry, Canada thistle, herb Robert, English ivy, common tansy, periwinkle, knotweed, reed canarygrass, oxeye daisy and non-native oaks. Herb Robert, periwinkle, and the blackberries account for the largest acreage. Northern red oaks (*Quercus rubra*) were planted on the compound between 1915 and 1943 and are contributing elements to the Historic District. The oaks have spread from their historic footprint and are now found on lands adjacent to the compound. Sporadic manual removal of herb Robert and mechanical removal of blackberry throughout the compound are activities that would continue under this alternative. The remaining species would continue to be untreated.

Park-wide Trails

The Park Complex contains over 350 miles of trails, over half of which is accessible to stock animals, including the park's own pack string. While the trail system is a primary pathway for introducing new invasive, non-native plants into the Park Complex and designated wilderness, it remains relatively uninfested. Invasive plant surveys of the trail system occur sporadically and have documented approximately 40 species. A recent survey of the trail system indicated that about eight acres are infested with invasive plants. Occasional manual control has been used to remove individual species found along trails. Under this alternative occasional survey and manual removal would continue for species such as common tansy, knapweed, oxeye daisy, St. Johnswort, and any of the other species which may respond to manual control.

Roads - SR 20 Corridor

State Route 20 has a long history of invasive plant problems that have primarily been treated using manual and mechanical efforts, and more recently with chemical applications. Dominant species include common tansy, hawkweed, knapweed, herb Robert, oxeye daisy, St. Johnswort, sulfur cinquefoil, and white sweetclover, while species that occur more sporadically include absinth wormwood, toadflax species, and evergreen (sweet) pea (*Lathyrus latifolius*). Manual and mechanical control efforts have concentrated on knapweed, Scotch broom, and some isolated populations of herb Robert that occur in the campgrounds. Annual volunteer weed pulls to remove knapweed have taken place regularly for over a decade. In 2007 the EPMT made a concentrated effort to implement chemical treatment methods along the highway corridor to control a number of other species for which manual control was ineffective. Dense infestations of St. Johnswort, white sweetclover, meadow hawkweed, oxeye daisy, sulfur cinquefoil, and diffuse knapweed (*Centaurea diffusa*) were treated with herbicide between the eastern NPS boundary and Colonial Creek Campground, while at the western boundary large monocultures of herb Robert and outlying populations of meadow hawkweed were treated. Newly emerging populations of white sweetclover between Newhalem and Colonial Creek Campground have also been treated, and backpack and ATV-mounted sprayers were used to selectively treat meadow hawkweed near Goodell Creek Campground. Under this alternative, treatment of these species using the methods described above would continue.

Figure 2-5. Roadside spot spraying

Roads - Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads)

A number of other park roads consisting of approximately 19 miles are utilized for trail access, administrative purposes (either NPS or Seattle City Light), or are part of the transmission line corridor. The upper one mile of the Thornton Lakes Road is within designated wilderness (this section will be closed and rehabilitated). Scattered weed populations exist along these road corridors, consisting primarily of white sweetclover, herb Robert, cheatgrass, knapweed, oxeye daisy, common tansy, Scotch broom, blackberry species, and St. Johnswort. Herb Robert is the only species that has been treated on a regular basis. Under this alternative, treatment of herb Robert would continue to consist of a combination of manual and mechanical removal and herbicide spot treatments.

Ross Lake Reed Canarygrass

Reed canarygrass populations on Ross Lake are primarily confined to seasonally dry wetlands that were formed as a result of the building of Ross Dam and consequent flooding of the Upper Skagit Valley. The plant also exists in small bays and other protected areas along the shoreline, primarily in areas where wind or wave action accumulates detritus from the lake. A survey performed in 2003 identified approximately 50 acres of reed canarygrass in such locations spread around the lake. Additionally, a population exceeding 100 acres exists at the head of the lake, most of which occurs across the border in British Columbia, Canada. Work has focused on the chemical control of reed canarygrass in seasonally dry wetlands near the Dry Creek, Little Beaver, and Ponderosa campgrounds using foliar spot and broadcast herbicide treatments during reservoir drawdown in the spring. While pilot projects have been successful at controlling this invader, the large infestation along the lake's northern end, where it extends into Canada, still needs to be addressed. Under this alternative, treatments of reed canarygrass near the campgrounds described above would continue, and they would occur during reservoir drawdown in the spring.

Skagit River Knotweed
Small populations of Japanese knotweed totaling less than ten acres exist along the Skagit River, from the base of Gorge Dam to the park boundary near the Copper Creek boat launch. These populations have been repeatedly treated with spot herbicide applications in conjunction with ongoing efforts by Seattle City Light and The Nature Conservancy of Washington, and brought to a level of maintenance control. Persistent re-growth from the rhizomes of previously treated populations requires that the park continue to implement an annual survey of known knotweed populations, and work to prevent the establishment of new populations from vegetative reproduction of existing populations. Under this alternative, annual re-treatment of known populations would continue in order to provide maintenance control of this species.

Restoration

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to develop an effective restoration program.

Outreach, Education, and Cooperation

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to achieve the goal of outreach, education, and cooperation.

2.5 Alternative 2 – Integrated Pest Management with Herbicides (Preferred Alternative)

Under Alternative 2 the NPS would use an IPM approach that includes select use of certain herbicides in order to implement a well-balanced invasive plant management program. Compared to Alternative 1, there would be an increase in the number of species that would be treated, the number of projects that would be undertaken, and the type and quantity of herbicides that could be used for treatment projects. A new prioritization technique would also be implemented to better identify species that pose the greatest risk to park resources.

Prevention and Early Detection

See "Elements Common to All Alternatives," which describes the measures that the Park Complex would implement to achieve the goal of prevention and early detection.

Inventorying and Monitoring

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to establish an effective inventory and monitor program.

Prioritization and Control

See "Elements Common to All Alternatives" for a description of some basic prioritization and control actions that are common to all alternatives. The difference between prioritization and control actions in this alternative and those described in Alternative 1 is in the way in which species are prioritized as well as the frequency with which some of the control methods are used. Under this alternative a new prioritization technique is proposed, which is described below.

In order to implement a successful control strategy, there must be a clear set of priorities based on known conditions on the ground. To address this concern, resource managers developed a Decision-making Tool (Appendix B) to determine priorities for invasive plant control. Action thresholds were used to determine when treatment strategies should be implemented. Action thresholds are met if an invasive species:

- Alters ecosystem processes.
- Outcompetes native species.
- Does not outcompete natives, but:
  - Prevents recruitment/regeneration,
  - Reduces/eliminates resources, or
  - Provides resources to non-native animals.
- May overtake or exclude native species following disturbance.
- Is listed as required to control on a state, county or federal noxious weed list.
- Infestation occurs in high quality/high value habitat or resource areas, including designated wilderness.

Using the tool, 40 of the 225 non-native species documented within the Park Complex have been identified as current management priorities and grouped into first, second, and third priority based on their abundance, distribution, and difficulty of control. Eighteen species are currently a high, or first, priority for control, while 17 species are second priority, five species are third priority, and the remaining 185 species are last priority. The species that are last on the priority list generally would not be treated; however, they may be treated opportunistically if they occur among infestations of other priority species. The priority list is dynamic and would be used to focus treatment efforts under this alternative. As new species are found within the Park Complex or as more is learned about existing species and infestations, the priority list will change. The current list of species receiving first through third priority ranking is found in Table 2-5. The entire list of non-native species currently known to occur within the Park Complex is found in Appendix A.

Table 2-5. Priority Species Ranked using the Decision Tool (Alternative 2)

Species	Washington State Weed Board Listing
First Priority	
Absinth wormwood *Artemisia absinthium*	Class C
Black locust *Robinia pseudo-acacia*	No rating
Bristly locust *Robinia hispida*	No rating
Butterfly bush *Buddleja davidii*	Class B
Butternut *Juglans cinerea*	No rating
Common mullein *Verbascum thapsus*	No rating

Species	**Washington State Weed Board Listing**
Dalmatian toadflax *Linaria dalmatica*	Class B
Eggleaf spurge *Euphorbia oblongata*	Class A
English holly *Ilex aquafolium*	No rating
English ivy *Hedera helix*	Class C
Evergreen (sweet)pea *Lathyrus latifolius*	No rating
Myrtle spurge *Euphorbia myrsinites*	Class B
Oak species *Quercus spp.*	No rating
Poison hemlock *Conium maculatum*	Class B
Sulfur cinquefoil *Potentilla recta*	Class B
Tansy ragwort *Senecio jacobaea*	Class B
Yellow toadflax (butter-and-eggs) *Linaria vulgaris*	Class C
Traveler's joy *Clematis vitalba*	Class C
Second Priority	
Bull thistle *Cirsium vulgare*	Class C
Canada thistle *Cirsium arvense*	Class C
Cutleaf (evergreen) blackberry *Rubus laciniatus*	Class C
Hawkweed species (meadow, mouse-ear, & yellow) *Hieracium spp.*	Class A (meadow) Class B (mouse-ear, & yellow)
Herb Robert *Geranium robertianum*	Class B
Himalayan blackberry *Rubus discolor*	Class C
Knapweed species (diffuse & spotted) *Centaurea spp.*	Class B

Species	Washington State Weed Board Listing
Knotweed species (Bohemian, giant, & Japanese) *Polygonum spp.*	Class B
Reed canarygrass *Phalaris arundinaceae*	Class C
Rush skeletonweed *Chondrilla juncea*	Class B
Scotch broom *Cytisus scoparius*	Class B
White sweetclover *Melilotus alba*	No rating
Third Priority	
Cheatgrass *Bromus tectorum*	No rating
Common tansy *Tanacetum vulgare*	Class C
Oxeye daisy *Leucanthemum vulgare*	Class B
Periwinkle *Vinca major*	No rating
St. Johnswort *Hypericum perforatum*	Class C

The following is a summary of the types and extent of treatments that would be used under this alternative. Specific projects that would implement any of these treatment methods are described in Section 2.4.7 under Proposed Invasive Plant Projects.

Cultural Control

Under the Preferred Alternative, cultural practices would be used more often and on a more regular basis, often as a preventative method. Areas that are disturbed by human actions would be reseeded and/or planted as soon as possible to facilitate the reestablishment of native plants. Areas disturbed by natural phenomena such as fire, landslide, or flooding would be evaluated for their potential for invasion by non-native plants, and areas deemed to be threatened by invasion could be seeded as a preventative measure. Restoration may be necessary in dense invasive plant infestation areas that no longer support native species, where invasive species have altered the site (via alleopathy or very dense leaf litter) to the point that native species would be unable to re-establish, or where native species adjacent to the site are not in sufficient quantities to revegetate the site. Following treatment and removal of invasive plants, these areas would be reseeded or planted using native plant materials. Any materials used in revegetation (including mulch and organic fertilizers) would be free of non-native plant seeds or materials. In addition, locally grown, native plant materials would be used where possible. All plant materials used would be “certified weed-free.”

Manual and Mechanical Control
Under the Preferred Alternative, manual and mechanical treatments would continue to take place, and while similar to those mechanical treatments described in Alternative 1, there would likely be a reduction in the annual number of acres treated using these techniques (less than 150 gross infested acres). This reduction would be due to herbicides being used in place of or in conjunction with projects historically carried out using manual or mechanical treatments to increase treatment efficacy. Herbicide use would also replace mechanical treatments on projects where target species and populations have not responded to repeated mechanical treatments.

Biological Control
Although a number of biocontrol agents currently exist within park boundaries, no new biocontrol treatments are proposed at this time under the Preferred Alternative. However, should an approved biocontrol agent be identified as an effective treatment for an invasive plant species within the Park Complex, the agent could be released if it already has been approved for release in Washington State. If not approved for release in Washington State, the Park Complex would seek public input in addition to meeting the permitting requirements described in Section 1.8.

Chemical Control
Five additional herbicides could be used under this alternative, listed in Table 2-6. The same types of herbicides as those described in Alternative 1 would be used, however, additional herbicides could be added if a risk assessment has been conducted for the active ingredient, and the use of the herbicide is consistent with actions discussed in this document. Herbicide treatments would include the same application methods that are currently used in Alternative 1: cut stump, basal bark, foliar spot, and foliar broadcast applications. The number of herbicide treatments would increase from current levels because several species that haven't been treated due to either their large extent or unresponsiveness to other control methods would be targeted under this alternative. Depending on which projects are undertaken each year, the area treated with herbicides will vary, and could range from 600 to 2,000 gross infested acres per year. The upper limit (2,000 acres) is based on the size of the largest project area, which is the Stehekin Cheatgrass project.

Herbicide use in and adjacent to riparian and wetland environments would be expanded under this alternative. Foliar spot treatments of knotweed populations would be implemented along the Stehekin River and within its floodplain as well as spot treatments of other species that have been unresponsive to hand pulling. The park would continue spot herbicide applications of Japanese knotweed along the Skagit River, and also begin foliar applications to treat a number of weed species present in the floodplain of the Skagit River. Foliar spot and broadcast herbicide applications would be increased to treat reed canarygrass populations around the shoreline of Ross Lake, including at the mouths of several tributaries, and within the permanent wetlands associated with the Big Beaver drainage. More consistent herbicide treatments of terrestrial weed populations would be made along the SR 20 corridor in close proximity to the Skagit River, and near small tributaries which cross the road prism. Best Management Practices designed to minimize the impacts of herbicides are found in Appendix E.

To understand the amount of herbicide that would be applied to a gross infested area, the following example is used: Japanese knotweed exists across 456 gross infested acres along the Stehekin River; however, the canopy coverage of the infestation is estimated to be less than 10 acres, with most populations covering a 25 square foot area, and the largest infestation exists on less than ½ acre. Using backpack sprayers and an application rate of 25 gallons of water (i.e., carrier) per acre mixed with 1% herbicide (imazapyr), this translates to roughly 1 quart of herbicide for every 25 gallons of water that is applied. To put this into perspective, treating a 25 square foot area of knotweed may require up to 1.5 pints (or 20 ounces) of formulated solution (herbicide mixed with water). The fraction of this solution that would actually consist of herbicide would be equivalent to approximately 0.2 ounces. In an application covering a continuous ½ acre, approximately 16 ounces of herbicide would be applied.

See the Proposed Invasive Plant Projects Section below for the projects that would include the use of herbicides.

Table 2-6. Additional Herbicides that could be used within the Park Complex (Alternative 2)

Common Name	Trade Name(s)	Potential Species Treated
Chlorsulfuron	Telar	Toadflax, St. Johnswort, sulfur cinquefoil
Fluroxpyr	Vista	St. Johnswort
Imazapic	Plateau	Cheatgrass
Metsulfuron-methyl	Escort	Common tansy, oxeye daisy, St. Johnswort, sulfur cinquefoil
Rimsulfuron	Matrix	Cheatgrass

Proposed Invasive Plant Projects

This section describes proposed invasive plant monitoring and control projects that would be implemented under Alternative 2. In addition to the priority species list (Table 2-5), which prioritizes species based on their park-wide status, a project list was formulated by applying the decision-making tool criteria to distinct populations of these species. Resource managers considered the density and distribution of a particular invasive species population, the risk and impacts posed by each population to park resources, and the feasibility of control or eradication in developing the project list. This process helped to refine projects and focus management efforts where they are most needed. Consequently, a number of high priority species are not currently included in specific proposed projects due to their low abundance, limited distribution, and the limited resources required to manage them. In other words, removal of a small population or single invasive plant that is ranked first priority is not defined in a project, even though it will be considered the highest priority for treatment. Conversely, many of the second and third ranked priority species have large enough populations that they require significant resources, planning, and personnel, and merit discussion as specific projects to identify these needs.

Under this alternative these projects, and others similar in scope, would continue each year until maintenance control levels can be reached. It is expected that most new projects would require two to three years of initial control work in order to establish maintenance control levels (a better than 90% reduction) of invasive species, with significantly fewer follow-up treatments to control remaining individual plants that sprout from the seed bank, from root fragments, or from previously undetected infestations. The amount of herbicides and mechanical work that would be needed for subsequent treatments would be significantly reduced after the initial control work is completed. Project success would be evaluated during an annual planning process and results would be used to adapt and modify management goals as necessary.

Seven projects would take place within designated wilderness: Stehekin Valley Cheatgrass, Stehekin Knotweed, Big Beaver Creek Reed Canarygrass, Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lake Road, and Park-wide Trails. Table 2-7 lists the proposed projects, the priority invasive species at each site (all of which would be treated under this alternative), and the gross infested area of each project. Using data that is current as of 2009, there are 25 proposed invasive plant projects of various sizes that are described in this alternative, 12 of which would be implemented in Stehekin, and 13 of which would be implemented in the Skagit. Maps displaying project locations are found in Appendix H.

Although this listing contains current information on infestations, managers realize that over time new species will move in and infestations will change. Control of new species and new infestations may take priority over other treatments. Methods used to control new species or new infestations would be based on the ecology of the species and the most current research on effective control methods.

Table 2-7. Proposed Projects (Alternative 2)

Project Name	Priority Invasive Species (all would be treated)	Gross Infested Acres[1]
East Side - Stehekin Projects		
Airstrip, fairways, and other cleared areas	Bull and Canada thistle, cutleaf and Himalayan blackberry, Dalmatian toadflax, knapweed, oxeye daisy, rush skeletonweed, sulfur cinquefoil	57
Airstrip wetland and beaver ponds	Canada thistle, reed canarygrass	1
Buckner Homestead Historic District	Knapweed, rush skeletonweed, yellow toadflax	32
Company Creek gravel pit	Cheatgrass, knapweed	6
Lake Chelan reed canarygrass	Reed canarygrass	7
Mill Pond and maintenance yard	Bull thistle, evergreen (sweet)pea, Himalayan blackberry, knotweed, oxeye daisy, reed canarygrass, sulfur cinquefoil	10
Riparian weeds (excluding knotweed)	Bull and Canada thistle, knapweed, rush skeletonweed, Scotch broom, yellow toadflax	50
Stehekin Landing	Black locust, cheatgrass, evergreen (sweet)pea, Himalayan blackberry, knapweed, yellow toadflax	10
Stehekin River & tributaries knotweed	Knotweed	456
Stehekin Valley cheatgrass	Cheatgrass	1,994
Stehekin Valley road improvements	Unknown	12
Stehekin Valley Scotch broom	Scotch broom	19
West Side - Skagit Projects		
Big Beaver Creek reed canarygrass	Reed canarygrass	< 0.1
Gravel pits	Common tansy, hawkweed, herb Robert, knapweed, oxeye daisy, white sweetclover	6
Hozomeen developed area	Knapweed, oxeye daisy, St. Johnswort, white sweetclover	10
Marblemount Ranger Station	Canada thistle, common tansy, cutleaf and Himalayan blackberry, English ivy, oak species, herb Robert, knotweed, oxeye daisy, periwinkle, reed canarygrass	4.5

Project Name	Priority Invasive Species (all would be treated)	Gross Infested Acres[1]
Park-wide trails	Common tansy, knapweed, oxeye daisy, reed canarygrass, St. Johnswort, yellow toadflax	8
Ridley Lake reed canarygrass	Reed canarygrass	0.1
Roads-Cascade River Road	Herb Robert, oxeye daisy, Scotch broom, St. Johnswort, white sweetclover	10
Roads-SR 20 Corridor	Absinth wormwood, common tansy, Dalmatian and yellow toadflax, evergreen (sweet)pea, hawkweed, herb Robert, knapweed, oxeye daisy, St. Johnswort, sulfur cinquefoil, white sweetclover	56
Roads-Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads)	Cheatgrass, common tansy, herb Robert, Himalayan blackberry, knapweed, oxeye daisy, Scotch broom, St. Johnswort, white sweetclover	19
Ross Lake reed canarygrass	Reed canarygrass	150+
Ruby pasture	Canada thistle, bull thistle	5
Skagit River knotweed	Knotweed	<10
Skagit River other weeds	Bull and Canada thistle, cheatgrass, cutleaf and Himalayan blackberry, English holly, English Ivy, herb Robert, oxeye daisy, periwinkle, Scotch broom, traveler's joy, white sweetclover	170
[1] Gross infested acre estimates include the outer perimeter of an infestation.		

EAST SIDE – STEHEKIN PROJECTS

Airstrip, fairways, and Other Nearby Cleared Areas

This project would remain the same as described in Alternative 1, except treatments would expand to include all invasive species present (see Table 2-7) and foliar broadcast herbicide applications would be used to control infestations that have grown since broadcast spraying was discontinued in 2001.

Airstrip Wetland and Beaver Ponds

This one-acre wetland site is associated with a side channel of the Stehekin River and has both open water and seasonally saturated soils. Reed canarygrass is distributed in patches on the edges of the beaver ponds and is interspersed with native sedges and red osier dogwood. Canada thistle occupies the saturated soils throughout the wetland. Foliar spot herbicide treatments would be conducted to reduce these populations.

Buckner Homestead Historic District

Manual removal of knapweed and spot herbicide treatments of rush skeletonweed outside the orchard perimeter would continue as described in Alternative 1. Additionally, herbicide spot and broadcast applications would be made outside the orchard in order to contain populations of yellow toadflax. Mowing between orchard trees would be timed to reduce seed production of yellow toadflax within the orchard. No herbicide applications would occur within the orchard.

Company Creek Gravel Pit
Manual treatments as described in Alternative 1 would be augmented to include foliar spot herbicide applications using a non-selective herbicide in order to remove all invasive, non-native plants present within the immediate area of pit operations. Spot applications of selective herbicides would be used to control cheatgrass within the restored area of the pit.

Lake Chelan Reed Canarygrass
Reed canarygrass is most prevalent at the head of Lake Chelan where it dominates a seven-acre section of the lake characterized by seasonal inundation during full pool. Sparse populations of this species also inhabit other seasonally inundated areas in the lower valley. In accordance with the Lake Chelan Settlement Agreement (PUD 2003), which was approved in 2003 for the Lake Chelan Hydroelectric Project (FERC Project No. 637), this area is funded for wildlife habitat enhancement. The reed canarygrass would be controlled using various methods including mechanical removal with heavy equipment, use of shade cloth, and limited herbicide use. After removal, native species would be planted to replace reed canarygrass stands and provide a basis for native plant spread. The restoration plan developed for this project can be found in Appendix F.

Mill Pond and Maintenance Yard
This 10-acre site has both wetland and upland components. The majority of invasive species are found in the wetland area. The mill pond is heavily infested with knotweed and Himalayan blackberry along the banks surrounding open water. Reed canarygrass is interspersed in areas seasonally inundated. Evergreen (sweet) pea, bull thistle, oxeye daisy, and sulfur cinquefoil are found in the drier upland areas around the existing maintenance buildings. Treatments would include mechanical removal and herbicide spot treatment.

Riparian Weeds (excluding knotweed)
Scattered along the Stehekin River corridor and surrounding tributaries, there are relatively small, often isolated infestations of invasive species. These populations have spread by the movement of seed or plant material due to flooding. Rush skeletonweed and knapweed have been found on some of the islands in both dense and sparse populations, along with small populations of bull thistle, Canada thistle, yellow toadflax, Scotch broom, and comfrey (*Symphytum officinale*). Treatments would include manual removal and herbicide spot treatment of all priority invasive species.

Stehekin Landing
This 10-acre site includes the Golden West Historic District at the Stehekin Landing (Golden West Visitor Center and various historic cabins) and the surrounding areas including the Purple Point Overflow Campground, Purple Point Stock Camp, and the Imus, Purple Pass, and Lakeshore trailheads. Many infestations are small, isolated or patchy populations that include Himalayan blackberry, black locust (*Robinia pseudo-acacia)*, yellow toadflax, foxglove, evergreen (sweet) pea, and spotted and diffuse knapweed. Species such as cheatgrass, bulbous bluegrass (*Poa bulbosa*) and prickly lettuce (*Lactuca serriola)* are ubiquitous throughout the area. All invasive species at this site would be treated using mechanical removal and herbicide spot treatments.

Stehekin River & Tributaries Knotweed
In addition to inventory and monitoring as described in Alternative 1, treatment of knotweed would occur under this alternative, and would require foliar spot herbicide applications over a minimum of three years to bring this population under maintenance control. It is anticipated that follow-up treatments of a greatly reduced scale would be required on a biennial basis (every two years) to detect new popula-

tions resulting from flood events and to retreat sprouts from dormant plants. In order for knotweed treatments to be effective throughout the watershed, the seven to 10 percent of the population located on private property should also be treated, and has been considered as part of the environmental analysis in this document. The NPS would work with the Chelan County Noxious Weed Board and private landowners to establish a mutually acceptable agreement for ensuring that populations on private lands can be controlled.

Stehekin Valley Cheatgrass

Detection surveys within the Rainbow Bridge fire perimeter would be conducted as described in Alternative 1. Additionally, as funding permits, experimental spot herbicide treatments would begin as part of an ongoing effort to determine the most successful treatment for different land cover types. Several research plots would be installed in prescribed burn units on the valley floor, as well as within the boundary of the Flick Creek and Rainbow Bridge fires. Rapid response survey followed by spot herbicide treatments applied by backpack sprayers would be carried out in areas of the Rainbow Bridge Fire in an effort to curtail spread and expansion of cheatgrass like that which occurred after the Flick Creek fire. Additional cheatgrass populations located throughout the valley would also be treated with spot herbicide applications in the future as time and funding allow. Herbicide applications would be a mix of selective and non-selective products based on the local vegetation community, the timing of applications, and the success of experimental treatments.

Depending on the level of infestation encountered during initial surveys of the Rainbow Bridge Fire, stock support or a helicopter may be necessary to deliver supplies, equipment, and water to the treatment area. Additionally, the sporadic use of a motorized pump and hose-lay may be necessary to provide water needed to conduct herbicide applications. Given current estimates of the infestation, it is expected that a battery-operated water pump will be sufficient to provide water for treatments; however, should cheatgrass recruitment exceed expectations, it may be necessary to transport water with a gas-powered water pump, stock, or helicopter. Refer to Appendix C for a Minimum Requirements Analysis that analyzes the impacts of herbicides, helicopters, and motorized equipment use in wilderness.

Stehekin Valley Road Improvements

As part of the Preferred Alternative for the Draft Stehekin River Corridor Implementation Plan/EIS, a 1.89 mile section of the Stehekin Valley Road is proposed to be rerouted out of the channel migration zone, and the Stehekin Valley Road would be paved using asphalt chip seal. The abandoned section of road and all areas of ground disturbance associated with road construction (approximately 12 acres) would be revegetated using seed collected on site from native species. Conservation measures to prevent the introduction or spread of invasive weed species would be implemented throughout the project. Those measures include requiring all equipment and vehicles be power washed prior to barging up lake, using only certified weed free erosion materials, inspecting down lake sources of gravel, mitigating potential weed issues prior to barging up lake, and treating invasive plant species in staging areas before construction begins. In addition, inventory and treatment of invasive plant species would be done for a minimum of three years following road construction. The proposed reroute is currently clear of invasive weeds; however, the potential for invasion is possible as a result of large areas of ground disturbance and the use of imported fill and machinery.

Stehekin Valley Scotch Broom

Mechanical treatments as described in Alternative 1 would be augmented to include cut-stump herbicide treatments that would be used in situations where plants cannot be mechanically removed (e.g., where roots are buried in rocks or boulders and cannot be extracted) or where ground disturbance would result in resource damage.

WEST SIDE – SKAGIT PROJECTS

Big Beaver Creek Reed Canarygrass
Surveys as described in Alternative 1 would continue. Additionally, populations of reed canarygrass would be eradicated through foliar spot herbicide treatments over a two to three year period.

Gravel Pits
This project would remain the same as described in Alternative 1, with the exception that foliar broadcast treatments would occur biannually (spring and fall).

Hozomeen Developed Area
In addition to the manual control efforts for knapweed described in Alternative 1, a combination of manual control and herbicide spot treatments would be used to treat all invasive species present.

Marblemount Ranger Station
Instead of the sporadic herb Robert and blackberry removal that is described in Alternative 1, this alternative would control all priority invasive species with a combination of mechanical removal and herbicide spot treatments. Since the oak trees are contributing elements of the Historic District, they would be maintained within their historic planting footprint. At this time there are no plans to treat oaks that have spread to adjacent lands.

Park-wide Trails
Occasional surveys and manual treatments as described in Alternative 1 would continue, and would be augmented by the use of herbicide spot treatments for species for which manual control is ineffective.

Ridley Lake Reed Canarygrass
Ridley Lake is located over three miles from Hozomeen within designated wilderness. There is no constructed trail to the lake from the Hozomeen Lake Trail; rather it is accessed by an informal “fisherman’s” trail. The lake supports a sedge species that the Washington State Natural Heritage program considers to be sensitive, and it also has a small population of reed canarygrass. This project is a priority due to the threat of reed canarygrass to a State listed species and because it is a small remote population. Herbicide spot treatments would be utilized to control the reed canarygrass.

Roads - Cascade River Road
The final five miles of the Cascade River Road from the park boundary to the end of the road is host to several invasive species, with infestations currently covering approximately 10 acres. Dominant species include herb Robert, oxeye daisy, St. Johnswort, white sweetclover, and Scotch broom; all of these are species that the park has been unable to control in the past through repeated hand pulling, and consequently treatments were discontinued in 2009. Under this alternative, annual surveys and herbicide treatments of problem infestations would take place in order to establish maintenance control levels of known populations, and to detect the introduction of new invasive species. Treatments would generally extend no more than ten feet from the road prism; however, in several cases, established populations have begun to escape down steep talus slopes toward the north fork of the Cascade River drainage. Treatments would consist of combinations of foliar spot and broadcast treatments, applied by backpack, ATV-mounted boom-less sprayers, or truck-mounted tank sprayers.

Roads - SR 20 Corridor
This project would remain the same as described as Alternative 1 except treatments would be expanded to consist of annual treatments by a combination of foliar spot and broadcast treatments applied by backpack, ATV-mounted boomless sprayers, or truck-mounted tank sprayers. Limited hand pulling may occur, especially in difficult to reach areas.

Roads - Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads
Under this alternative, all priority species would be treated using manual removal and spot herbicide applications, and treatments would be timed in conjunction with road maintenance and improvement activities.

Ross Lake Reed Canarygrass
This project would remain the same as described in Alternative 1, except that treatments would be expanded to include infestations that exist along the entire lakeshore (excluding Canada). The NPS would explore options for treatment of the infestation within Canada with BC Parks. If an agreement should be reached with BC parks, the NPS would consider the use of ATV-mounted sprayers to treat populations at the head of the lake.

Ruby Pasture
In the early 1940s, the US Forest Service Ruby Guard Station and associated stock grazing area were inundated by the creation of Ross Lake. Ruby Pasture was subsequently created by Seattle City Light to provide a replacement grazing area for stock animals. The area was cleared and planted in grass and orchard trees, and supported Forest Service stock until 1968. It is now used as a backcountry stock camp within designated wilderness that measures approximately five acres in size and consists of a mosaic of native and non-native plants. Canada thistle is the most common species while bull thistle is in lower abundance. The pasture would be treated with selective broadcast herbicide to reduce the incidence of the invasive species and replanted with beneficial native plants.

Skagit River Knotweed
This project would remain the same as described in Alternative 1.

Skagit River Other Weeds
A number of other small invasive plant populations exist on islands or in low lying areas along the stretch of the Skagit River between the base of Gorge Dam, and the park's western boundary near Bacon Creek. This includes small populations of cutleaf and Himalayan blackberry, bull and Canada thistle, cheatgrass, English Holly (*Ilex aquafolium*), English Ivy (*Hedera helix*), herb Robert, oxeye daisy, periwinkle, Scotch broom, traveler's joy, and white sweetclover. The extent of these populations is not completely known, but the NPS estimates approximately 25 percent of the Skagit River floodplain, or 170 gross acres, are infested. Treatments would consist primarily of foliar spot herbicide applications, as well as a combination of cut stump and mechanical removal for woody species and vines.

Restoration

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to develop an effective restoration program.

Outreach, Education, and Cooperation

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to achieve the goal of outreach, education, and cooperation.

2.6 Alternative 3 – Integrated Pest Management without Herbicides

Under Alternative 3 the NPS would follow the same adaptive management principles as Alternative 2, except herbicide use would be discontinued. This alternative was developed in response to public comments that expressed concern about the use of herbicides. Control efforts would include mechanical, cultural, and biological methods, with the goal of eradicating invasive weeds when it is a feasible option. Several invasive species would not be controlled, including cheatgrass, common tansy, hawkweed species, knotweed species, oxeye daisy, periwinkle, and spurge species, because they cannot be effectively managed without herbicide.

Prevention and Early Detection

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to achieve the goal of prevention and early detection.

Inventorying and Monitoring

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to establish an effective inventory and monitor program.

Prioritization and Control

See "Elements Common to All Alternatives" for a description of some basic prioritization and control actions that are common to all alternatives. This alternative uses the same prioritization techniques as those described in Alternative 2. Control efforts would be similar to Alternative 2; however, there would be notable differences. The control methods available to reach the objectives that are common to all alternatives would be reduced (i.e., chemical control methods would not be available). The priority species list derived from the Decision-making Tool would still be used; however, several species (12) would drop off of the list because the available control methods would be ineffective at reaching the objectives. Species that would not be treated include: eggleaf spurge; myrtle spurge; meadow, mouse-ear, and yellow hawkweed; Bohemian, giant, and Japanese knotweed; cheatgrass; common tansy; oxeye daisy; and periwinkle.

For many of the remaining species, control efforts would only be effective for controlling or containing small populations; species and examples under this scenario are described further in the manual/mechanical control section below. Table 2-8 lists the priority species and how they would be treated under this alternative.

Table 2-8. Priority Species that Would be Treated without Herbicides (Alternative 3)

Species	Non-chemical Means of Control
First Priority	
Absinth wormwood *Artemisia absinthium*	Mechanical (suppression via seed removal)
Black locust *Robinia pseudo-acacia*	Mechanical (suppression via cutting)
Bristly locust *Robinia hispida*	Mechanical (suppression via cutting)
Butterfly bush *Buddleja davidii*	Mechanical (suppression via cutting)
Butternut *Juglans cinerea*	Mechanical (suppression via cutting)
Common mullein *Verbascum thapsus*	Mechanical (pulling)
Dalmatian toadflax *Linaria dalmatica*	Mechanical (suppression via seed removal); Biological
English holly *Ilex aquafolium*	Mechanical (suppression via cutting)
English ivy *Hedera helix*	Mechanical (pulling)
Evergreen (sweet)pea *Lathyrus latifolius*	Mechanical (pulling)
Oak species *(Quercus spp.)*	Mechanical/cultural (suppression via cutting and shading)
Poison hemlock *Conium maculatum*	Mechanical (pulling)
Sulfur cinquefoil *Potentilla recta*	Mechanical (suppression via seed removal)
Tansy ragwort *Senecio jacobaea*	Mechanical (pulling)
Traveler's joy *Clematis vitalba*	Mechanical (suppression via pulling)
Yellow toadflax (butter-and-eggs) *Linaria vulgaris*	Biological
Second Priority	
Bull thistle *Cirsium vulgare*	Mechanical (pulling); Biological
Canada thistle *Cirsium arvense*	Biological
Cutleaf (evergreen) blackberry *Rubus laciniatus*	Mechanical (pulling)

Species	Non-chemical Means of Control
Herb Robert *Geranium robertianum*	Mechanical (pulling)
Himalayan blackberry *Rubus discolor*	Mechanical (pulling)
Knapweed species (diffuse & spotted) *Centaurea spp.*	Mechanical (pulling)
Reed canarygrass *Phalaris arundinaceae*	Mechanical (pulling and digging); Cultural (suppression via shading); large populations would not be treated
Rush skeletonweed *Chondrilla juncea*	Biological; Cultural (suppression via shading)
Scotch broom *Cytisus scoparius*	Mechanical (pulling); Biological
White sweetclover *Melilotus alba*	Mechanical (pulling)
Third Priority	
St. Johnswort *Hypericum perforatum*	Biological

Cultural Control

The use of cultural practices would be similar to those described in Alternative 2, with the exception that additional mulching and shading efforts would likely take place in an attempt to control isolated populations of perennial rhizomatous species discovered within the Park Complex. Except in the case of newly established populations, or populations occurring in wilderness areas or other areas of high value habitat, or where invasive non-native species would threaten the survival of listed native species, cultural treatments would not be used to control perennial rhizomatous species. For example, isolated populations of rush skeletonweed species discovered within designated wilderness could not be treated mechanically due to the risk of spreading the population by rhizome fragments. Black plastic could be used to reduce the vigor of these populations, however given the expected lifespan of the material in the field, installations would need to be inspected and replaced as necessary on at least a bi-annual basis. Such installations in wilderness would be required to undergo a minimum tool analysis.

Manual and Mechanical Control

Under Alternative 3 manual and mechanical treatments would likely increase, however, priority would be given to populations of annual, biennial, and simple perennial species where there would be a reasonable likelihood of reaching maintenance control levels. Except in the case of newly established populations, or populations occurring in wilderness areas or other areas of high value habitat, or where invasive non-native species would threaten the survival of listed native species, mechanical and manual treatments would not be used to control perennial rhizomatous species. Manual or mechanical removal would exacerbate infestations of perennial rhizomatous species because new growth would occur from remaining portions of rhizomes left in the ground, and ground disturbance could spread rhizome material to new locations. Perennial rhizomatous species that are on the priority list include: absinth wormwood, blackberry species, Canada thistle, common tansy, English holly, English ivy, evergreen (sweet) pea, hawkweed, knotweed species, locust, oxeye daisy, periwinkle, reed canarygrass, rush skeletonweed, St. Johnswort, and toadflax species. Table 2-8 describes how these species would be treated under the above-described scenarios (new populations, occurrence in wilderness or other high value habitat, risk of harming listed species), but in many cases these species may not be treated if they do not fall under any of these scenarios.

Biological Control

Under Alternative 3 the use of biological control agents could potentially increase to include the use of less effective agents not currently utilized by the Park Complex. These agents would be released in an effort to degrade the cumulative health of targeted invasive non-native species populations, and releases would adhere to the guidelines described in Section 1.8. Expanding the use of biological control to include less effective agents would also require further consideration regarding the potential effect of releasing less specific agents into park ecosystems, and any collateral impact on native species. For example choosing to release *Rhinocyllus conicus* (musk thistle head weevil) to assist in the control of Canada and bull thistle would also likely result in damage to native edible thistle (*Cirsium edula*) populations. Should the park decide to expand its use of biocontrol to include less specific agents, additional public input would be sought prior to the release.

Chemical Control

Control of invasive plants with herbicides would not occur under this alternative. Of the 40 invasive plant species that are a priority for control, 28 (70%) could be treated, and suppressed or controlled to some degree without herbicides (see Table 2-8). These species could be treated using various combinations of cultural, mechanical, and biological control. Though it is encouraging that a significant percentage of species could be treated without the use of herbicides, the remaining 12 are some of the most tenacious, problematic species because they can quickly and easily out-compete native vegetation, change fire regimes, and threaten fragile subalpine ecosystems.

Proposed Invasive Projects

This section describes proposed invasive plant monitoring and control projects that would be implemented under Alternative 3. Proposed projects would focus on managing the invasive non-native species that could be effectively controlled without herbicides. Control efforts would include cultural, manual/mechanical, and potentially biological treatments. Eight projects described in Alternative 2 would not occur under this alternative; because the species that occur within these projects are perennial rhizomatous and are most effectively controlled by herbicide application, they could not feasibly be undertaken under Alternative 3. Although some level of control could be achieved using manual, mechanical, and cultural treatments, implementation would be prohibitively expensive, time-consuming, and would not result in a significant level of control. Furthermore, management objectives would not be met for these projects. The projects that would not be implemented under this alternative include:

- Airstrip wetland and beaver ponds
- Big Beaver reed canarygrass (inventory would still occur)
- Cascade River Road
- Gravel pits
- Ross Lake reed canarygrass
- Skagit River knotweed
- Stehekin River and tributaries knotweed (inventory would still occur)
- Stehekin Valley cheatgrass (inventory would still occur)

Four projects would take place within designated wilderness: Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lakes Road, and Park-wide Trails. Fewer species would be treated under each of these projects (except for Ridley Lake reed canarygrass).

In contrast to the other alternatives, it is generally expected that most projects undertaken would require longer treatment periods in order to address areas that contain persistent seed banks. Since the seeds of some species remain viable for many decades, it is possible that manual removal would need to occur at least every year for over 10 years. Where mechanical removal is used to contain species that cannot be effectively controlled, this type of treatment would need to occur annually, and with some infestations, multiple times per year to prevent seed set or vegetative spread. This type of containment work would also likely be ongoing for an indefinite period of time.

Table 2-9 outlines proposed projects under this alternative.

Table 2-9. Proposed Projects (Alternative 3)

Project Name	Priority Species Treated /Not Treated	Gross Infested Acres[1]
East Side – Stehekin Projects		
Airstrip, fairways, and other cleared areas	**Species treated:** Bull thistle, knapweed **Species not treated:** Canada thistle, cutleaf & Himalayan blackberry, Dalmatian toadflax, oxeye daisy, rush skeletonweed, sulfur cinquefoil	57
Buckner Homestead Historic District	**Species treated:** Knapweed **Species not treated:** Rush skeletonweed, yellow toadflax	32
Company Creek gravel pit	**Species treated:** Knapweed **Species not treated:** Cheatgrass	6
Lake Chelan reed canarygrass	**Species treated:** Reed canarygrass **Species not treated:** none	7
Mill Pond and maintenance yard	**Species treated:** Bull thistle, evergreen (sweet)pea, Himalayan blackberry **Species not treated:** Knotweed, oxeye daisy, reed canarygrass, sulfur cinquefoil	10
Riparian weeds (excluding knotweed)	**Species treated:** Bull thistle, knapweed, Scotch broom **Species not treated:** Canada thistle, rush skeletonweed, yellow toadflax	50
Stehekin Landing	**Species treated:** Black locust, evergreen (sweet)pea, Himalayan blackberry, knapweed **Species not treated:** Cheatgrass, yellow toadflax	10
Stehekin Valley Road improvements	**Species treated:** Unknown	12
Stehekin Valley Scotch broom	**Species treated:** Scotch broom **Species not treated:** none	19
West Side – Skagit Projects		
Hozomeen developed area	**Species treated:** Knapweed **Species not treated:** Oxeye daisy, St. Johnswort, white sweetclover	10

Project Name	Priority Species Treated /Not Treated	Gross Infested Acres[1]
Marblemount Ranger Station	**Species treated:** Cutleaf and Himalayan blackberry, herb Robert **Species not treated:** Common tansy, English ivy, oak species, knotweed, oxeye daisy, periwinkle, reed canarygrass	4.5
Park-wide trails	**Species treated:** Common tansy, knapweed, oxeye daisy, St. Johnswort **Species not treated:** reed canarygrass, yellow toadflax	8
Ridley Lake reed canarygrass	**Species treated:** Reed canarygrass **Species not treated:** none	0.1
Roads - SR 20 Corridor	**Species treated:** Absinth wormwood, evergreen (sweet)pea, knapweed **Species not treated:** Common tansy, hawkweed species, herb Robert, oxeye daisy, St. Johnswort, sulfur cinquefoil, toadflax species, white sweetclover	56
Roads - Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads)	**Species treated:** Knapweed **Species not treated:** Cheatgrass, common tansy, herb Robert, Himalayan blackberry, oxeye daisy, Scotch broom, St. Johnswort, white sweetclover	19
Ruby pasture	**Species treated**: Bull thistle **Species not treated**: Canada thistle	5
Skagit River other weeds	**Species treated**: Scotch broom **Species not treated**: Bull and Canada thistle, cheatgrass, cutleaf and Himalayan blackberry, English holly, English Ivy, herb Robert, oxeye daisy, periwinkle, traveler's joy, white sweetclover	170
[1] Gross infested acre estimates include the outer perimeter of an infestation.		

EAST SIDE – STEHEKIN PROJECTS

Airstrip, Fairways, and Other Nearby Cleared Areas
This project would only include manual/mechanical treatment of knapweed and bull thistle. None of the other seven dominant invasive species at this location would be treated (Canada thistle, cutleaf and Himalayan blackberry, Dalmatian toadflax, oxeye daisy, rush skeletonweed, and sulfur cinquefoil).

Buckner Homestead Historic District
This project would continue to include manual removal of knapweed and mowing to contain yellow toadflax, as described in Alternative 2, but herbicide treatment of rush skeletonweed and yellow toadflax would not occur.

Company Creek Gravel Pit
This project would remain the same as described in Alternative 1.

Lake Chelan Reed Canarygrass
This project would remain the same as described in Alternative 2, except that herbicides would not be used. Mechanical removal, use of shade cloth, and revegetation with native plants would be used; however, without the use of herbicides, the success of this project would be compromised and the resulting habitat would be less desirable for wildlife.

Mill Pond and Maintenance Yard
This project would include manual/mechanical removal of bull thistle, evergreen (sweet) pea, and Himalayan blackberry. Knotweed, oxeye daisy, reed canarygrass, and sulfur cinquefoil would not be treated.

Riparian Weeds (excluding knotweed)
This project would include manual/mechanical removal of bull thistle, knapweed and Scotch broom. Canada thistle, rush skeletonweed, and yellow toadflax would not be treated.

Stehekin Landing
This project would include manual/mechanical removal of all of the invasive species at the landing, except that cheatgrass and yellow toadflax would not be treated. Repeated cutting of black locust and Himalayan blackberry would be necessary in order to keep these species under maintenance control; however, eradication would not be feasible.

Stehekin River & Tributaries Knotweed
This project would remain the same as described in Alternative 1 (inventory only).

Stehekin Valley Cheatgrass
This project would remain the same as described in Alternative 1 (inventory only).

Stehekin Valley Road Improvements
This project would remain the same as described in Alternative 2, except invasive plants would only be treated manually or mechanically if feasible.

Stehekin Valley Scotch broom
This project would remain the same as described in Alternative 1.

WEST SIDE – SKAGIT PROJECTS

Big Beaver Creek Reed Canarygrass
This project would remain the same as described in Alternative 1 (inventory only).

Hozomeen Developed Area
This project would remain the same as described in Alternative 1.

Marblemount Ranger Station
This project would remain the same as described in Alternative 1, except that a greater effort would be made to reduce the presence of invasive species manually or mechanically in parking areas and around equipment storage facilities.

Park-wide Trails
This project would remain the same as described in Alternative 1, except that a greater effort would be made to reduce the presence of invasive species manually or mechanically in order to prevent seed dispersal into the backcountry and wilderness.

Ridley Lake Reed Canarygrass
Efforts would be made to dig up the reed canarygrass to limit the infestation around the shoreline of Ridley Lake. Eradication may not be successful and repeated treatments would be required.

Roads – SR 20 Corridor
This project would be limited to manual removal of absinth wormwood, evergreen (sweet) pea, and knapweed. Common tansy, hawkweed species, herb Robert, oxeye daisy, St. Johnswort, sulfur cinquefoil, white sweetclover, and toadflax species would not be treated because of the extensive distribution along the highway and manual and mechanical treatments have proven to be ineffective for control of these species.

Roads—Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads
Under this alternative, only manual treatments of knapweed would occur because of the extensive distribution of the other species and their lack of response to manual and mechanical treatments.

Ruby Pasture
Under this alternative manual control of bull thistle would occur. No treatments for Canada thistle would take place.

Skagit River Other Weeds
Under this alternative manual control of Scotch broom would occur. No treatments for the other invasive species would take place.

Restoration

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to develop an effective restoration program. There is one area in which this alternative differs from the others: under this alternative, fewer restoration projects would be undertaken because some of them would have no reasonable expectation of success. Due to the inability to control certain species because of restrictions on herbicide use, restoration efforts would not be undertaken in those areas. Proposed projects that would have a reasonable chance of success are listed in table 2-9.

Outreach, Education, and Cooperation

See "Elements Common to All Alternatives," which describes the actions that the Park Complex would implement to achieve the goal of outreach, education, and cooperation.

2.7 Alternatives Considered but Rejected

Two alternatives that considered the use of only one treatment methodology were considered but rejected. Similarly, integrated management plans that did not use chemical or biological control options were also considered but rejected. The use of domestic ruminants, such as goats, to control invasive plants was also considered but rejected. These alternatives are described below.

Use Only Mechanical Control Methods

Mechanical treatment alone will not control all invasive weeds. It is a viable option for scattered individual plants or in areas where other control techniques are not recommended. However, it can cause soil disturbance and is labor/time intensive. Because of the difficulty of removing rootstocks from compact or rocky soil, it can be ineffective. In some cases, mechanical control can make the infestation worse. For example, pulling invasive weeds that have rhizomatous roots (such as rush skeletonweed or Japanese knotweed) actually induces the plant to send up shoots from root fragments that are left in the ground, creating many small plants from what used to be a single plant. Also, some plants that can usually be controlled by pulling, such as knapweed, are so widespread and have huge seed banks that a combination of pulling and chemical treatment is preferred.

Using mechanical methods alone can:

- create major ground disturbance, allowing weed seeds to germinate;
- leave root fragments in the ground to resprout;
- take excessive amounts of time to control, for example, regular revisits to the infested site;
- result in trampling of native vegetation during repeat control efforts; and
- cost more and be less effective than a combined treatment approach.

For these reasons, this alternative was considered but rejected.

Use Only Chemical Control Methods

The use of chemical control alone was considered but rejected because in some situations, invasive plants can be controlled without the use of herbicides. For example, the spread of weeds that are annual or biennial species (such as some knapweed species, mullein, and herb Robert) that do not occur in large densities can usually be controlled by pulling. Because reproduction of these species relies primarily on the ability of the plant to produce seed, physical removal can often be an effective control method if the entire root is removed. However, with perennial species, which may reproduce by fragmentation of roots or shoots as well as seeds, systemic herbicides are necessary to ensure mortality of the entire plant. Additionally, mechanical and chemical control are often used in combination, for example, roadside mowing followed by selective herbicide application, or cut-stump treatments performed on woody species.

Weed Management without Biological Control

Developing an IPM Program that considers all treatments except biological control was considered, but was eliminated because of the efficiency and efficacy of some biological control agents for treating some invasive plants. In some instances, biological control may be the only feasible method available for reducing the threat of invasive plants to environmental and cultural resources.

Use Domestic Ruminants to Control Weeds

The use of domestic ruminants as a mechanical means of weed control (grazing) was an issue that was considered as a management tool, but not further addressed. Ruminants, such as goats, are non-selective grazers. The use of ruminants as a management tool within the Park Complex would not be feasible for the following reasons: 1) because of the potential for removing native plants; 2) the need to fence the animals in order to contain them would be very difficult given the rough terrain throughout the Park Complex and the ground disturbance caused by the animals could compound the invasive plant issue; and 3) because few of the invasive plant populations within the Park Complex are large enough to make this effort cost effective.

2.8 Environmentally Preferred Alternative

The National Park Service is required to identify the environmentally preferable alternative in the environmental documents it produces for public review and comment. In accordance with National Environmental Policy Act (NEPA) Section 101(b) (516 DM 4.10), the environmentally preferable alternative is the alternative that best promotes the national environmental policy. The environmentally preferred alternative is further defined as “the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.” As described in Section 101, the environmentally preferable alternative must:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
- Assure safe, healthful, productive, and aesthetically and culturally pleasing surroundings for all Americans;
- Attain the widest range of beneficial use of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
- Preserve important historic, cultural, and natural aspects of our national heritage and, wherever possible, maintain an environment that supports diversity and variety of individual choice;
- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life’s amenities; and
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Alternative 1, the No Action Alternative, would attempt to meet environmental policy goals by continuing the Park Complex’s existing invasive, non-native plant management program. Control efforts would be limited to current projects. No additional techniques, herbicides, or biological controls would be introduced. Projects would remain limited in scope and new projects would need to be vetted on a case by case basis through the park’s compliance process.

Alternative 2, Integrated Pest Management with Herbicides, meets environmental policy goals by expanding and improving upon the Park Complex’s current invasive, non-native plant management efforts through implementation of an adaptive management strategy that would assist with prioritization of invasive plant management projects, and allow a wider range of control options. This would include expanding the use of herbicides for the control of extensive populations of perennial rhizomatous species, for species and populations that managers have been unable to control through previous mechanical and cultural efforts, and for those species that are currently too widespread to manage effectively by other means. Alternative 2 would allow a greater range of control methods to be considered, and further incorporate restoration into the complex’s long-range invasive plant management program.

Alternative 3, Integrated Pest Management without Herbicides, would attempt to meet environmental policy goals by instituting and adaptive management strategy similar to that of Alternative 2, however, herbicides would not be used to achieve management goals. As a result, the Park Complex would be unable to effectively treat some invasive, non-native plant species currently being managed under the existing management program. The inability to treat a number of priority invasive plant species would result in loss of habitat that would directly impact populations of native flora and fauna as invasive species continue to spread and out-compete native plant species. Additionally, the spread of some invasive species could result in immediate danger to local communities and park infrastructure. For example, not treating cheatgrass in the Stehekin Valley could cause a substantial increase in fine fuels, resulting in more frequent and easily ignited fires.

Alternative 2, Integrated Pest Management with Herbicides, is the Environmentally Preferred Alternative. The biological and physical environment is best protected by implementing an Integrated Pest Management program that controls invasive, non-native plants that threaten native ecosystems. Control of invasive plant populations allows impacted ecosystem processes and functions to recover, while protecting healthy ecosystems that have not been impacted and facilitating restoration of areas previously damaged by invasive plant species. The potential short-term impacts resulting from an increase in herbicide use and expanded control of invasive plant species populations are outweighed by the long-term benefits of removing invasive plant species from the Park Complex, as demonstrated in Chapter 4, Environmental Consequences.

2.9 Summary Tables

Table 2-10. Summary of Proposed Actions by Alternative

Plan Elements	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
General Description	Invasive plant management would continue into the future just as it has been conducted in the last five years. Limited herbicide use would continue in some areas; however, many species that are currently not being treated would continue to go untreated.	An Integrated Pest Management program that includes all invasive plant management techniques (cultural, mechanical, biological, and chemical) would be available to best manage invasive species. A number of species and infestations that currently are not being treated under Alt. 1 would be treated under this alternative.	An Integrated Pest Management program that excludes the use of herbicides would be implemented. Invasive plant management would focus on projects that have a reasonable chance of success at removing invasive plants without the use of herbicides. A number of species would not be treated because available methods would be ineffective at controlling the infestation.
Wilderness	One treatment project would take place in designated wilderness.	Seven treatment projects would take place in designated wilderness.	Four treatment projects would take place in designated wilderness.
Minimum Requirements Analysis	Common to all Alts: A programmatic level MRA was completed for invasive plant management actions within designated wilderness (Appendix C). Treatment of invasive plants within wilderness was deemed a necessary action, and therefore meets the minimum requirement for administration of the area as wilderness. A combination of *Mechanical/herbicide treatments using human/stock transport and motorized equipment* (water pumps) and *Mechanical/herbicide treatments using helicopter transport and motorized equipment* (water pumps), were determined to be the minimum tool.		

Plan Elements	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
Prevention & Early Detection	Common to all Alts: A comprehensive list of Best Management Practices (BMPs) to prevent the introduction and spread of invasive plants would be adhered to by all park employees, contractors, and partners (see Appendix E); an early detection/eradication protocol would be established that calls for annual surveys of susceptible points of introduction paired with an employee education program; portions of the invasive plant management budget would be devoted to education and other forms of prevention.		
Inventorying & Monitoring	Common to all Alts: The Park Complex would be inventoried for non-native and sensitive plants every five years; known non-native and sensitive plant populations would be monitored every year; annual reports would be produced that summarize management activities for the year.		
Prioritization & Control	24 priority species exist under this alternative. New priority species would be determined using the best judgment of park staff with consideration for the amount of time and effort required for treatment. All four control techniques (cultural, mechanical, biological, and chemical) would continue to be used. **Cultural** treatments would focus on seeding, planting, and some irrigation; **mechanical** treatments would focus on hand pulling and cutting up to 150 acres per year; no **biocontrol** agents are proposed for release; and **chemical** treatments would focus on cut stump, basal bark, foliar spot, and foliar broadcast applications on 25 to 100 acres each year.	40 priority species exist under this alternative. The current priority species and the status of any new species would be determined using the Decision-making Tool (Appendix B). All four control techniques would be used. **Cultural** treatments would be used more often, especially reseeding/replanting; **mechanical** treatments would decrease to less than 150 acres per year, as species that haven't responded to this type of treatment would be treated with herbicide; no **biocontrol** agents are proposed for release; and **chemical** treatments would increase to 600-2,000 gross infested acres per year, as species that haven't responded to other treatment methods would be treated with herbicide, or a combination of methods.	27 priority species exist under this alternative. 13 additional species would still be considered priority; however, they would not be treated under this alternative because they do not respond to treatment methods other than herbicide. The current priority species and the status of any new species would be determined using the Decision-making Tool (Appendix B); however, species that cannot be effectively treated without herbicides would not be listed. All control techniques would be used except for chemical. **Cultural** treatments would be used more than the other Alts., especially mulching and shading; **mechanical** treatments would increase, with priority given to annual, biennial, and simple perennial species; no **biocontrol** agents are proposed for release, but the potential to release less effective agents would be high; and **chemical** treatments would not be used.
Restoration	Restoration plans for each project would be developed. Sites would be surveyed to determine which species of native plants would be used, and seed collection and/or propagation of native plants would begin. After invasive plant removal, disturbed areas would be restored.	Same as Alt. 1.	Same as Alt. 1, except that fewer restoration projects would be undertaken because some of them would have no reasonable expectation of success without the use of herbicides to control certain species.

Plan Elements	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
Outreach, Education & Cooperation	Common to all Alts: Collaboration would be enhanced by working with additional stakeholders. Cooperative agreements could be established with other landholders to conduct invasive plant management activities on private land. Employee and public education would be enhanced by interpreting the results of the latest research on invasive plants; providing volunteer activities; outreach to horseback riders and packers. Research to inform invasive plant management would be encouraged.		

Table 2-11. Invasive Plant Projects Summarized by Alternative

Project Name	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
East Side - Stehekin Projects			
Airstrip, fairways, and other cleared areas *(9 invasive species present)*	Treating bull & Canada thistle, Dalmatian toadflax, knapweed, rush skeletonweed, & sulfur cinquefoil using manual/mechanical removal & foliar spot herbicide applications	Same as Alt. 1, plus treating remaining species (cutleaf & Himalayan blackberry & oxeye daisy); treatments would expand to include foliar broadcast herbicide applications	Treating knapweed & bull thistle using manual/ mechanical methods; no other species would be treated
Airstrip wetland and beaver ponds *(2 invasive species present)*	No treatments would occur	Treating Canada thistle & reed canarygrass using foliar spot herbicide applications	Same as Alt. 1
Buckner Homestead Historic District *(3 invasive species present)*	Treating knapweed using manual control & rush skeletonweed using occasional spot herbicide treatments (outside of the orchard)	Same as Alt. 1, plus yellow toadflax would be treated using herbicide spot & broadcast applications outside of the orchard, & mowing within the orchard to help to reduce seed dispersal	Treating knapweed using manual control; seed dispersal of yellow toadflax would be reduced by mowing within the orchard
Company Creek gravel pit *(2 invasive species present)*	Treating knapweed using manual removal	Same as Alt. 1, plus cheatgrass and other new non-native species would be treated using foliar spot herbicide applications	Same as Alt. 1
Lake Chelan reed canarygrass *(1 invasive species present)*	No treatments would occur	Treating reed canarygrass using heavy equipment, shade cloth, & limited herbicide application followed by native species replanting & restoration	Same as Alt. 2, except herbicides would not be used
Mill Pond and maintenance yard *(7 invasive species present)*	No treatments would occur	Treating bull thistle, evergreen (sweet)pea, Himalayan blackberry, knotweed, oxeye daisy, reed canarygrass, & sulfur cinquefoil using mechanical removal & herbicide spot treatments	Treating bull thistle, evergreen (sweet)pea, & Himalayan blackberry using manual/ mechanical removal; no other species would be treated

Project Name	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
Riparian weeds (excluding knotweed) *(6 invasive species present)*	No treatments would occur	Treating bull & Canada thistle, knapweed, rush skeletonweed, Scotch broom, & yellow toadflax using manual/ mechanical removal & herbicide spot treatments	Treating bull thistle, knapweed, & Scotch broom using manual/mechanical methods; no other species would be treated
Stehekin Landing *(6 invasive species present)*	No treatments would occur	Treating black locust, cheatgrass, evergreen (sweet)pea, Himalayan blackberry, knapweed, & yellow toadflax using mechanical removal & herbicide spot treatments	All species would be treated using manual/ mechanical removal, except for cheatgrass & yellow toadflax
Stehekin River & tributaries knotweed *(1 invasive species present)*	No treatments would occur-inventory & monitoring only	Treating knotweed using foliar spot applications	Same as Alt. 1
Stehekin Valley cheatgrass *(1 invasive species present)*	No treatments would occur-inventory & monitoring only	Treating cheatgrass populations using spot herbicide applications	Same as Alt. 1
Stehekin Valley road improvements *(unknown number of invasive species present)*	No treatments would occur	Treatment of any priority invasive plants that may occur using the most effective means (including manual/ mechanical & herbicide applications).	Same as Alt. 2 except herbicides would not be used
Stehekin Valley Scotch broom *(1 invasive species present)*	Treating Scotch broom using manual/ mechanical removal	Treating Scotch broom using manual/ mechanical removal & cut-stump herbicide applications	Same as Alt. 1
West Side - Skagit Projects			
Big Beaver Creek reed canarygrass *(1 invasive species present)*	No treatments would occur-inventory & monitoring only	Treating reed canarygrass using foliar spot herbicide treatments	Same as Alt. 1
Gravel pits *(6 invasive species present)*	Treating common tansy, hawkweed, herb Robert, knapweed, oxeye daisy, white sweetclover using foliar broadcast herbicide application	Same as Alt. 1, plus herbicide applications would occur biannually (spring/fall)	No treatments would occur
Hozomeen developed area *(4 invasive species present)*	Treating knapweed using manual removal	Treating knapweed, oxeye daisy, St. Johnswort, & white sweetclover using manual removal & spot herbicide application	Same as Alt. 1

Project Name	Alt. 1 – Current Plan	Alt. 2 – IPM with Herbicides	Alt. 3 – IPM without Herbicides
Marblemount Ranger Station *(11 invasive species present)*	Treating herb Robert & cutleaf & Himalayan blackberry using manual/mechanical removal	Treating Canada thistle, common tansy, English ivy, oak species, herb Robert, cutleaf & Himalayan blackberry, knotweed, oxeye daisy, periwinkle & reed canarygrass using mechanical removal & spot herbicide application	Same as Alt. 1 except that greater effort would be made to remove priority invasive species from parking areas & around equipment storage facilities.
Park-wide trails *(6 invasive species present)*	Treating common tansy, knapweed, oxeye daisy, St. Johnswort using manual removal	Treating common tansy, knapweed, oxeye daisy, reed canarygrass, St. Johnswort, & yellow toadflax using herbicide spot treatments & mechanical removal	Same as Alt. 1 except that a more focused effort would be made to prevent seed dispersal into the backcountry/wilderness
Ridley Lake reed canarygrass *(1 invasive species present)*	No treatments would occur	Treating reed canarygrass using herbicide spot treatments	Treating reed canarygrass by manual removal (digging)
Roads-Cascade River Road *(5 invasive species present)*	No treatments would occur	Treating herb Robert, oxeye daisy, Scotch broom, St. Johnswort, & white sweetclover using foliar spot & broadcast herbicides treatments (via backpack, ATV, or truck)	No treatments would occur
Roads-SR 20 Corridor *(12 invasive species present)*	Treating absinth wormwood, common tansy, Dalmatian and yellow toadflax, evergreen (sweet)pea, hawkweed, herb Robert, knapweed, oxeye daisy, St. Johnswort, sulfur cinquefoil, & white sweetclover using mechanical/manual removal & herbicide applications	Same as Alt. 1, plus treatments would occur annually & would be expanded to consist of a combination of foliar spot and broadcast herbicide applications (via backpack, ATV, or truck)	Treating absinth wormwood, evergreen (sweet) pea & knapweed using manual removal; no other species would be treated
Roads-Other Roads (Thornton Lakes, Haul Road, Newhalem Creek, Gorge, Diablo Dam, other access roads) *(9 invasive species present)*	Treating herb Robert using a combination of manual/mechanical removal & herbicide spot treatments	Treating cheatgrass, common tansy, herb Robert, Himalayan blackberry, knapweed, oxeye daisy, Scotch broom, St. Johnswort, & white sweetclover using same methods as Alt. 1	Treating knapweed using manual removal; no other species would be treated

Project Name	**Alt. 1 – Current Plan**	**Alt. 2 – IPM with Herbicides**	**Alt. 3 – IPM without Herbicides**
Ross Lake reed canarygrass *(1 invasive species present)*	Treating reed canarygrass near campgrounds using foliar spot & broadcast herbicide applications	Same as Alt. 1, plus treatment area would be expanded to include the entire lakeshore within the US; options for treatment within Canada would be explored	No treatments would occur
Ruby Pasture *(2 invasive species present)*	No treatments would occur	Treating bull & Canada thistle using selective broadcast herbicide	Treating bull thistle using manual removal
Skagit River knotweed *(1 invasive species present)*	Treating knotweed using spot herbicide applications	Same as Alt. 1	No treatments would occur
Skagit River other weeds *(13 invasive species present)*	No treatments would occur	Treating blackberry species, bull & Canada thistle, cheatgrass, traveler's joy, English holly, English ivy, herb Robert, oxeye daisy, periwinkle, Scotch broom, & white sweetclover using foliar spot & cut-stump herbicide applications & mechanical removal	Treating Scotch broom using manual removal; no other species would be treated

3 AFFECTED ENVIRONMENT

North Cascades National Park (501,458 acres), Ross Lake National Recreation Area (116,798 acres), and Lake Chelan National Recreation Area (62,902 acres) are collectively known as the North Cascades National Park Service Complex (See Section 1.5 for a general map). The Park Complex contains over 680,000 acres of the heart of the North Cascades ecosystem, 94 percent of which is designated as the Stephen Mather Wilderness. The ecosystem is host to wide ranges in rainfall, temperature regimes, and elevation, which together result in a great diversity of habitat types. Human activity and associated impacts tend to be concentrated in the recreation areas, where consequently most of the invasive plant infestations occur.

Approximately six million acres of public lands surround the Park Complex. These lands encompass two units of the National Forest System: the Mount Baker-Snoqualmie National Forest and the Okanogan-Wenatchee National Forest. On the Canadian side of the border, several Provincial Parks and protected areas are adjacent to the Park Complex. Notable protected areas include E.C. Manning Provincial Park, Skagit Valley Provincial Park, and Chilliwack Lake Provincial Park. State Route 20 bisects the Park Complex; completed in 1972, it established the northernmost corridor between eastern and western Washington. A rough dirt road existed prior to the construction of the highway for logging, mining, and access to the three dams along the Skagit River administered by Seattle City Light. Until the completion of the highway, there were few corridors by which weeds could be disseminated into pristine areas of the Park Complex. Despite the relatively short period of time since the completion of SR 20, the Park Complex currently has over 200 weed species, as many as Yosemite National Park, which was established more than 100 years earlier in 1890. In the Lake Chelan NRA, Stehekin was settled in 1897, but travel and development up the valley and away from the lake was limited primarily to miners and sheep herders. Because of this, the backcountry that is accessed by the Stehekin Valley Road is free of most invasive, non-native plants.

The State of Washington is heavily impacted by invasive non-native plants across a wide range of ecosystems. In Western Washington the threat is posed primarily by ornamental plants which have escaped cultivation, and have become established in the forest understory, or along the state's lakes, streams, and wetlands. Currently, the state is working to control several of these species at the ecosystem level. For example, Washington has established and funded a program to control Japanese, giant, Himalayan, and Bohemian knotweed along waterways and across land ownership boundaries. In Eastern Washington the most problematic species were often introduced through grazing or through contaminated seed stocks. Spotted and diffuse knapweed, cheatgrass, and Dalmatian toadflax are examples of species that are widespread throughout the Palouse and coniferous forests east of the Cascade Crest. The state has implemented releases of biological control agents, and supported control programs that are implemented by county noxious weed boards to control a number of invasive, non-native plant species throughout the state.

3.1 History of Invasive Plant Management at Each Park Unit

In the past, efforts to control invasive plants in the Park Complex have been piecemeal and reactive, primarily due to sporadic funding. A more consistent level of funding and support has occurred since the establishment of the EPMT in 2002. Approval of this plan would allow the Park Complex to establish a comprehensive invasive plant management program that it hasn't been able to accomplish to date.

Volunteer help is a valuable component of the invasive plant control program at the Park Complex. Projects that are large in scope and/or those that need regular maintenance have benefitted from volunteer help. Examples include annual weed pulls for knapweed and Scotch broom along the SR 20 corridor, the Stehekin "bakery bucks" program, Stehekin "volunteer weekends," and numerous informal weed-pulling activities organized by the park's volunteer coordinator. The "Bakery Bucks" program provides volunteers who pull one bag of knapweed (or 100 small plants) a coupon good for $1 off their purchase at the local bakery. In addition to this program, the Stehekin airstrip hosts a "Pilots Clean-up Day" during which volunteers pull knapweed along the airstrip and surrounding area. The Stehekin District also hosts "Volunteer Weekends" throughout the summer, where manual control of invasive species is among the multiple tasks accomplished by these groups. The NPS is very fortunate to have the help of two particular volunteers that have been persistent in their commitment to eradicating knapweed in the Stehekin Valley; for over 10 years, they have consistently volunteered hundreds of hours every year to pulling knapweed. A park volunteer coordinator position was added in 2008; this position has helped to mobilize volunteers for several informal weed-pulling activities focused on Colonial Creek Campground, the Newhalem campground area, Gorge Campground, the Marblemount Ranger Station, and the Hozomeen area.

Ross Lake National Recreation Area

In the Ross Lake National Recreation Area (ROLA), prior to the establishment of the EPMT, invasive plant control was sporadic, and often a collateral duty for available staff members. Efforts focused mostly on the mechanical removal of knapweed species along the SR 20 corridor and the Hozomeen visitor use area, various species at gravel pits and car campgrounds, and selected populations of Japanese knotweed. Efforts were also made to increase employee awareness about invasive, non-native plant species. Regular inventory and monitoring had not taken place; however, a thorough inventory was conducted in 2000 along the SR 20 corridor, and in 2002 a randomized survey was conducted at several front country and wilderness locations. Restoration was not incorporated into projects.

Since the establishment of the EPMT in 2002, repeated invasive plant surveys have been made of the SR 20 corridor, the Skagit River, the shoreline of Ross Lake, and the trail system within the recreation area. The EPMT has worked with staff members to mechanically remove a number of annual, biennial, and perennial species along the SR 20 corridor as well as portions of the trail system and scenic viewpoints adjacent to the highway. Beginning in 2006, the EPMT began limited herbicide spot treatment of expanding populations of these same species throughout the SR 20 right-of-way. The crew has also used herbicide spot treatments to control Japanese knotweed along the Skagit River and reed canarygrass along the shoreline of Ross Lake. Invasive plant surveys conducted by park personnel include a backcountry trail survey in 2006 and mapping of cheatgrass populations on the east side of Ross Lake (North of Lightning Creek) in 2006 and 2007.

Due to funding constraints, few invasive plant removal projects have involved restoration. However, in 2003 the Park Complex received funding to establish a native grass seed bed to be used in the revegetation of areas treated with herbicide along the SR 20 corridor. This resource was located at the Marblemount NPS administrative compound but it is currently not in operation.

Lake Chelan National Recreation Area

Management of invasive, non-native plants in the Lake Chelan National Recreation Area (LACH) began in the late 1980s. The main species of concern at the time was knapweed. Three biocontrol agents were released in various locations throughout the lower valley in June 1989 to control spotted knapweed, including two species of seed head gall flies, Urophora quadrifasciata and U. affinis, and the spotted knapweed seed head moth, Metzneria paucipunctella. Also in 1989, populations of rush skeletonweed were discovered and were identified as the westernmost infestation in the state at that time. Additionally, a 1989 exotic plant survey conducted along the roadsides and trails detected the presence of cheatgrass "everywhere," however, no documented actions were taken to control the species.

In the 1990s, additional species were targeted for control. Small infestations of rush skeletonweed were covered with black weed cloth to prohibit germination. This technique reduced the density of small populations in some developed areas. Scotch broom was detected in the orchard and was treated by mechanical removal. Japanese knotweed was detected in 1994 and mechanical treatment was attempted. Continued focused work to control knapweed at the Stehekin Airstrip and along Stehekin roads occurred throughout the 1990s. A large volunteer program was successful in greatly reducing the density of knapweed in the Stehekin Valley. Additionally, repeated applications of a broadleaf-specific herbicide (Tordon) were used to bring the monoculture of knapweed under control at the Stehekin Airstrip. Spot applications were also made in the valley in an attempt to control newly established populations of rush skeletonweed. Mechanical removal of various other species, such as Scotch broom, common mullein, yellow toadflax, and yellow salsify (*Tragopogon dubius*), also occurred during this time throughout the lower valley. Sites were monitored several times per year, known populations were mapped, and data about each infestation was collected. Restoration was a sporadic activity that was incorporated into some projects and not incorporated into others.

Since 2002, the EPMT has continued to follow existing priorities regarding invasive plant management in LACH. This has included a combination of both spot treatment of knapweed, rush skeletonweed, and Canada thistle populations at the airstrip using broadleaf herbicides and mechanical removal of a number of non-native species along the road corridor, the river corridor, other disturbed areas, and prescribed burn and thinning units. Since 2003, repeated surveys have been conducted along the Stehekin River corridor to determine the extent of populations of Japanese knotweed. These surveys were confined to the lower seven miles of the river, working downstream from the highest known population. From 2006 to 2009, concentrated efforts were made by park personnel to survey cheatgrass on the south-facing slopes from Coon Creek southeast to the NPS boundary shared with the US Forest Service, with efforts concentrated on areas proposed for prescribed burning and areas burned during the Flick Creek Fire of 2006. In addition to the surveys, the crew pulled patches of prickly lettuce along the Lakeshore Trail and pulled Scotch broom located within the burn perimeter. All three species increased in abundance and density following the fire.

North Cascades National Park

In North Cascades National Park proper, very little invasive plant work has been conducted to date due to its more remote nature and consequent lack of invasive plant infestations. Sporadic hand-removal of a number of annual, biennial and perennial species has taken place along the Cascade River Road between the park boundary and the parking area for the Cascade Pass trailhead, as well as along the old Stehekin Road, between High Bridge and Cottonwood. Additionally, repeated hand removal of oxeye daisy has occurred on the trail leading to Boston Basin. Over 90 percent of the park's trail system and backcountry camps have been surveyed and mapped. The trail system serves as the main pathway by which invasive plants spread into the backcountry, so surveys that identify invasive plant locations along trails can help to focus efforts and prevent their spread into off-trail areas.

3.2 Resource Topics Considered

The resource topics considered in this document include natural, cultural, and socio-cultural resources. They were selected based on the issues identified in Section 1.6. For each issue, the resources that could be affected were identified, forming the basis of the impact analysis. The natural resource topics include soils, hydrology, water quality, wetlands, vegetation, fish and wildlife, special status species, and natural soundscapes. Cultural resource topics include archeological resources, historic districts, and cultural landscapes, as well as isolated historic sites, structures and features. Many of the historic resources are locally and/or nationally significant and are listed on the National Register of Historic Places, and many of the structures are on the List of Classified Structures. Socio-cultural resources include wilderness character, visitor use and experience, human health and safety, socioeconomics, and park and partner operations. In this chapter, the current environment that could be impacted by implementation of any of the alternatives is described. Chapter 4 subsequently analyzes the impacts to each resource topic through implementation of each of alternative.

3.3 Soils

Soil types in the Park Complex exhibit some diversity because of the variety of topographic settings, parent materials, vegetation, climatic regimes, and landform ages. Parent materials include alluvium, glacial drift, colluvium, volcanic ash and bedrock. Soil orders represented in the Park Complex include Andisols, Inceptisols, Spodsols, Entisols, and Histosols. Soils on steep bedrock slopes and in alpine areas are thin and poorly developed. Soils formed in glacial drift and alluvium on valley bottoms are thicker and better developed. Those soils on stable landforms such as mountain passes are very well-developed and contain preserved tephra layers. Most soils in the Park Complex are well-drained and highly erodible.

The majority of the invasive plant infestations that occur within the Park Complex are found in valley bottoms, including the Stehekin Valley and the Skagit Valley. Soils of the Skagit Valley bottom consist of very deep, somewhat poorly drained soils formed in alluvium from meandering rivers in the floodplain. Soil texture is typically a fine to coarse sandy loam. Alongside the valley bottom are very deep, well drained soils formed in mixed volcanic ash and glacial drift over glacial drift on debris aprons, valley walls, and bedrock benches. These soils tend to be ashy sandy loams. Above the Newhalem area, where the Skagit Gorge is located, the soil characteristics change dramatically. Soils tend to consists of shallow, well drained soils formed in volcanic ash mixed with glacial drift and colluvium over gneiss, granite, or granodiorite bedrock. They are cobbly, ashy, sandy loams and have a high component of rock outcrop in their descriptions. Along Ross Lake, the soils consist of mostly volcanic ash over glacial drift, with volcanic ash over alluvium mapped at the mouths of larger tributaries. Soils tend to be gravelly and ashy sandy loams that transition to very gravelly sandy loam to very cobbly loamy sand at depth. Areas of high bedrock exposure contain soils that are cobbly ashy sandy loams to loamy sands with bedrock at 14 – 24 inches.

In the Stehekin Valley the floodplain and terrace soils tend to be very deep, somewhat poorly drained to moderately well-drained. Typical textures are sandy loam to loamy sand on the floodplain and terraces. On the debris apron and valley wall soils tend to be very deep and well drained, the parent material being volcanic ash and reworked glacial drift over glacial drift on valley walls, debris cones, fan terraces, and alluvial fans. Textures can be gravelly to very gravelly ashy fine sandy loam. There are also areas of shallow, well drained soils that are cobbly, ashy, sandy loams and contain a high component of rock outcrop.

3.4 Hydrology and Water Quality

The Park Complex has two major watersheds, the Skagit River and the Stehekin River. Smaller areas are drained by the Chilliwack, Nooksack, and Baker rivers. The Chilliwack is tributary to the Fraser River in British Columbia, the Baker is tributary to the Skagit River, and the Nooksack flows directly into Puget Sound. Mainstem reaches of these rivers and lower reaches of major tributaries generally exhibit low to moderate gradients supporting a variety and abundance of fish habitat. Tributaries located further upstream in these drainages exhibit moderate to steep gradients with generally cobble and boulder beds. Waterfalls and cascades are common in these reaches and form barriers to fish migration.

Hydrological patterns in NOCA are primarily influenced by glaciers and snowmelt. There are 318 glaciers in the park that are primarily located on the west side of the Cascade Crest. Glacially dominated streams generally are very cold and subject to high turbidity during peak melting periods during the summer. Other streams exhibit a range of temperature and sediment load as influenced by the contribution of glacial melt-waters in each catchment.

The Skagit River drains an area of 3,000 miles^2 before reaching Puget Sound, including parts of Canada, two national forests, and private and state lands in Whatcom and Skagit Counties in the United States. Its headwaters begin in British Columbia, Canada in the North Cascades Mountains and it flows approximately 150 miles, through three dams, before it empties into Puget Sound. The Skagit is the only river that crosses the Skagit hydrologic crest, a major hydrologic divide running from Cascade Pass to Mt. Redoubt. Geologic data indicate that the river used to flow in two directions from the crest; west to Puget Sound and north to the Fraser River (Riedel et al., 2007). It is the largest river draining into the Puget Sound, providing 20 percent of the flows into the Sound, and the third largest river on the west coast of the United States.

The Stehekin River contributes more than 50% of the flow into Lake Chelan. The river and its tributaries extend from the head of Lake Chelan to the Cascade Crest, a distance of more than 30 stream miles, and covering almost the entire south unit of North Cascades National Park and Lake Chelan National Recreational Area. To the south, headwaters of several Stehekin tributaries (Company Creek, Devore Creek, Agnes Creek, Flat Creek, and a few smaller tributary streams) are within the Glacier Peak Wilderness Area, administered by the Wenatchee National Forest.

Because most of the Park Complex is located in protective wilderness, it appears that water quality is generally very good although some impacts have been documented and other impacts, related to various ecosystem stressors within and outside the park boundaries, are likely to be occurring. Currently only two water bodies are listed by the state (303d, Clean Water Act) as not meeting state water quality standards. These include Newhalem Creek for instream flows and Lake Chelan for three pesticides (DDT, Chlordane, Dieldrin) and two other persistent organic pollutants (PCBs and Dioxin). Lake Chelan is also listed for invasive aquatic species and total phosphorus.

Outstanding water rights are primarily in the Stehekin Valley. Most of these are for private domestic use. However, Chelan PUD has a permit for withdrawal from Company Creek for operation of its hydroelectric project. Since some residents in the Stehekin Valley use the river as their source of drinking or irrigation water, concerns about herbicide use near the river are warranted. In addition to domestic use, the river is used by people who fish, raft, and swim.

Aquatic weeds are of major concern to park managers. Parrot feather (*Myriophyllum aquaticum*) and Eurasian water milfoil (*Myriophyllum spicatum*) have been found in Lake Chelan (though not within the Lake Chelan NRA), and reed canarygrass is becoming established along the periphery of Ross, Diablo, and Gorge lakes and at the head of Lake Chelan. Japanese knotweed is present in both the Skagit and Stehekin river drainages, and has formed some thick monocultures along streambanks and on islands. Additionally, there is the possibility that cold-tolerant hydrilla (*Hydrilla verticillata*) could be introduced to the Park Complex by visiting watercraft. All of these species have the potential to form thick monocultures in slow moving or stationary water, and may result in the degradation of habitat for native flora and fauna and a reduction in recreational opportunities.

3.5 Wetlands

Wetlands, as defined by the U.S. Fish and Wildlife Service (USFWS) and adopted 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). Three key features characterize wetlands: 1) the presence of standing water throughout part of the growing season; 2) unique wetland soils; and 3) vegetation adapted to or tolerant of saturated soils. Hydrology of the wetland is considered the primary driver of wetland ecosystems, creating wetland soils and leading to the development of wetland communities.

Wetlands are an important part of the North Cascades ecosystem. Major wetland systems are found in Big Beaver, Little Beaver, Chilliwack, Thunder Basin, and Fisher Basin drainages on the west side of the Park Complex. In Stehekin, the Stehekin River and its tributaries have associated wetlands which provide important habitat in an otherwise dry east side ecosystem. Isolated wetlands occur in higher elevations often associated with lakes, streams, and ponds. These wetlands provide habitat for a variety of invertebrate and amphibian species. High elevation wetlands are very vulnerable to the effects of climate change and air pollutant deposition. Lower elevation wetlands adjacent to major river and stream channels offer valuable habitat for anadromous salmonids other fish species. All wetlands perform important hydrological processes such as flood abatement, sediment retention, groundwater recharge, nutrient capture, and decomposition of organic matter. Wetlands are particularly vulnerable to invasive plant invasions, which can degrade wetland habitat by changing sediment loading, surface and subsurface flows, and water table depth (Gordon 1998). Finally, wetlands are afforded special protection under the Clean Water Act.

There are several proposed projects that, if implemented, would take place within or near wetland environments. These include Big Beaver, Ross Lake, and Ridley Lake reed canarygrass, Skagit River knotweed and other riparian weeds, Lake Chelan reed canarygrass, Stehekin River knotweed and other riparian weeds, mill pond and maintenance yard, and airstrip wetlands. Special consideration for invasive plant treatments in or near wetlands would be taken, and include: treatments in seasonally flooded wetlands and riparian areas would be scheduled during the dry or low water phase of the year, or during reservoir draw down, and appropriately labeled herbicide formulations would be used in wetlands and within 10 feet of standing and moving water.

3.6 Vegetation

Native Vegetation

Great variation in vegetation exists in the North Cascades ecosystem due to the dramatic differences in rainfall, slope, aspect and elevation. Four broadly defined vegetation zones are found within the North Cascades: lowland forest, montane forest, subalpine parkland, and the alpine zone. Overlaying these are three biogeographic zones caused by two orographic barriers within the Park Complex: the Boston-Picket-Spickard Divide and the Cascade Crest. Temperate marine conditions are found west of the Boston-Picket-Spickard Divide, while areas east of the Cascade Crest lie in the semi-arid continental zone. The region between the Boston-Picket-Spickard divide and the Cascade Crest, essentially the Ross Lake drainage, comprises a transitional zone where vegetal and climatic characteristics are intermediate between the mild, wet conditions typical of the west side and the semi-arid conditions typical east of the Cascade Crest.

The lowland forest, which grows from sea level to 3,000 feet, is dominated by western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and Douglas fir (*Pseudotsuga menziesii*) in the temperate marine zone; Douglas fir, ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*Pinus contorta*) dominate the lower elevations of the semi-arid continental zone, with western red cedar found in riparian areas. A mixture of all these species is found in the transitional zone, with the Park Complex's largest pure stands of lodgepole pine found here.

The montane forest (3,000 feet to 5,400 feet) is dominated by Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*), with lesser amounts of subalpine fir (*Abies lasiocarpa*), grand fir (*Abies grandis*), and Alaska yellow cedar (*Chamaecyparis nootkatensis*). Douglas fir continues to be present in this zone from lower elevations. On the eastern slopes of the Cascades, whitebark pine (*Pinus albicaulis*) and larch (*Larix lyallii*) are also common at the higher elevations of this zone; again, the transitional zone includes a mixture of west and east species. White bark pine in particular is found in many locations west of the Cascade Crest but is rarely abundant.

The subalpine parkland (5,400 feet to 6,800 feet) is a mosaic of tree islands and subalpine meadows. Dominant trees within tree islands west of the Cascade Crest include subalpine fir and mountain hemlock. Drier areas, almost exclusively east of the Cascade Crest, are characterized by communities of subalpine fir, whitebark pine and larch. Subalpine meadow vegetation is often found in a mosaic of lush herbaceous heath shrub on the mesic sites. On wet sites the meadows are dominated by sedge and rush species while dry sites are dominated by sedges and grass species.

Finally, the alpine zone begins at the limit of upright trees (Krummholz trees may be present), generally above 6,500 feet. Alpine land cover is characterized by fell fields (generally occupied by sedges, grasses, composites, heather, Krummholzed junipers (*Juniperus communis*), pines and subalpine firs), talus and snowfields.

Deciduous trees dominate in moist and exposed areas throughout the Park Complex such as floodplains, riparian areas, and avalanche chutes. Common species include bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera spp. trichocarpa*), red alder (*Alnus rubra*), birch (*Betula papyrifera*), slide alder (*Alnus viridis*), vine maple (*Acer circinatum*), and willow (*Salix spp.*).

Sensitive, Threatened, or Endangered Plants

No federally listed endangered or threatened plant species are known to exist in the Park Complex; however, of the 72 plant species listed as sensitive, threatened, or endangered by the State of Washington, 39 of them have been documented within the Park Complex (See Appendix I). Prior to any project implementation, rare plant surveys are conducted within the project footprint. If a rare plant is found, mitigation measures are developed to avoid the population or minimize impacts.

Non-native Vegetation

Non-native vegetation in the Park Complex is most widely distributed in areas of human-caused disturbance including roadsides, visitor use areas, administrative use sites, campgrounds and trailheads. Other disturbed sites where non-native plant species have become established include seasonally flooded riparian areas, reservoir shorelines, and areas impacted by forest fires or prescribed burns. Although there are over 200 non-native plant species in the Park Complex, only a small percentage of these species display invasive characteristics, and an even smaller number have become distributed to the point where they have the potential to impact native ecosystem processes. Current surveys indicate that non-native, invasive vegetation infests approximately 3,100 acres (gross infested estimate[2]) representing 0.5% of park lands.

On the west side, along roadsides and in many administrative sites (such as gravel pits and equipment storage areas), herb Robert and various hawkweed species have become the dominant ground cover. These species are now expanding outward from the disturbed areas where they were initially introduced, and have begun forming monocultures within the closed canopy lowland forest along the Skagit River floodplain. Along with herb Robert and hawkweed species, common tansy, knapweed, oxeye daisy, St. Johnswort, toadflax and white sweetclover can be commonly found along roadsides, throughout the campgrounds, and in other highly disturbed and heavily used visitor use areas. While the impacts that these plants create in developed areas is often little more than a nuisance, these populations serve as a source to transport seed and other vegetative material to the Complex's relatively pristine backcountry and wilderness areas. Once established in the backcountry these species may then invade high alpine meadows or riparian areas and wetlands, displacing native plant and animal species.

In the Stehekin River floodplain, Japanese knotweed has become established and threatens to outcompete native riparian vegetation by forming dense monocultures that prevent the recruitment of native species. Knotweed infestations can increase sedimentation in shallow backwater sloughs that support fish spawning habitat, and may change the quality and availability of food and nutrients available to aquatic microorganisms, subsequently affecting the riparian food-chain and local water quality (Urgensen et al. 2009). Along the shoreline of Ross Lake, reed canarygrass is moving from regularly disturbed areas of the shoreline up into the pristine wetlands of the Big Beaver drainage. Reed canarygrass also infests approximately seven acres of wetland at the head of Lake Chelan. Monocultures of reed canarygrass significantly reduce the diversity of native wetland plant species (Kilbride and Paveglio 2000) and the availability and quality of habitat for fish, birds, and amphibians that utilize these sites.

[2] Gross infested area can be defined as the outer perimeter of an infestation; it includes target species and the spaces between populations or individual plants. Actual treated area can be considerably less than gross infested area.

Forest fires and to a lesser extent, prescribed burning have disturbed large areas of land, especially in the Lake Chelan National Recreation Area. In several of these areas, cheatgrass has become established, and populations have begun to expand in size. An increase in the dominance of cheatgrass could lead to more frequent, low-intensity fires that will prevent the recruitment of native vegetation, subsequently reducing native plant diversity, and increasing the potential for soil erosion as perennial grasses, forbs and trees are replaced by this annual grass (Sheley and Petroff 1999).

While the encroachment of invasive non-native plants into the Park Complex is still occurring, infestations are small and there is an opportunity through implementation of this plan to prevent the continued spread of these species and to restore impacted areas.

3.7 Fish and Wildlife

Surrounded by several million acres of designated wilderness, North Cascades National Park Service Complex provides essential habitat for a diverse array of wildlife species that require large tracks of remote, mountainous land to survive. Some species that require these attributes include grizzly bear, gray wolf, wolverine, mountain goat, white-tailed ptarmigan and Clark's nutcracker. This variable landscape supports over 320 vertebrate species. There are approximately 75 mammal species in 20 families and approximately 20 species of reptiles and amphibians representing at least five orders. The avian fauna of the Park Complex is composed of roughly 210 species in 38 families. At least 28 species of fish are known to be present within the Park Complex, and recent surveys have documented over 500 terrestrial invertebrate taxa and approximately 250 aquatic invertebrate taxa. These findings comprise an unknown, but most likely tiny, fraction of the actual number of invertebrate taxa living within the Park Complex. Very few quantitative data are available on the population status and distribution of either vertebrates or invertebrates within park boundaries. Some quantitative and semi-quantitative data are available concerning the abundance of fish, amphibians, and aquatic invertebrates for park streams, lakes, and reservoirs. More information is available describing the distribution of fish, amphibians, and aquatic invertebrates throughout the Park Complex.

Common mammal species within the Park complex include the pika, Townsend's chipmunk, hoary marmot, Douglas squirrel, beaver, black bear, and black-tailed deer. More elusive mammals include snowshoe hare, northern flying squirrel, coyote, martin, spotted skunk, river otter, mountain lion, bobcat, and elk. Nine species of bats are known to occur within park boundaries. A small herd of mountain goats, numbering less than 25 individuals, resides on Jack Mountain.

Of the more than 200 bird species found within the Park Complex, over half of them live there year-round and/or come to habitats within the park to breed and raise offspring. Nearly 40 percent are neotropical migrants that winter south of the U.S. border. Birds that are prevalent in the Park Complex include an assortment of flycatchers, thrushes, warblers, and sparrows. American dippers are commonly found along the park's many fast moving streams. Harlequin ducks, Barrow's goldeneye, and common mergansers breed along the shores of the park's lakes and rivers. Steller's jays and gray jays are commonly seen near the park's campgrounds. Up to eight pairs of osprey nest along the Skagit River and three reservoirs. Along the Skagit River, deciduous forests of black cottonwood, red alder, bigleaf maple, and several species of willow support small breeding populations of several bird species that are rare elsewhere in western Washington, such as the veery, Nashville warbler, American redstart, and lazuli bunting. The largest concentration of bald eagles in Washington over-winter along the Skagit River due to its abundance of spawning anadromous fish and mild climate. Eagles arrive in November to gorge on spawning salmon and depart in March to return to their breeding grounds.

As many as 14 species of reptiles potentially inhabit the Park Complex; while only eight species (64%) have been confirmed present within park boundaries. These include the northern alligator lizard, western fence lizard, western skink, and five snakes: the rubber boa, racer, western terrestrial garter snake, common garter snake, and western rattlesnake.

Twelve species of amphibians are known to occur in the Park Complex, and currently two of them are listed for special management status by either the Washington Department of Fish and Wildlife or the U.S. Fish and Wildlife Service (See Section 3.8). Because amphibians occupy both aquatic and terrestrial environments and possess permeable skin, they are potentially at an increased risk from exposure to a wide range of stressors found in both of these environments. Reported declines have been attributed to disease, non-native predator populations, ultra-violet radiation, pollution, changing hydrologic regimes, and habitat alteration.

The Skagit River system is one of the few watersheds within the Puget Sound area that is managed for natural production of salmon and the only river system in Washington that supports all five species of salmon including: the sockeye, pink, coho, chum, and Chinook. In addition, anadromous steelhead, coastal cutthroat trout, and bull trout are also found in the mainstem and accessible portions of tributaries. Natural barriers have limited fish species distribution in the Skagit drainage to the lower sections of major tributaries. Resident rainbow trout, bull trout, mountain whitefish, and coastal cutthroat trout are also commonly found in these waters. Two non-native species (westslope cutthroat trout and brook trout) are commonly found throughout the Skagit watershed.

In the Stehekin River system, westslope cutthroat trout is the only native salmonid. Bull trout appeared to be extirpated from Lake Chelan and the Stehekin River by 1950, with disease and competition with non-native fish species suspected in their demise. Non-native fish species found in upper Lake Chelan and the Stehekin River include rainbow trout, brook trout, lake trout, Kokanee and Chinook salmon. Rainbow trout are currently abundant in the lower 15 miles of the Stehekin River and in a number of high lakes in the watershed. The Lake Chelan and lower Stehekin River fish populations are very closely linked. The majority of the spawning areas for trout, Kokanee and Chinook salmon found in Lake Chelan are in the lower eight miles of the Stehekin River. Currently, native westslope cutthroat trout (*Oncorhynchus clarki lewisi*) is a species of concern for park management. Historically, they were found throughout most of the Stehekin River and consisted of both stream resident and adfluvial life history strategies. Hybridization with non-native rainbow trout and competition/predation with other non-native fish species in Lake Chelan has severely impacted the distribution of pure westslope cutthroat trout which is currently limited to the upper part of the watershed.

3.8 Rare, Threatened, or Endangered Fish and Wildlife

There are 27 fish and wildlife species documented within the Park Complex that are listed as threatened, endangered, candidate, monitor, and/or sensitive species by the State of Washington and/or the federal government. Section 7 of the Endangered Species of 1973, as amended, requires federal agencies to consult with the US Fish and Wildlife Service (USFWS) to ensure that actions taken by the agencies do not jeopardize the continued existence of any listed species. It further requires federal agencies to consult with USFWS on actions that may affect listed species. NPS Management Policies (2006) requires the NPS to inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species, as well as inventory other native species that are of special management concern.

Within the Park Complex, seven species of mammals, fifteen bird species, three fish species, and two species of amphibians have special status on federal and state listings because their populations and/or habitat are at risk of declining and becoming extinct, or they are recovering from a threatened or endangered status and need to be monitored. All of these species are closely watched by federal and state fish and wildlife services, specialists in other federal agencies and friends and interest groups with the goal of helping these species at risk back to a more stable population and habitat condition.

Federal and State listed species are found in Table 3-1. Determinations on whether any of the listed species could be affected by invasive plant management as proposed in this EA can be found in Section 4.6 of the Environmental Consequences chapter. Additionally, in compliance with Section 7 of the Endangered Species Act, federally listed species that could be impacted by invasive plant management are the subject of a separate, in-depth biological evaluation that has been submitted to USFWS and the National Marine Fisheries Service as part of the consultation process.

Table 3-1. Threatened and Endangered Fish and Wildlife (Federal and State Listed)

		Status*	
Common Name	**Scientific Name**	**Federal**	**State**
American peregrine falcon	*Falco peregrinus anatum*	M	S
American white pelican	*Pelecanus erythrorynchos*		E
Bald eagle	*Haliaeetus leucocephalus*	M	S
Black-backed woodpecker	*Picoides albolarvatus*		C
Bull trout	*Salvelinus confluentus*	T [1&2]	C
California wolverine	*Gulo gulo luteus*		C
Canada lynx	*Lynx Canadensis*	T	T
Columbia spotted frog	*Rana luteiventris*	C	C
Ferruginous hawk	*Buteo regalis*		T
Golden eagle	*Aquila chrysaetos*		C
Gray wolf	*Canus lupus*	E [1&2]	E
Grizzly bear	*Ursus arctos*	T [1&2]	E
Lewis' woodpecker	*Melanerpes lewis*		C
Marbled murrelet [3]	*Brachyramphus marmoratus marmoratus*	T [1&2]	T
Merlin	*Falco columbarius*		C
Northern goshawk	*Accipiter gentilis*		C
Northern spotted owl	*Strix occidentalis caurina*	T [1]	E
Pacific fisher	*Martes pennanti pacifica*	C	E
Pileated woodpecker	*Dryocopus pileatus*		C
Puget Sound Chinook salmon	*Oncorhynchus tshawtscha*	T [1]	C
Puget Sound steelhead	*Oncorhynchus mykiss*	T	none
Sandhill crane	*Grus canadensis*		E
Townsend's big-eared bat	*Corynorhinus townsendii*		C
Vaux's swift	*Chaetura vauxi*		C
Western gray squirrel	*Sciurus griseus griseus*		T
Western grebe	*Aechmorphorus occidentalis*		C
Western toad	*Bufo boreas*		C

***Status refers to Endangered Species Act designations on federal and state lists: C = Candidate; E = Endangered; M = Monitor; S = Sensitive (informal); T = Threatened.

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[1] Federal critical habitat defined; [2] Federal recovery plan approved; [3] West side of Cascade Crest only

Definitions. As currently defined through the Endangered Species Act (ESA), ***endangered*** is the most serious designation and indicates an animal or plant species in danger of becoming extinct through all or a significant portion of its range. A ***threatened*** species is likely to become endangered within the foreseeable future through all or a significant portion of its range. A ***candidate*** species shows biological vulnerability and is proposed as a listed species (as endangered or threatened) but has not yet been listed. A ***monitor*** species is a species in recovery recently removed from ESA listing but being monitored to ensure that recovery goals are met within a five-year period after removal. If populations of a monitor species drop below recovery goals they can be re-listed in an expedited fashion. In addition to the formal definitions, the State of Washington also uses the informal category of ***sensitive*** species or species that have potential for listing within the state but population decline and habitat loss have not yet reached a critical level that would trigger consideration for listing.

For the purpose of this EA, the category of "***species of concern***" is a term used internally to describe species for which park biologists have a management concern because they are vulnerable to population or habitat loss within the Park Complex itself but do not appear on federal or state ESA listings. Only three species of concern for the Park Complex are not reflected on state or federal lists. These are the black swift (*Cypseloides niger*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and Cascades frog (*Rana cascadae*).

Amphibians

Cascades frog *(Rana cascadae)* – Species of concern within NOCA
The Cascades frog is usually found near water. They breed in shallow water often in ephemeral ponds. They are also found along streams and in seeps. Eggs are deposited in shallow water near the shoreline. Egg development through metamorphosis requires between 40-60 days, depending on water temperature. Aquatic and terrestrial insects comprise their diet. Cascades frogs are active from early spring through late fall. They hibernate in mud over the winter. A 1991 survey found Cascades frogs in a variety of habitats in the Stehekin Valley (Kuntz and Glesne 1993), including on the south side of the Stehekin River, on Battalion Creek, in riparian areas south of the airstrip, and in overflow channels along the river. Other locations in NOCA where this species has been documented include Bridge Creek, Park Creek, and Big Beaver Creek.

Columbia spotted frog *(Rana luteiventris)* – Federal: candidate, State: candidate
The Columbia spotted frog is nearly always found in or near a perennial water body (required for breeding) such as a spring, pond, lake or stream backwater. It is most often associated with non-woody wetland plant communities (sedges, rushes and grasses). Breeding occurs in February or March at lower elevations of eastern and western Washington but does not occur until late May or early June at higher elevations. Males are not territorial and may gather in large groups of 25 or more at specific locations in a pond. Females usually lay their eggs adjacent to or mixed with other egg masses. The gelatinous masses are only partially submerged. Eggs are typically deposited in the same locations in successive years. Sometime during their first summer, the tadpoles transform into small froglets about 3⁄4 inch (16-23 mm) in length (Leonard and Bull 2005). Olson, et al. (1997) list dates of oviposition as March – June (laid communally), and metamorphose three to four months after eggs are laid.

In the Park Complex Columbia spotted frogs have been found throughout the lower Big Beaver Valley (1,600 feet) in appropriate wetland habitat and in middle McMillan Creek beaver ponds (2,500 feet) and lower Luna Creek ponds (2,700 feet). On the east side of the crest they have been documented at Dagger Lake (5,500 feet) and a wetland 0.3 mile downstream; McAlester Lake (5,500 feet), McAlester Pass Pond (6,000 feet), and upper Kettling Lake (5,550 feet) (Holmes and Glesne, 1997, 1998, 1999).

Western Toad (*Bufo boreas)* – Federal: none, State: candidate
The Western toad ranges in elevation from sea level to over 7,000 feet. Ovipositon sites and aquatic habitat include lakes, springs, ponds, wetlands, stock ponds and slow-moving parts of streams. Terrestrial habitats are forests, grasslands and along streams. Timing of ovipostion is from January to July with one to eight weeks at a site. Tadpoles metamorphose approximately three months after eggs are laid (Olson 2005).

Western toads are most common near marshes and small lakes, but they may wander great distances through dry forests or shrubby thickets. In contrast to the jumping habits of frogs, toads move overland by climbing or crawling. Outside of the breeding season, western toads are nocturnal, spending the day buried in the soil, concealed under woody debris, or in the burrows of other animals. Breeding may occur from February to April at low elevations west of the Cascades and from May to early July at higher elevations in the Cascade Mountains. During daylight, males rest quietly upon logs, moss or grasses along the edge of the breeding pool and at night actively swim in search of the few gravid females visiting the pond. Western toad tadpoles commonly form large schools and swim along the margins of ponds or lakes feeding upon filamentous algae and organic detritus and scavenging carrion. Late in the summer, large concentrations of tiny toadlets may be encountered as they roam about the forest floor or as they cross roads (Olson 2005). The western toad has been documented in the Stehekin Valley, Big Beaver Valley, Skagit River corridor, Ross Lake and Bridge Creek watershed.

Birds

American Peregrine Falcon *(Falco peregrinus anatum)* – Federal: monitor, State: sensitive
Once globally common, the peregrine falcon experienced a dramatic population decline throughout its range due to the widespread use of the insecticide DDT after World War II (Hayes and Buchanan 2002). Banning of DDT in the early 1970s and an aggressive reintroduction program have led to the recovery of the species. Peregrines were delisted by the US Fish and Wildlife Service in 1999. In Washington during the period 1980-2001, peregrines increased at an annual rate of over 14% (Hayes and Buchanan 2002).

Peregrines can be found breeding along the Washington coast (highest density in the San Juan Islands and northern Puget Sound) to the arid canyons of the Columbia River and tributaries in eastern Washington. The presence of prominent cliffs is the most common habitat characteristic of peregrine nesting habitat (Hayes and Buchanan 2002). Suitable nest sites require ledges that are inaccessible to mammalian predators and provide protection from inclement weather (Campbell et al. 1990). Usually a lake, river, marsh, or saltwater is in close proximity to the site (Johnsgard 1990). In winter, Puget Sound estuaries and other western Washington coastal estuaries are known to contain high densities of peregrines (Anderson and DeBruyn 1979).

Park surveys conducted in the early to mid 1980s failed to document any active peregrine eyries, though much potential habitat appears to be available (Bjorklund and Drummond 1987). Recently peregrines have been documented nesting near Newhalem and are thought to breed on cliffs overlooking Big Beaver Valley (P. DeBryun pers. comm.). Biologists from the National Park Service, Washington Department of Fish and Wildlife, and Seattle City Light, conducting surveys of breeding habitat over the last several years, have documented six active eyries along the upper Skagit River.

American White Pelican *(Pelecanus erythrorynchos)* – Federal: none, State: endangered
American white pelicans are very rare spring and fall migrants to reservoirs in the Park Complex; only five observations have been reported (NOCA Wildlife Observation Database). In Washington, colonies of American white pelicans have disappeared from historical breeding areas (Johnsgard 1955). Currently, only one breeding colony exists in Washington, occurring in the Columbia River (Walla Walla County). Suitable nesting habitat that is free from human disturbance is rapidly declining (Motschenbacher 1984), thus there are few opportunities for breeding populations of American white pelicans to become reestablished. Additionally, non-breeding and wintering populations occur in Washington throughout the year. Factors limiting success of breeding and non-breeding American white pelican populations include habitat destruction, utilization of wetlands and lakes for other purposes (e.g., irrigation, hydroelectricity, waterfowl production), and intentional or unintentional human disturbance of nesting colonies.

American white pelicans are colonial nesters that breed most often on isolated islands in freshwater lakes and occasionally on isolated islands in rivers. Islands free from human disturbance, mammalian predators, flooding, and erosion are required for successful nesting. American white pelicans require shallow water for foraging. Most feeding occurs between water depths of 0.3-2.5 meters (1-8.3 feet) (Anderson 1991). Feeding mostly takes place along lake or river edges, in open areas within marshes, and occasionally in deep waters of lakes and rivers. American white pelicans feed largely on nongame or "rough" fish, amphibians, and crustaceans.

Bald Eagle *(Haliaeetus leucocephalus)* – Federal: monitor, State: sensitive
Bald eagles are large raptors that primarily forage on fish, but will eat a variety of small mammals, amphibians, crustaceans, and birds (particularly waterfowl). Bald eagles are highly mobile and respond to seasonally fluctuating food supplies by migrating to areas with large dependable concentrations of these resources. In the Pacific Northwest, annual concentrations of spawning salmon and waterfowl populations provide ample food resources for wintering eagles. One of the largest wintering bald eagle concentrations occurs along the Skagit River, both within and adjacent to the Park Complex. The Nature Conservancy and National Park Service have monitored eagle use of the upper Skagit River since 1978 (Dunwiddie and Kuntz 2001). Eagles typically occur in greatest numbers along the Skagit from mid-December until the end of January. Peak 1-day counts varied from 77 in 1983-84 to 506 in 1991-92. Annual eagle detections increased since first counts were made in 1978. Detections increased most rapidly from 1987-92, but have since averaged about 36% below the 1991-92 peak. Besides the Skagit River, wintering bald eagles are also observed in small numbers along park reservoirs and occasionally along the Stehekin River.

Nesting activity of bald eagles is associated with aquatic habitats (coastal areas, rivers, lakes, and reservoirs) with forested shorelines or cliffs. Throughout their range, they select large, live-topped trees or large snags normally in close proximity to major bodies of water such as lakes and rivers. Nest sites are usually located within 0.25 mile of large bodies of water (Montana Bald Eagle Working Group 1991). Bald eagles were not known to nest within the Park Complex until an active nest was found near the head of Lake Chelan in 2001. This nest blew down in 2002. In 2010, a new nest was found on Ross Lake (G. Cook, NPS, pers. comm.).

The decline of the bald eagle coincided with the introduction of the pesticide DDT in 1947. Eagles contaminated with DDT failed to lay eggs or produced thin eggshells that broke during incubation. Other causes of decline included shooting, trapping, and poisoning. Since implementation of the Pacific Bald Eagle Recovery Plan, eagle populations have rebounded dramatically. Bald eagles were listed as threatened within the lower 48 states in 1967. In 2007, USFWS de-listed the species, citing population and productivity levels were adequate to insure survival of the species.

Black-backed Woodpecker *(Picoides albolarvatus)* – Federal: none, State: candidate
Black-backed woodpeckers are uncommon residents in moderate to high elevation, open- canopy east-side coniferous forests. They are locally uncommon in burns at lower elevations and rare in western Washington at high elevations along the Cascade Crest (Smith et al. 1997). In Washington, Kreisel and Stein (1999) found black-backs foraged predominately in western larch and Douglas fir. They feed primarily on larvae of wood-boring beetles, engraver beetles, and mountain pine beetles (Dixon and Saab 2000). The black-backed woodpecker has been observed in the Complex in late July through mid- August, all east of the Cascade Crest in the Stehekin River drainage (NOCA Wildlife Observation Database).

Black swift *(Cypseloides niger)* – Species of concern within NOCA
The black swift is an uncommon breeder in forested habitats at moderate elevations along both the east and west slopes of the northern Cascades (Kuntz, NPS biologist, pers. comm.). Black swifts require a specialized habitat for nesting that are on dark wet cliffs where their nests are often located behind waterfalls. This provides the birds with an unobstructed way to approach the nest and protects them from nest predators. Black swifts may nest singly or in small colonies. Nests may be reused from year to year, with more material added each year. Black swifts are patchily distributed, with apparently stable numbers. Because of the difficulty in locating and observing nests, however, this species' ecology is not well known.

Ferruginous Hawk *(Buteo regalis*) – Federal: none, State: threatened
Ferruginous hawks nest on cliffs, small rock outcrops, or in trees. They are obligate grassland or desert-shrub habitat nesters, found in Washington only east of the Cascade Range. They are very rare migrants with the Park Complex, moving through the alpine and subalpine habitats in late summer. The Park Complex has three records of lone birds moving along alpine ridges (NOCA Wildlife Observation Database).

Golden Eagle *(Aquila chrysaetos)* – Federal: none, State: candidate
This species is a rare breeder and fall migrant in the Cascades Range, occurring most frequently in subalpine/alpine habitats. Bjorklund and Drummond (1989) documented a fall migration in the Park Complex of 0.1 birds per hour of survey effort over the period 1984-1988. A Washington state survey in 1985 revealed only 20 territories (11 occupied) in all of western Washington.

Lewis' Woodpecker *(Melanerpes lewis)* – Federal: none, State: candidate
Lewis' woodpecker is common in open forests and woody riparian corridors of eastern Washington in the ponderosa pine zone (Smith et al. 1997). While it has been documented nesting in both living and dead deciduous and coniferous trees, it shows a preference for ponderosa pine and black cottonwood (Campbell et al. 1990). Smith et al. (1997) identified core habitat in Washington as including the Stehekin Valley. This woodpecker has been observed four times in the Park Complex (NOCA Wildlife Observation Database).

Marbled Murrelet (***Brachyramphus marmoratus marmoratus)*** – Federal: threatened, State: threatened
The marbled murrelet was federally listed as threatened under the ESA in 1992 due to loss of breeding habitat and mortality associated with gill net fishing and oil spills (57 FR 45328-45337). This species ranges from Alaska to the central California coast and populations have declined throughout this area over the last 30 years. A recent review of its status by the USFWS found that the Califor-

nia/Oregon/Washington marbled murrelet population is a Distinct Population Segment (DPS) that continues to be subject to a broad range of threats, such as nesting habitat loss, habitat fragmentation, and predation (USFWS 2009). Based on this assessment, the USFWS concluded in January 2010 that removing the species from the list of threatened species is not warranted.

The marbled murrelet is a diving seabird that forages in near shore marine habitats preying on small fish and invertebrates. Marbled murrelets in the Pacific Northwest usually nest in old growth forests and select large, old trees with branches that support mats of epiphytes (McShane et al. 2004). Typically, nests are widely distributed in suitable habitat but occasionally occur within close proximity to one another. Marbled murrelets lay only one egg on the limb of a large conifer tree and probably nest only once a year, although there is some evidence of re-nesting if the initial attempt fails (Desanto and Nelson 1995). Nesting in Washington occurs over an extended period from late April through late August (McShane et al. 2004). During the nesting period, the parents travel daily between the marine waters and the nest to deliver food to the chick. Although murrelets are known to fly into their nesting areas and roost in large trees year around, most flight activity near the nest sites is concentrated during the breeding season. Most activity occurs in the hour before and after sunrise and again at dusk which maximizes diurnal feeding time in marine waters and reduces the risk of predation while moving to and from nest areas (Naslund and O'Donnell 1995).

Murrelets often use rivers as flight corridors (McShane et al. 2004). Marbled murrelets have exhibited "occupied" behaviors up to 4,400 feet in elevation and have been detected in stands up to 4,900 feet in the North Cascade Mountains (USFWS 2009). The distance inland that marbled murrelets breed is variable and is influenced by a number of factors, including the availability of suitable habitat, climate, topography, predation rates, and maximum forage range (McShane et al. 2004). In Washington, the primary range is considered to extend 40 miles inland from marine habitats, but occupied habitat has been documented 52 miles from the coast (Hamer 1995; Madsen et al. 1999) and the species has been detected up to 70 miles inland. Due to the loss of late successional forest habitat and its replacement with urban development and early successional forests in the Puget Trough, much of the remaining suitable nesting habitat for marbled murrelets east of Puget Sound is a considerable distance from the marine environment (> 20 miles) (USFWS 1997).

Habitat fragmentation and proximity of human activity appears to increase the risk of predation on marbled murrelets by American crows (*Corvus brachyrhynchas*) and Stellar's jays (*Cyanocitta stelleri*). Marbled murrelets are highly vulnerable to nest site predation. Most active murrelet nests that have been detected and monitored have been found to fail, and most failures appear to be the result of predation (McShane et al. 2004). At-sea breeding population estimates for marbled murrelets in Puget Sound and the Strait of San Juan de Fuca have fluctuated in the years 2000 through 2008, with no discernable increasing or decreasing trend; however, additional years of data are needed before a population change can be detected with high confidence (Lance et al. 2009). Recent data on nest success and adult:juvenile ratios at sea continue to confirm that murrelet reproduction in Washington, Oregon, and California is too low to sustain populations (USFWS 2009).

In 2008, park biologists initiated a survey of five drainages along the Park Complex's western boundary. Using radar, preliminary results showed probable detections along the lower Skagit River. However, in 2009 and 2010 ground surveys of sites where radar showed probable murrelet detections could not confirm murrelet presence (Hamer Environmental L.P. 2010).

Merlin *(Falco columbarius*) – Federal: none, State: candidate
Merlins are uncommon to fairly common winter residents at lower elevations statewide (Wahl et al. 2005). In the Park Complex, merlins are rare breeders, most likely of the race *suckleyi* (Wahl et al. 2005) and uncommon winter residents. This species nests in a wide range of forested habitat (Johnsgard 1990).

Northern Goshawk *(Accipiter gentilis)* – Federal: none, State: candidate
The northern goshawk is an uncommon to rare breeder in suitable coniferous forests of Washington (Wahl et al. 2005). The species is more common east of the Cascade Crest where it is found in most mid- to high-elevation forests. West of the Cascade Crest, it is found in all forest types. Small numbers occur in migration throughout the Cascades. In the Park Complex, the goshawk is an uncommon nester. Bjorklund and Drummond (1989) documented a dispersed fall south-bound movement of goshawks through the Park Complex (0.02 birds/hr of survey effort).

Northern Spotted Owl *(Strix occidentalis caurina)* – Federal: threatened, State: endangered
The northern spotted owl was federally listed as threatened in June 1990 (65 FR 5298-5300), with the final recovery plan for the species published in May 2008 (USFWS 2008). The spotted owl is a state-listed endangered species in Washington. The final recovery plan designates MOCAs (Managed Owl Conservation Areas) in non-fire dominated habitats west of the Cascades. Two MOCA-2s are designated within the Park Complex. MOCA-2s have enough "habitat-capable" area to support 1-19 pairs of breeding spotted owls (USFWS 2008).

Northern spotted owls occupy mature/old-growth Douglas fir/western hemlock forests that have multi-layered, multi-species canopies with moderate to high canopy closure (USFWS 2008). In Washington, populations of spotted owls are thought to have declined precipitously since 1990; however, the current number of occupied territories is unknown because not all areas have been or can be surveyed annually (USFWS 2008). In northern Washington and southwestern British Columbia most spotted owl detections are below 5,000 feet (1500 m) in elevation (Gutiérrez 1996). Dense forested areas are utilized for day-time roosting, and roosting and nesting sites are typically within a few hundred yards of one another. Though diets vary seasonally and according to prey availability, spotted owls feed mostly on small mammals, with flying squirrels (*Glaucomys sarbinus*) and woodrats (*Neotoma* spp.) the primary prey species. Northern spotted owls typically lay eggs in late March or April. After the incubation and brooding period, the young usually start flying nearby between May and June, and parental care continues into September. Young disperse from the nest area during late summer and fall, often dispersing many miles. During the non-breeding season, adults either remain within their home range surrounding their nest, or move to other areas as far as 20 miles from the nest (USFWS 2008).

The primary threats to northern spotted owls are habitat loss and fragmentation, increased human disturbance, and predation and inter-specific competition with barred owls. There is also evidence that increased barred owl populations have reduced spotted owl site occupancy, reproduction, and survival (USFWS 2008). In areas where barred owls have become more common than spotted owls, such as in the western North Cascades, barred owls out-compete spotted owls (Herter and Hicks 2000). Hybridization between the two species is also a major threat to spotted owls (Hamer et al. 1994).

During a recent owl survey of the Park Complex, biologists documented six spotted owl activity sites and approximately 35 barred owl activity sites. This same area was originally surveyed in 1993-1996 by NPS staff. Results of that survey documented 11 spotted owl activity sites and approximately 35 barred owl activity sites (Kuntz and Christophersen 1996). In 1995, a hybrid spotted/barred owl mated to a female barred owl in the Big Beaver Valley. No hybrids were found during the most recent 4-year survey.

Pileated Woodpecker *(Dryocopus pileatus)* – Federal: none, State: candidate
The pileated woodpecker is an uncommon resident of Washington in mid-seral and late-seral forests, mostly below 4,000 feet in elevation (Smith et al. 1997). Key habitat includes large trees and the presence of large snags for nesting. Pileateds roost in cavities of both live and dead trees. Preferred nest and roost stands are characterized by greater than 60 percent canopy closure and dominated by trees greater than 80 years old. Primary food items include ants, beetles, termites, western spruce budworm, and where available fruit and mast of wild nuts (Bull and Jackson 1995). In the Complex, pileated woodpeckers are uncommon year-round residents, found on both east and west slopes of the Cascade Crest. Siegel et al. (2004) documented this species as occurring in late seral forests at low densities (0.006 birds/ha).

Sandhill Crane *(Grus canadensis*) – Federal: none, State: endangered
This species is a fairly common to locally abundant migrant in Washington, preferring open fields near estuaries and wet farm fields (Wahl et al. 2005), but is a rare migrant within the Park Complex. All park records are of individuals found along the shore of Ross Lake Reservoir or at the head of Lake Chelan (NPS files).

Vaux's Swift *(Chaetura vauxi)* – Federal: none, State: candidate
Vaux's swift is a fairly common summer visitor to the Complex (NOCA Wildlife Observation Database). The swift prefers to breed in coniferous and mixed coniferous/deciduous forests (Bull and Collins 1993). It is more common in old-growth forests than in younger stands (Manual and Huff 1987). Vaux's nest and roost in hollow trees. It is an aerial forager that spends much of its time in flight just above the forest canopy or over water hawking ants, bugs, flies, moths, spiders, and aphids. Park studies (R. Kuntz, BBS data) have documented this species as regularly occurring in NOCA from May through September. This species likely visits high elevation sites (above treeline) strictly as "fly-overs."

Western Grebe *(Aechmophorus occidentalis)* – Federal: none, State: candidate
This species is a locally common breeder on large freshwater ponds, lakes, and reservoirs in arid areas. In winter, it moves to coastal saltwater lagoons, or stays on large freshwater bodies that remain ice free. The western grebe is a rare migrant and non-breeding summer visitor to the park's reservoirs. However, the species is most likely to be seen from mid September through mid November (NPS files).

Fish

Bull Trout *(Salvelinus confluentus*) – Federal: threatened, State: candidate
Bull trout, members of the family Salmonidae, are char native to the Pacific Northwest and western Canada. Bull trout are widespread throughout tributaries of the Columbia River basin in Washington, Oregon, and Idaho, including its headwaters in Montana and Canada. Within the Park Complex, healthy populations of bull trout inhabit Ross Lake, Diablo Lake, Gorge Lake, the mainstem Skagit River, and accessible portions of tributaries to the Skagit River below the Newhalem Powerhouse. Bull trout are also native to Lake Chelan and the Stehekin River however they are believed to be extirpated from the entire watershed as no specimens have been observed since the 1950s. In 2005 the U.S. Fish and Wildlife Service designated critical habitat for bull trout in 29 stream reaches within North Cascades National Park and Ross Lake National Recreation Area. All natural lakes in the Park Complex were fish-free but many have been stocked. However, none contain bull trout.

The overall present status of bull trout as a threatened species relates to various factors including general habitat degradation and fragmentation from past and ongoing land management activities, such as timber harvest, mining, road construction and maintenance, hydropower and water diversion/withdrawal activities, agriculture, and grazing. Over-fishing and interspecific competition with introduced non-native fishes, such as brook trout (Salvelinus fontinalis) and lake trout (Salvelinus namaycush), are also contributing factors in their decline (Bond 1992; Donald and Alger 1993).

Bull trout have relatively specific habitat requirements compared to other salmonids (Rieman and Mclntyre 1993). Habitat components that appear to influence distribution and abundance include water temperature, cover, channel form/stability, valley form, spawning and rearing substrates, and availability of migratory corridors (Rieman and Mclntyre 1993).

Bull trout primarily inhabit colder streams. Water temperature above 59° F (15° C) is believed to limit bull trout distribution thereby partially explaining their patchy distribution within a given watershed (Fraley and Shepard 1989; Rieman and Mclntyre 1993).

Bull trout exhibit resident and migratory life history strategies through much of their current range (Rieman and McIntyre 1993). Resident bull trout complete their life cycles in the tributary streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where the juvenile fish rear from one to four years before migrating to either a lake (adfluvial), river (fluvial), or in some coastal areas, to saltwater (anadromous) where maturity is reached. Bull trout typically spawn from October to December during periods of decreasing water temperatures, with most adult migratory bull trout moving upstream in autumn.

Puget Sound Chinook Salmon *(Oncorhynchus tshawtscha)* – Federal: threatened, State: candidate
The Puget Sound Chinook salmon occurs in the Skagit River upstream to Newhalem and in major tributaries including the Sauk, Suiattle, and Cascade Rivers. The Skagit Chinook populations are comprised of a single fall stock (lower Skagit River), two summer stocks (upper Skagit and lower Sauk Rivers), and three spring stocks. The six populations are genetically unique, and have different spawning migration timings, habitat requirements, and life history traits.

There are two basic Chinook life-history forms (or guilds) in the Skagit watershed. The first are called "ocean-type" fish, and spawn in the main stem and tributary areas of the Skagit but rear in these areas for only a relatively short time (days to weeks) before migrating downstream as fry. Ocean-type fish include summer and fall Chinook salmon. Because ocean-type juveniles spend relatively little time in their natal streams, they are dependent upon channel margin habitats of the lower and middle main stem Skagit, and the distributary channels and blind sloughs of the Skagit Delta and Skagit Bay, for foraging and rearing. The second basic life-history form includes spring Chinook salmon, which are called "stream type" fish because they spawn in the middle reaches and headwater areas of the watershed, and then rear as juveniles in these areas for one or more years before migrating.

Stream-type fish are better adapted to the habitat conditions present in the headwater areas of the watershed, including the cold winter temperatures and highly variable flows characteristic of snowmelt and glacial streams. There is high degree of variability in life-history traits of Skagit salmonids that extend far beyond the basic delineation of "ocean-type" and "stream-type" fish. This variability is most evident in Chinook salmon. Ocean-type Chinook employ several life-history strategies in the Skagit, including parr migrants (rearing in mainstem river and freshwater tidal areas), estuary users (rearing in estuary sloughs and distributaries), and fry outmigrants (very limited freshwater and estuary rearing).

Spawning escapement of Skagit summer and fall Chinook has been variable but fairly stable since escapement estimates were first made in 1952. Total escapement has ranged from a low of approximately 5,000 fish to a high of 26,000 fish during the period of 1952 to 2004. Escapements were relatively low in the mid-1950s and the early 1990s, while escapements were higher in the 1970s, and there has been an increasing trend since 1996. There are, however, differences in trends between populations. Since about 1984, Upper Skagit summer Chinook have made up an increasing percentage of the total escapement. Prior to 1984, approximately 60% of the summer and fall production unit escapement was comprised of Upper Skagit summer Chinook, yet, since that time, Upper Skagit summer Chinook have averaged about 75% of the total summer and fall production unit escapement. Side by side to this change in escapement composition, a complementary decrease in the percentage comprised of Lower Skagit falls and Lower Sauk summers has also been observed.

For the period of 1994-2004, the escapement of the three stocks of Skagit springs has ranged from lows of 83 to 167 fish and highs ranging from 625 to 700 fish. Trends in Skagit springs since 1992 have been fairly flat with a slight increasing trend. Each of the three spring populations has contributed approximately equal percentages of the escapement, and since 1994 there has been no noticeable change in the percentage contributed by each population.

The cause of the declines in salmon stocks involves a complex interplay of factors that vary among watersheds. Chief among these factors are loss of habitat through land-use activities (such as logging, grazing, agriculture, urbanization, channelization, and road-building, which introduce pollutants and silt, alter stream hydrology, and otherwise impact upland and aquatic habitat conditions); hatchery supplementation programs; fish harvest; hydropower; and water allocations. Various negative natural events (e.g., ocean conditions, weather patterns and environmental variability) have served to adversely impact Chinook salmon populations. In 2005 critical habitat was designated for portions of the Skagit River and Goodell Creek within the Park Complex.

Puget Sound Steelhead (*Oncorhynchus mykiss*) – Federal: threatened; State: none
The Puget Sound Distinct Population Segment of steelhead was listed as a threatened species under the federal Endangered Species Act on May 11, 2007 by the National Marine Fisheries Service. The Skagit River below Gorge Powerhouse supports all fresh water life history stages (egg, fry, juvenile rearing, and adult spawning) of both summer and winter steelhead. Adult winter steelhead typically return to the river mouth from November through May or early June, with peak spawning occurring from mid-April through mid-May in most Western Washington streams. Summer steelhead return to the river mouth between April and October, enter freshwater sexually immature, and require several months to mature and spawn. In general, summer steelhead spawn earlier in the year than winter steelhead. In 2002 winter steelhead in the mainstem Skagit and its tributaries was rated as depressed due to a long-term negative trend in escapements since 1992 and a short-term severe decline in 2000 and 2001.

Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*) – Species of concern within NOCA
Westslope cutthroat trout are distributed throughout the Park Complex however they are considered as non-native in all locations except for the Stehekin River watershed. Historically, native westslope cutthroat trout were found throughout most of the Stehekin River and consisted of both stream resident and adfluvial life history strategies. Hybridization with non-native rainbow trout and competition/predation with other non-native fish species in Lake Chelan has severely impacted the distribution of pure westslope cutthroat trout. Genetic introgression between cutthroat and rainbow trout has been documented by the USGS Western Fishery Research Center (Ostberg and Rodriguez 2006) and results have

shown that current pure strains of westslope cutthroat only exist in the upper Stehekin River (and upper reaches of some of its tributaries).

Widespread non-native fish introductions in Lake Chelan and the Stehekin River coupled with the apparent isolation of existing cutthroat indicate that these populations are vulnerable to extirpation. With the relicensing of the Chelan Hydroelectric Project, funds were made available to focus on westslope cutthroat trout protection and recovery. Currently, a number of monitoring programs have been implemented and past recreational stocking allocations of rainbow trout in the Wapato Basin of Lake Chelan have been replaced by sterile rainbow trout and cutthroat trout.

Mammals

California Wolverine *(Gulo gulo luteus)* – Federal: none, State: candidate
The wolverine is a rare, secretive mammal that occurs at low densities, even in core areas of its range. They are generally found in areas remote from humans and human development. Home ranges of adults in North America are large and vary from less than 100 km^2 to over 900 km^2 (Banci 1994). Habitat conditions that influence wolverine distribution and abundance are largely unknown (Banci 1994), but their habitat is probably best defined in terms of "adequate year-round food supplies in large, sparsely inhabited wilderness areas, rather than in terms of particular types of topography or plant associations" (Kelsall 1981). Wolverines are described as opportunistic omnivores in summer and scavengers in winter. In the Yukon and British Columbia, wolverine diets consisted of snowshoe hares, porcupines, sciuridae, birds, small mammals, ungulates, and fish (Banci 1994).

Current research being conducted near the east border of the park is following the movements of several collared animals and has documented presence in NOCA. Currently, a substantial portion of a male and female's home range has been documented in the Lake Chelan National Recreation Area (Keith Aubrey, USFS, pers. com.).

Canada Lynx *(Lynx canadensis)* – Federal: threatened, State: threatened
The Canada lynx was state listed as threatened in Washington in 1993 and federally listed as threatened in 2000 (FR 65 FR 16051-16086). Primary threats to the species include habitat loss and over utilization (trapping). Critical habitat was designated in 2006 and revised in 2009 by the USFWS. The revised critical habitat for Unit 4 (North Cascades) is limited to suitable habitat above 4,000 feet in north-central Washington in portions of Chelan and Okanogan counties. A state recovery plan was published in 2001 (Stinson 2001); there is no federal recovery plan to date for the lynx.

Lynx are closely associated with subalpine and boreal forests because of their near-dependence on a single prey species-the snowshoe hare-which is mostly limited to this habitat type (Witmer et al. 1998; Aubry et al. 1999). Lynx generally use higher elevation (above 4,000 feet) forests. They can travel over 300 miles when dispersing during prey declines. Lynx populations in the northern boreal forest fluctuate on an approximate 10-year cycle in response to changes in snowshoe hare numbers. Cyclic variations in snowshoe hare/lynx populations are dramatic in Alaska and Canada but tend to be more moderate in Washington (Stinson 2001).

As of 2001, there were thought to be only about 100 Canada lynx in Washington, with most records from the northeastern and north central portions of the state, in the Selkirks, Kettle Range, Pasayten Wilderness, and North Cascades east of the crest (Stinson 2001). Extensive forest fires through lodgepole pine stands in the Pasayten Wilderness Area in the mid-2000s may have reduced the population. Most evidence suggests that even historically lynx were scarce west of the Cascade Crest (Stinson 2001).

Suitable lynx habitat exists east of Ross Lake, but it is found only in small patch sizes. A remote camera survey completed in 2005 and targeting forest carnivore species did not document lynx. However, there is unconfirmed evidence that lynx may occasionally wander as far west as Mount Baker.

Gray Wolf *(Canus lupus)* – Federal: endangered, State: endangered
The gray wolf is federally listed as endangered in central and western Washington. Wolves typically prey on large ungulates, but will also feed on fish, carrion, small mammals, rabbits, and birds. They may travel as far as 43 miles within a 24 hour period to hunt and range over greater distances during dispersal (USFWS 1987). Wolves are highly social animals with large home ranges that include a variety of habitat types. Key components of wolf habitat include: (1) sufficient, year-round prey base of ungulates and alternate prey (i.e., beaver and smaller mammals); (2) suitable and somewhat secluded denning and rendezvous sites; and (3) sufficient space with minimal exposure to humans. Wolf distribution is largely influenced by distance from human activity, and wolves are highly susceptible to human-caused mortality. There is abundant habitat that is largely isolated from humans in the North Cascades that also provides suitable cover, dens, and rendezvous sites for gray wolves. Prey may be limited, however, because this region does not currently support large ungulate populations, particularly west of the Cascade Crest (WDFW 2009).

Gray wolves were formerly common throughout most of Washington. They declined rapidly between 1850 and 1900 due to killing by ranchers and farmers who considered them vermin. Between 1991 and 1995, there were 20 confirmed wolf sightings in Washington, 16 in the Cascades (Almack and Fitkin 1998). The state's first fully confirmed wolf pack was discovered not far from the eastern edge of the Park Complex in Okanogan County in 2008. This was followed by the discovery of single additional packs in Pend Oreille County in 2009 and 2010. In July 2011 packs were confirmed in both Kittitas and Stevens counties, bringing the known total to five packs inhabiting Washington. Small numbers of gray wolves persist within the Park Complex, as evidenced by annual observations. Recent confirmed sightings include areas just east of the Park Complex, near Hozomeen, and near McAlester Pass. During the winter of 2010-2011 wolves were photographed in the northeast part of the Park Complex, east of Ross Lake. The State of Washington is developing a wolf conservation and management plan, which is expected to be presented to the Washington State Fish and Wildlife Commission in August 2011. There is currently no USFWS recovery plan for wolves in the North Cascades.

Grizzly Bear *(Ursus arctos)* – Federal: threatened, State: endangered
Grizzly bears were listed by the USFWS as threatened in 1970 (35 FR 16047-16048). In the lower 48 states, remnant populations currently occur in Washington as well as Idaho, Wyoming, and Montana. The Grizzly Bear Recovery Plan (USFWS 1993) includes the North Cascades as one of the six ecosystems in which grizzly bears are known to have occurred within the decade prior to listing. Approximately 41 percent of the North Cascades recovery zone is within the Park Complex and surrounding designated wilderness areas. Priority recovery actions for the North Cascades Ecosystem as set out in the North Cascades Ecosystem recovery plan chapter are to: develop a strategy for implementation of the North Cascades grizzly bear recovery chapter; develop an intensive ongoing educational program to provide information about grizzly bears and grizzly bear recovery to the public; initiate the NEPA process to evaluate a range of alternatives to recover this population; conduct an intensive research and monitoring effort to determine grizzly bear population size and distribution, habitat use, and home ranges; and to implement the Interagency Grizzly Bear Guidelines (USFWS 1997).

The Park Complex and adjacent wilderness areas contain sufficient quality habitat to recover and maintain a grizzly bear population (USFWS 1997, Almack et al. 1993). The grizzly bear population in the North

Cascades Ecosystem, which includes British Columbia and Washington, has been estimated at <35 bears based on sighting data (IGBC-NCE Grizzly Bear Management Subcommittee - unpubl. report 2007). Population estimates based on DNA hair sampling methods are lower, about six bears for the entire ecosystem or 0.39 bears/100 square miles (0.15 bears/100 km) (Romain-Bondi et al. 2004, based on a project conducted in approximately 11% of the international ecosystem). Observations of grizzly bears within the North Cascades Ecosystem are very rare. Confirmed observations within the last 20 years include one south of Glacier Peak in 1996 and a male photographed in the Upper Skagit watershed in the spring of 2010. Natural recovery of grizzly bears in this region is considered unlikely due to the demographic and environmental stochastic events associated with small populations (Romain-Bondi et al. 2004).

Grizzly bears are omnivorous and opportunistic feeders. While their diet is often dominated by herbaceous material, they will prey on almost any available food including ground squirrels, ungulates, carrion, and garbage. Grizzly bears need high-protein high-carbohydrate foods in order to survive denning and post-denning periods. In the North Cascades region, grasses, roots, bulbs, tubers, and fungi are important food, especially in the spring after bears emerge from den sites. High quality foods such as berries, nuts, and fish are important in some areas (Interagency Grizzly Bear Committee 1987). Home ranges of grizzly bears encompass a mosaic of numerous habitat units or types. This phenomenon also may be related to the breadth of the species food habits. Use of cover varies with sex, age, reproductive status, human activity, or management (hunted or unhunted populations). Mating occurs from May through July with a peak in mid-June. Grizzly bears spend up to six months in dens beginning in October or November. Denning habitat is characterized by steep slopes where wind and topography cause accumulation of deep snow not likely to melt during warm periods (USFWS 1993); typically this habitat occurs above 5,670 feet in the North Cascades (Almack 1986). No den sites have been identified in the North Cascades but suitable denning habitat is not considered a limiting factor in this area (Almack 1986).

Pacific Fisher *(Martes pennanti pacifica)* – Federal: candidate, State: endangered
Pacific fishers were listed by USFWS as a candidate species in 2004 (69 FR 18770-18792). Fishers historically occurred in the northern coniferous and mixed forests of Canada and the northern US. Their range was dramatically reduced in the late 1800s and early 1900s due to over-trapping, predator and pest control, and alterations of forest habitats by logging, fire, and farming (Lewis and Stinson 1998). While fishers are generally associated with late-successional coniferous and mixed coniferous-deciduous forests, second growth forest with good cover may also be used. Core habitat zones on the east-slope of the Cascades include subalpine fir and grand fir/Douglas fir forests. Fishers require snags and logs for natal and maternal dens and rest sites.

In Washington, due to lack of recent sightings or trapping reports, the fisher is considered to be extirpated or reduced to scattered individuals (Aubry and Houston 1992). Recent remote camera surveys, targeting forest carnivore species failed to document fisher presence (Kuntz and Glesne 1993, Duke Engineering and Services 2000, Christophersen et al. 2005, and Christophersen 2006). Occasional observations are reported to park staff, but all sightings remain unconfirmed. In 2007, the fisher was reintroduced in Olympic National Park (P. Happe, NPS, 2008 pers. com.). If reintroduction efforts are successful on the Olympic Peninsula, similar efforts will be implemented in the Cascades.

Townsend's Big-eared Bat *(Corynorhinus townsendii)* – Federal: none, State: Candidate
Townsend's big-eared bats hibernate in caves and use caves, lava tubes, and abandoned buildings for breeding and roosting sites. Nursery colonies are extremely sensitive to human activity, and sites are

readily abandoned if disturbed. A Complex-wide baseline inventory of bats conducted in 1998-2001 did not document this species in the Park Complex (Christophersen and Kuntz 2003); however, this species was confirmed to be using an abandoned cabin within Ross Lake National Recreation Area in 2004 (Christophersen NPS field notes).

Western Gray Squirrel *(Sciurus griseus)* – Federal: none, State: threatened
Western gray squirrels are the largest native tree squirrel in Washington State. They assist in forage tree propagation by burying single seeds primarily as a food cache, but seeds not retrieved germinate to establish the next generation. The western gray squirrel ranges from north-central Washington south through Oregon to southern California. Historically, in Washington the western gray squirrel occurred in mixed conifer and oak communities from southern Puget Sound south to the Columbia River, east along the Columbia River through the Cascades and north along the east-slope of the Cascades to Okanogan County (Hall 1981). Today only three geographically isolated populations of this species remain in Washington (Bartels 2000, Linders 2000, Ryan and Carey 1995). Within each of these isolated populations, the numbers of squirrels or squirrel nests are thought to be declining. One population, found in Chelan and Okanogan counties, may be fragmented further into small sub-populations. One of these small sub-populations of squirrels is located within the Stehekin Valley, Lake Chelan National Recreation Area. While this sub-population continues to persist, a current research study has found mortality to be very high (K. Stewart, U. of Washington, 2010 pers. comm.).

Characteristics that make the western gray squirrel vulnerable to extinction include: reliance on increasingly rare large, old mixed oak and conifer forests; dependence on canopy travel for dispersal and escape; high susceptibility to disease; low reproductive rate (one litter per year) and slow recovery time from population reductions; small and isolated populations; and sensitivity to human disturbance. In the Chelan-Okanogan squirrel population, preferred habitat has been described as occurring in the grand fir-Douglas fir zone, typically in a densely vegetated valley with significant amounts of ponderosa pine near water (WDFW 1993).

3.9 Natural Soundscapes

Natural sounds are an important value for Park Complex visitors enjoying the ever present cascades of water that the park is so aptly named after, or in experiencing the solitude of the vast Stephen Mather Wilderness. Many wildlife species depend on sounds as part of complex communication networks. In habitats where wildlife vocalizations signify mating calls, danger from predators, or territorial claims, hearing these sounds is important to animal reproduction and survival. Noise, defined as un-natural, or human-caused sound, can impact both visitor experience and natural ecosystem functions. The NPS is required to preserve natural soundscapes of parks, which are composed of the natural sound conditions that exist in absence of any human-produced noises.

There are three major sources of noise intrusions that occur within the Park Complex: vehicles, aircraft, and motorboats. In general the frequency, magnitude, and duration of acceptable levels of un-natural sounds are greater in developed areas. In designated wilderness, noise intrusions still occur and are generally more noticeable. For example, aircraft can be heard from almost anywhere within the Park Complex; only in areas where rushing water masks aircraft noise does it become inaudible.

Invasive plant management activities typically do not produce unacceptable levels of noise; however, one project proposed under Alternative 2, the Stehekin Cheatgrass project, has the potential to impact the natural soundscape through the use of a motorized water pump and helicopter. The analysis for this

EA will concentrate on results obtained along the Rainbow Loop Trail in Stehekin, which is centered near the area where cheatgrass treatments would occur under Alternative 2. In 2009 sound data was collected near the Rainbow Loop Trail. Results show that the area has very few human-caused noises other than aircraft. Extrinsic (human-caused) noise can be heard 13.2 percent of the time at this site, with the majority being aircraft, which is heard 12.4 percent of the time. Existing ambient sound levels, measured in decibels audible (dBA), are identical with natural ambient sound levels (sound levels with all human–caused sounds removed), and include 33 dBA during the daytime and 34 dBA at night.

3.10 Cultural Resources

The rugged landscape of the North Cascades has been occupied and modified by human populations for thousands of years. Precontact indigenous peoples, whose descendants still occupy nearby lands, were followed in the 19th century by Euro-American explorers, miners, adventurers, and settlers, and, finally, in the 20th century, by government bureaucracies and utility companies. All left evidence of their presence in the form of a variety of cultural resources ranging from prehistoric quarries and lithic scatters to modern hydroelectric complexes.

Two hundred and sixty-six (266) prehistoric archeological sites are recorded within the Park Complex. These sites are found in all altitudinal zones, including the alpine and subalpine; most are found within major river valleys and their tributaries. Site types include lithic scatters; stone quarries and collecting areas; hunting, gathering, fishing, and food processing camps; rock shelters and overhangs; rock features including talus pits, rock walls and alignments, and rock cairns; pictographs; culturally-modified trees; villages and camps; and prehistoric trails and resource use areas. As a group, these sites reveal that the mountains of the North Cascades were used by Native Americans much more than earlier researchers believed.

Historic archeological sites and structures presently identified within the Park Complex are associated with 19th and early 20th century settlement and mining. Aside from the 1984 Historic Structures Inventory, which identified several structural historic sites for consideration as historic archeological sites, systematic survey for historic archeological sites is routinely conducted concurrent with surveys for prehistoric archeological sites. As a result, 44 historic archeological sites are recorded in the Park Complex.

Ethnographic resources potentially constitute another type of cultural resource. These are resource types that reflect traditional and contemporary use by park-associated groups, whether they be tribal governments and their members or members of other communities. The resource types may consist of ceremonial/spiritual locations, resource use areas, traditional cultural properties that embody values central to a group's history, origin, and cultural identity. These resource types are identified through consultation with representatives of the several park-associated, federally-recognized tribes.

Less than five percent of the total Park Complex area has been surveyed at any level for prehistoric or historic sites. Since the early 1970s, a variety of small, project-driven archeological surveys have been conducted in compliance with Section 106 of the NHPA (National Historic Preservation Act). A reconnaissance-level inventory in the Park Complex was undertaken in 1977 to determine the potential for archeological resources. In 1986 an Archeological Overview and Assessment predicted that many hundreds of prehistoric and historic sites probably exist within park boundaries. Archeological inventories between 1988 and 1993 were focused on Ross Lake with funding assistance provided under a Memorandum of Agreement between NPS and Seattle City Light. Since 1992 systematic surveys and site evaluations have been undertaken in compliance with Section 110 of the NHPA through the NPS System-wide Archeological Inventory Program. The park's archeological overview and research design has successfully guided implementation of subsequent investigations.

NPS Management Policies (2006) provides guidance for the management of invasive (or exotic) species located within cultural landscapes. It states that, “In rare situations, an exotic species may be introduced or maintained to meet specific, identified management needs when all feasible and prudent measures to minimize the risk of harm have been taken and it is…needed to meet the desired condition of a historic resource, but only where it is noninvasive and is prevented from being invasive by such means as cultivating (for plants), or tethering, herding, or pasturing (for animals). In such cases, the exotic species used must be known to be historically significant, to have existed in the park during the park’s period of historical significance, to be a contributing element to a cultural landscape, or to have been commonly used in the local area at that time.”

Where non-native species are features of park developments or National Register eligible cultural landscapes, NPS staff assess the ecological risk of these species (for example, the ability to spread into adjacent landscapes) and the cost of maintaining the cultural landscape and preventing their spread outside this boundary. Non-native plants that pose no significant threat or nuisance in surrounding natural areas are exempt from control efforts within the boundaries of developments and cultural landscapes, whereas non-native (invasive) plants that pose a threat or are a nuisance will be managed as appropriate, taking cultural and historic resource needs into account, to prevent further natural resource management problems.

Each project proposed in this EA constitutes a federal undertaking. Prior to any undertaking the NPS will make an assessment of its effect to cultural resources. There are three projects proposed to take place within National Historic Districts. These include the Buckner Homestead Historic District, the Stehekin Landing (includes the Golden West Historic District), and the Marblemount Ranger Station Historic District.

Buckner Homestead Historic District

This district in Stehekin incorporates the largest group of structures relating to the theme of early settlement within the resource area. Representing a time period of over six decades, from 1889 to the 1950s, the district is comprised of 15 buildings, landscape structures and ruins, and over 50 acres of land planted in orchard and criss-crossed by hand-dug irrigation ditches.

The homestead remained a working farm until fairly recent times. In all, the district retains a high degree of integrity, both in the structures and the landscape. Elaborate floral gardens were planted, including a "flag bed" and a flower pattern delineating the letter "B." A variety of ornamentals were grown, including dogwood, lily, poppy, periwinkle, pansy, and rose. Today the primary species include blanket flowers (*Gaillardia sp.*), Shasta daisies (*Chrysanthemum maximum*), and periwinkle. The Buckner Homestead Historic District Management Plan (1998) calls for reestablishment of the historic gardens with perennial plants. Non-historic ornamental plants will be approved by the NPS based on factors such as visual similarity to historic plantings (color, shape, blossom, etc.), environmental viability, minimal ability to re-seed and potentially escape as an exotic plant, and whether they are annual or perennial.

Golden West Historic District

The Golden West Lodge Historic District is located at the Stehekin Landing. The complex sits high on a slope overlooking Lake Chelan and craggy snow-covered peaks, clearly sited to take advantage of the area’s scenic views. The eight contributing buildings within the district were built between 1926 and

1945. The Historic District is significant on a local level for its associations with recreation and recreational developments in the North Cascades between 1926 and WW II. Further, it represents the only extant example of large-scale wilderness resort development in the North Cascades. The area nominated includes (approximately) four acres.

Modest in appearance, the Golden West Lodge has not changed substantially since first constructed. Its use has changed from that of a resort facility to a seasonal visitor and administrative headquarters by the National Park Service. The associated outbuildings, integral components of the historic complex, also retain a high degree of integrity. The landscape has changed minimally from when the complex operated as a resort lodge. The lodge itself overlooked an extensive series of stepped terraced lawns delineated by native rock walls and planted with grasses and beds of decorative plants. The gardens contained native and non-native plants; irises and roses are the only non-native ornamental plants that still remain in the area.

Marblemount Ranger Station Historic District

The Marblemount Ranger Station is an administrative facility within North Cascades National Park Service Complex that has been operated and expanded by the National Park Service since 1968. The Ranger Station was originally built by the United States Forest Service, and has existed in this location since 1908. The Marblemount Ranger Station Historic District is less than one quarter of the area of the whole Ranger Station proper. The Historic District has nine contributing buildings/structures, three contributing landscape features, and four contributing vegetation features. The Historic District represents the core of the Ranger Station that remains from the 1920s and 1930s. It is an integral part of the everyday functioning of the larger Marblemount Ranger Station, which currently serves as an administrative center, a maintenance facility, a residential area, a visitor contact station, a center of search and rescue, firefighting, and trail crew operations, and the center of the greenhouse and revegetation program for the entire Park Complex. The Marblemount Ranger Station Historic District is significant for its design and construction as an early USFS-style administrative facility, and for its association with the event of the early governmental administration of the public lands of the North Cascades Mountains.

Vegetation is a landscape characteristic of the Marblemount Ranger Station, as the overall types of vegetation that were planted or incorporated in the historic period remain relatively unchanged since the period of significance. The types of vegetation fall into three categories, the forest edge vegetation, the low grasses or lawn areas, and a mixture of native and non-native woody vegetation planted as either solitary specimens, an experimental grove or as ornamental groupings at various locations within the five-acre area.

District Ranger Tommy Thompson was the longest serving (1915-1943) district ranger at Marblemount Ranger Station and the historic physical development there is largely due to his length of tenure. During his service, Thompson planted an experimental grove of non-native northern red oaks at the ranger station to investigate their potential for timber products. He also planted a single specimen red oak in the open meadow area of the ranger station. The oak tree was given the name "Council Oak" in 1990s. Both the Council Oak and the oak grove are contributing elements to the Historic District.

3.11 Stephen Mather Wilderness

Geographic Overview

The Stephen Mather Wilderness was established by Congress in 1988 by the Washington Park Wilderness Act. Over 642,000 acres of North Cascades National Park Service Complex was designated wilderness, including 99.95% of North Cascades National Park, 89% of Lake Chelan National Recreation Area, and 73% of Ross Lake National Recreation Area. Five thousand acres within Ross Lake NRA were designated “potential wilderness” contingent on Seattle City Light’s plans to implement other hydroelectric projects. Where Ross Lake and Lake Chelan NRA share a boundary with North Cascades National Park, the Stephen Mather Wilderness continues seamlessly. Almost 55% of the Park Complex is bounded by designated wilderness managed by the US Forest Service, including the Glacier Peak, Lake Chelan-Sawtooth, Mount Baker, Noisy-Diobsud, and Pasayten wilderness areas.

Wilderness Character

The Stephen Mather Wilderness is at the core of one of the largest protected areas in the lower 48 states. It encompasses jagged mountain peaks flanked by spectacular glaciers and snowfields, colorful subalpine meadows, countless cascading waterfalls, and deep valleys of old-growth forest. Numerous trails provide access from the North Cascades Highway, Diablo and Ross Lake reservoirs, Lake Chelan, and Stehekin. Opportunities to experience solitude, mental and physical challenge, and discovery abound in this wilderness area.

Agencies responsible for administration of designated wilderness are required by law to preserve the wilderness character of the area. Managers at the Park Complex use a Minimum Requirements Analysis (Appendix C) to determine if, when, and how administrative actions that might impact wilderness character can be implemented. There are four qualities derived from the statutory language of the 1964 Wilderness Act that are used to describe wilderness character:

Untrammeled: *wilderness is essentially unhindered and free from modern human control or manipulation*

Natural: *wilderness ecological systems are substantially free from the effects of modern civilization*

Undeveloped: *wilderness is essentially without permanent improvements or modern human occupation*

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: *wilderness provides outstanding opportunities for people to experience natural sights and sounds, solitude, freedom, risk, and the physical and emotional challenges of self-discovery and self-reliance*

THE FOUR QUALITIES OF WILDERNESS CHARACTER:

- Untrammeled
- Natural
- Undeveloped
- Outstanding opportunities for solitude or a primitive & unconfined type of recreation

The current condition of wilderness character within the Park Complex is described below with regard to how well it retains these four qualities.

"Untrammeled"

The Stephen Mather Wilderness is generally unhindered and free from most human manipulation. There are two authorized actions, however, that occur within wilderness that degrade the untrammeled quality of wilderness character: fire suppression and fish stocking or removal. Suppression is chosen as a management action when the fire threatens life, improvements, or is determined to be a threat to natural and cultural resources. The act of suppressing the fire, regardless of how many acres it has burned or will burn, manipulates wilderness.

Ninety one mountain lakes (excluding small ponds) within the wilderness have a history of being stocked with non-native fish by the Washington Department of Fish and wildlife as part of its recreational fishery program. Under the 2008 Mountain Lakes Fishery Management Plan removal of reproducing populations of fish and cessation of fish stocking may occur in some lakes. Both stocking and removal of fish is a significant manipulation that degrades the untrammeled quality of wilderness character.

One unauthorized action that has been known to occur within the wilderness on at least one occasion is the development of a large-scale marijuana plantation. This type of action, though it can be small in size, is the most egregious example of trammeling wilderness.

"Natural"

Ecological systems within the Stephen Mather Wilderness are affected by things that happen both inside and outside the wilderness boundary. Affected components can be grouped by plant and animal species and communities, physical resources, and biophysical processes.

Plant species and communities

The condition of plant species and communities within the wilderness is generally good; there are no known federally listed species and no known extirpated species in the area. There are 39 known state-listed species, most of which are on this list due to restricted habitats, habitat degradation (outside NPS boundaries), and range limits (those species which are more abundant elsewhere). Out of approximately 225 non-native species in the entire Park Complex, 40 of them are considered invasive. The largest invasive plant threats to the natural quality of wilderness character come from reed canarygrass (Phalaris arundinacea), which was recently found in the Big Beaver Valley wetland system; and cheatgrass (Bromus tectorum), which occurs both along valley walls in Stehekin and above Ross Lake. These infestations have the potential to change this ecosystem from a highly diverse system, both in habitats and vascular and nonvascular plants, to a system with reduced diversity.

Other threats to plant species and communities include white pine blister rust, which is an invasive, non-native fungus that is threatening the survival of whitebark pines and Western white pines throughout the Park Complex; and mountain pine beetles, a native species that threatens pines, and whose population has exploded due to recent warmer winters and an abundance of drought-stressed trees – conditions which are likely the result of climate change and wildland fire suppression. Fire suppression may have exasperated the beetle problem. This major die-off of pine trees will change a large portion of the overstory plant communities within wilderness. As fuel loads continue to build in an area already impacted from past fire suppression, the chance for large, uncontrollable and unnatural wildfires increases.

Animal species and communities

The condition of habitat within the wilderness is generally within the range of naturally occurring conditions, but there are several fish and wildlife species that are in low abundance or are missing within the

Park Complex. The wilderness provides habitat for seven federally listed fish and wildlife species and 10 state listed species (some of which are also federally listed). Animals are on these lists due to over-harvesting, habitat loss, and impacts associated with non-native species. No non-native mammals, reptiles or amphibians have been documented in the area. The rock pigeon, European starling, and house sparrow are non-native birds known to be within the Park Complex but have not been documented within wilderness. The barred owl, an eastern species that has expanded its range westward, can be found in wilderness. Its ability to outcompete spotted owls may be contributing to dwindling numbers of spotted owls across the west.

Three non-native fish species are present within the wilderness as a result of stocking. Although the reservoirs are located outside of designated wilderness, they have significant impacts on demography and composition of communities within wilderness. When the reservoirs are full they inundate formerly impassable fish barriers and provide access to historically fish-free habitat (the falls at Big Beaver Creek, for example). These conditions have increased the amount spawning and rearing habitat for both native and non-native species. The recent invasion and population explosion of the non-native red-sided shiner has altered the ecology of Ross and Diablo lakes with unknown long-term effects on the food webs, nutrient cycles, and native fish populations in these systems.

Physical resources

Air quality is generally good in the wilderness. There is no apparent overall degradation in visibility, no apparent trends in sulfur and nitrogen, and a slight decrease in ozone between 1996 and 2005. However, recent research focusing on atmospheric pollution deposited in snow, from fog, and in surface water systems shows that we are receiving mercury and pesticide pollution from sources adjacent to the Park Complex as well as from across the Pacific Ocean. A wide range of pollutants have been found in vegetation samples, PCBs and pesticides have been found in lichens, and mercury and organochlorine compounds have been found in fish tissue. Water quality is very good in the Stephen Mather Wilderness. Human-caused soil disturbance or erosion occurs at a very localized scale, usually around trails that are snow-covered well into summer or in campsites where bare ground disturbance has increased over time. Soil crusts in wilderness are generally in good condition.

Biophysical processes

Most biophysical processes are intact and functioning naturally within the wilderness. A few natural processes are disrupted due to human influence, however. It is likely that natural fire regimes have been altered by fire suppression in and around Stehekin and on the east side of Ross Lake, where the majority of natural fires have occurred. Fire suppression enables dead and downed fuels to accumulate, thus increasing the potential for larger and more severe fires in the future. In turn, these higher severity fires have the potential to exacerbate soil erosion and volatize more nutrients than would be lost in less severe events (Agee 1993).

Creation of the reservoirs, and to a lesser extent, the North Cascades Highway, has resulted in a loss of connectivity with the surrounding landscape for a number of species. Although black bears and moose have been known to swim across the reservoirs, these features serve as significant barriers to movement for smaller mammals, and have likely altered the movements of the larger mammals as well. Loss of the Upper Skagit Valley due to the creation of Ross Dam has resulted in a general lack of suitable low elevation winter habitat for ungulates and other species. Although there are some large, flat, low elevation tributaries like Thunder and Big Beaver, they are higher in elevation and somewhat isolated in comparison to the Skagit.

The impact of climate change on natural processes is a growing concern. Impacts include decreased snow cover, glacial retreat, decreased summer stream flow, increased frequency and magnitude of floods, increased stream temperature, rising tree line, changes in phenology, and longer growing seasons. This partial list of changes is resulting in ecological changes that we are not currently monitoring.

"Undeveloped"

For the purpose of this description, and following guidance of "Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System (Landres 2008)," this section only monitors non-recreational developments, such as administrative or instrumentation sites. Recreation-focused developments, such as trails, camps, and toilets, are monitored under the solitude or primitive and unconfined recreation quality because of the strong connection these features have to recreational experiences.

The "undeveloped" quality of wilderness character within the Stephen Mather Wilderness is generally good. Installations include meteorological monitoring stations, Snowpack Telemetry (SNOTEL) sites, and radio repeaters. Two high elevation meteorological monitoring stations are operated by the National Park Service and consist of a 20-foot tower anchored to bedrock with instrumentation and solar panels attached to the tower at each site. Five mid-elevation SNOTEL sites are operated by the USDA Natural Resource Conservation Service for hydrometeorological modeling of mountain snowpack. They consist of an approximate 75-foot diameter footprint that includes an instrument shelter, a 24-foot tall precipitation gauge, two towers (16 and 30 feet tall), a leveled 20-foot diameter earthen pad, a marker pole, and three underground fluid lines. There are currently three mountaintop radio repeaters within wilderness that consist of equipment shelters and towers measuring up to 32 feet in height. An additional repeater is scheduled to be installed at Desolation Peak in the near future.

Fifteen historic structures are located within the wilderness, including cabins, shelters, fire lookouts, and mines. These protected cultural resources contribute positively to wilderness character because they help us understand our past and present relationship with the land.

Motorized equipment and aircraft (e.g., chainsaws and helicopters) are used for administrative purposes within the wilderness.

"Opportunities for solitude or primitive and unconfined recreation"

Opportunities for solitude within the Stephen Mather Wilderness are abundant. Local topography, dense vegetation, and spacing of campsites and trails within the wilderness provide a sense of remoteness from the sights and sounds of other people that may be nearby. Night sky visibility is excellent at lower elevations but diminishes at higher elevations where light pollution becomes visible from the Seattle and Vancouver metropolitan areas. The natural soundscape is in good condition, though noise intrusions occur from aircraft, motorboats, highway traffic, and NPS administrative activities. Aircraft noise can be heard throughout the wilderness at any time of day, but motorboat and highway noise significantly drops during nighttime hours. The source of NPS-generated noise typically includes chainsaw use to support trail maintenance activities and helicopter use to support fire management, trails, search and rescue, and resource management activities.

Opportunities for primitive and unconfined recreation are reduced by a number of facilities that decrease self-reliant recreation. A well-developed trail system and designated campsites with Wallowa toilets are the norm in this wilderness area. Trail signs at junctions and hitch rails at designated stock camps are common. Bridges made of both natural and steel materials are common facilities used to aid in stream crossings. Well-defined routes can be found in most cross country zones. Food storage boxes are provided at four camps on the west side of the park for the storage of food and other attractants in order to protect visitors, bears, and other wildlife; visitors are required to store food appropriately by either hanging or using canisters at all other camps. Management restrictions include backcountry camping permit requirements, limited use of campfires, and required use of designated campsites or campsite setbacks for cross country zone camping. These facilities and management restrictions are used to manage impacts from visitor use by spacing people out along trails and confining impacts to specific, localized areas.

3.12 Visitor Use and Experience

On average, about 400,000 people visit the Park Complex annually, mostly between the months of June and October. The largest concentration of visitors (90%) is along the State Route 20 corridor in Ross Lake National Recreation Area. The highway serves as the primary means of access for the majority of Park Complex visitors; it has heavy use during the summer, attracting people who stop to enjoy the scenic vistas, picnic, day hike, fish, bicycle, camp, or participate in educational activities. Other access points include Stehekin, which is reached via boat, foot, or plane; and Hozomeen, which is accessible by road through British Columbia, Canada, or via foot or boat through the US. Visitor activities in or near the Skagit and Stehekin rivers include rafting, fishing, sightseeing, hiking, boating, and camping. There are five car campgrounds within the Park Complex; four of which are along State Route 20, and one at Hozomeen that is accessed via Canada. The Environmental Learning Center, an educational facility operated by North Cascades Institute and located on Diablo Lake, opened in 2005.

In the backcountry, visitor activities include hiking, backpacking, mountaineering, horseback riding, and fishing. There are 386 miles of maintained trails in the Park Complex, and approximately 135 camps with over 300 tent sites have been designated along the trails. Since 1974, there has been an average of 30,000 backcountry use nights per year (total number of nights spent in the backcountry). Mountain climbing and cross-country use have increased significantly in recent years, and are currently estimated at 6,500 visitor nights annually.

Approximately 227 miles of trail, or 59% of total trails within the Park Complex (not including stock camp access trails), are stock accessible. Over the last nine years, overnight stock use has averaged about 23 parties per year using 148 stock animals each year. Unfortunately it is difficult to estimate private stock day use, since day use isn't tracked within the Park Complex, but the NPS estimates that it is likely as much or slightly less than the amount of overnight use. Commercial day rides occur in Stehekin and consist of daily summer trips to Coon Lake, which over the last six years have averaged about 520 horseback riders per year. There is additionally one commercial use permit issued to a pack stock outfitter in Stehekin for overnight use. Stock use occurring under this permit over the last six years has ranged from one to five trips per year using between 10 and 65 horses each year. This figure is likely underestimated because only overnight trips for which parties camp within NPS boundaries are tracked; trips that begin on NPS land but travel to US Forest Service land to camp are not counted. Another commercial use permit that allows stock use is issued in Stehekin for setting up, resupplying, and taking down a tent to tent camping service along the old Stehekin Road. Stock use consists of three horses used to set up and then take down the operation each year, and one horse used to resupply the operation between three and six times per year.

During the winter months, visitation drastically drops. Much of the Park Complex becomes inaccessible due to heavy snowfall, avalanche danger, and road closures. State Route 20 is closed between Ross Dam at milepost 134 and Early Winters at Milepost 178 from about mid-November to mid-April. Ferry access to Stehekin also declines to three to five ferry trips per week. Winter recreation in the Complex includes snowshoeing, cross-country skiing, hiking in the lower elevations, and wildlife observations.

Though it is classified as an emergency airstrip, the Stehekin Airstrip receives a fair amount of public use while it is open between June and September. The Washington State Department of Transportation – Aeronautics Division estimates that an average of 300 takeoffs/landings occur annually at the airstrip.

Visitor use activities have the potential to exacerbate existing invasive plant infestations, as well as introduce new invasive plants to un-infested areas. Weed seeds or propagules can be transported by vehicles, including cars, trucks, boats, and planes; in the hair or waste of stock animals or pets; or on the clothing, gear, and shoes of visitors. Invasive plants also have the potential to impact visitor experience by altering scenic landscapes and limiting access when thick infestations prevent entry into areas (especially with species such as blackberries and knotweed).

3.13 Human Health and Safety

There are certain amounts of risk to human health and safety associated with invasive plant management activities. Potential impacts to both park employees and members of the public are possible. For example, employees conducting surveys or treatments can be subject to working in rough terrain and harsh weather conditions. Work along busy roads, highways, and developed areas puts employees at risk from inattentive drivers. Equipment that is used for invasive plant removal, such as hand tools, backpack sprayers, and ATVs, if used improperly, can cause injury. Inappropriate herbicide application puts both employees and the public at risk of exposure. To reduce or eliminate these health and safety risks, the Park Complex has in place a number of safety protocols:

- Job hazard analyses are developed to identify potential hazards of particular activities, such as mechanical removal, herbicide application, and working along high-use areas such as SR 20. Each analysis defines the activity, identifies the hazards associated with each phase of the activity, and identifies ways in which to minimize or eliminate hazardous conditions that could result in injury.
- Equipment used for invasive plant management is considered a standard device with established safety protocols for its use; training on the proper use of equipment, including herbicide application, occurs every year with invasive plant management employees.
- Safety protocols for storing, mixing, transporting, application, handling spills, and disposing of unused herbicides and containers are followed at all times.
- Areas treated with herbicides are marked during the no-entry period to advise visitors against entering treated areas. Visitor information center employees also inform visitors of treatments taking place in areas included in their itinerary.

3.14 Socioeconomics

Several of the Best Management Practices proposed to reduce the effects that pack stock animals have on the spread of invasive plants have the potential to impact pack stock users within the Park Complex. The BMPs include a new requirement of the use of weed-free feed for all stock that enter the Park Complex, and encouraged use of weed-free feed for stock 24 hours prior to entering the Park Complex to account for the transport of weed seeds in stock manure.

Unlike other western states, weed-free feed is not required throughout the State of Washington; however, it is required on all National Forest lands. In 2009 a weed-free feed order was issued by the US

Forest Service Pacific Northwest Region (including 17 national forests in Washington and Oregon) requiring livestock owners to use feed that is either commercially processed feed or crop products certified to be free of weed seeds.

In 2008 the Washington State Noxious Weed Control Board began a pilot program to manage the weed-free inspection and certification program for the state, called the Washington Wilderness Hay and Mulch (WWHAM) program. Weed-free hay or crop products have been inspected according to standards used by the North American Weed Management Association (NAWMA) and member states. Under NAWMA standards, fields are inspected to ensure the absence of seed and reproductive parts from listed invasive weed species. Fields which pass the inspection are state certified and the producer may then officially label the products as a weed-free hay or crop product. The program has steadily increased in participation each year—so much so that the Washington State Department of Agriculture was asked to manage the program in 2011.

3.15 Park and Partner Operations

Invasive plant management is one of many operations that the Park Complex is committed to managing. Personnel from every division assist with invasive plant management, especially those who are in the field and can assist with prevention, early detection, and control efforts.

In addition to assisting with invasive plant management, there are a number of administrative activities that can also have a direct negative impact on invasive plant infestations. These include day to day maintenance activities as well as new construction, both of which typically involve ground disturbance, importation of fill, and/or importation of vegetative material. Activities such as ditch clearing, brush cutting, the use of fill for various road, trail, and campsite maintenance projects, and the use of imported soil for revegetation projects can exacerbate existing invasive plant infestations or introduce new species or new infestations to a previously un-infested area. Administrative stock use also has the potential to spread new invasive plants or exacerbate existing infestations. The Park Complex mitigates these potential impacts by feeding pack stock certified weed-free feed prior to each trip and throughout the duration of each stay within park boundaries.

Actions by park partners also have the potential to exacerbate invasive plant infestations in much the same way as park operations do. Park partners include Seattle City Light (SCL), Washington State Department of Transportation (WSDOT), and North Cascades Institute (NCI). Actions that could exacerbate invasive plant infestations include right-of-way clearing, road maintenance, and ornamental plantings by SCL; ditching of debris, mowing, and importation of sand/gravel by WSDOT; and grounds maintenance, manicured landscapes, and off-trail travel by a large number of school groups with NCI.

The Park Complex will attempt to mitigate these potential impacts by following the Best Management Practices (BMPs) found in Appendix E and requiring partners, contractors, and concessioners that work within park boundaries to follow the same guidelines.

4 ENVIRONMENTAL CONSEQUENCES

The impact analysis in this chapter is designed to predict the degree to which the resources listed in Chapter 3 – Affected Environment could be affected upon implementation of each of the alternatives. Each resource described in Chapter 3 has been analyzed for the direct, indirect, and cumulative impacts that might occur as a result of implementing one of the alternatives. Direct impacts are caused immediately by an action and they occur in the same place as the action. Indirect impacts are caused by the action but they occur later in time or farther away in distance from the action. Cumulative impacts have additive effects on a particular resource; they include impacts of actions in the past, present, and the reasonably foreseeable future.

The NPS is required by law to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. Adverse impacts that constitute impairment are prohibited. Impairment is an impact that would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources. Proposed actions that could lead to impairment must be thoroughly analyzed, and before being approved the impacts of the proposed action must be considered and determined, in writing, that the activity will not lead to impairment of park resources or values. If it is determined that an activity leads or might lead to impairment, the NPS is required to take action, to the extent possible, to eliminate the impairment. An impairment determination for the Preferred Alternative is in Appendix K. Guidance for determining impacts and the prohibition on impairment was established by the Organic Act of 1916 and reaffirmed by the General Authorities Act of 1970, as amended in 1978.

Methodology

In this chapter, the impacts of each alternative on each resource are identified, and the context, duration, and intensity of impacts are defined. The duration and intensity of impacts were determined after a review of scientific journals, field investigations, and the best professional judgments of NPS staff and consultants. Impacts are quantified in numbers when possible, and are described qualitatively based on intensity and duration. Impact definitions are described below. Mitigation measures (in the form of Best Management Practices) designed to minimize impacts are identified in Appendix E.

Nature of Impact
Adverse Impact: Moves the system away from the desired condition
Beneficial Impact: Moves the system toward the desired condition

Duration of Impact
Short-term: During project work or up to one year
Long-term: Longer than one year

Intensity of Impact
Negligible: Imperceptible, not measurable, or undetectable.

Minor: Slightly perceptible or measurable and limited in extent. Without further actions, impacts would reverse and the resource would return to the previous condition.

Moderate: Readily apparent and measurable but limited in extent. Without further actions, impacts would eventually reverse and the resource would return to the previous condition. Individuals of a species would be harmed or killed, with slightly measurable impacts to the population or surrounding community.

Major: Substantial and measurable, highly noticeable, and affecting a large area. Changes would not reverse without active management. Entire communities of species would be measurably affected.

4.1 Soils

Impacts of Alternative 1 – Current Management, on Soils

If left untreated, invasive plant infestations can impact soil function, organization, and structure in a number of ways. Invasive plants impact soil function by altering the dynamics of soil moisture and nutrient cycling. For example, the establishment of cheatgrass in forested systems could result in more frequent fires, favoring the establishment of cheatgrass over perennial grasses and forbs. Cheatgrass would thereby deplete soil nutrients earlier in the growing season, and with its shallow root system present a greater chance of erosion on steep slopes. Several invasive plants species, such as Scotch broom, evergreen (sweet) pea, and white sweetclover, change soil chemistry by increasing nitrogen levels, which in turn results in conditions that do not favor native plants, since they are adapted to low-nitrogen soils. Overall soil productivity would then decrease, lessening the chances of recovery of native vegetation that would replenish the soil of depleted nutrients.

Invasive plants may affect soil organization by deposition of secondary compounds, an effect known as allelopathy. Of the priority species in the Park Complex, both knapweeds and herb Robert are known to demonstrate this allelopathic effect. Allelopathic chemicals may affect the soil microbial community, as well as the recruitment of native plant species, allowing for a monoculture of an invasive species to establish.

Soil structure may also change as invasive plants become the dominant vegetation type in a system. Many problematic invasive plants have thick taproots as opposed to the fine fibrous roots of native herbaceous species. These taproots tend to be deeper than those of native species, and decompose more slowly. This can result in a reduced annual deposition of organic matter to the soil, reducing its nutrient value, as well as lead to erosion as tap rooted plants do not aggregate soil as aggressively as native species (Sheley and Petroff 1999). Conversely, in dynamic wetland or riverine systems, where soils are often transported, stabilization can occur by species such as knotweed and reed canarygrass. The effects include reductions in channel movement and changes in nutrient availability. Given the relatively small area in which invasive plants occur within the Park Complex, the impacts to soils would be extremely localized but they would be moderate, adverse, and long-term in duration, if left untreated.

Treatment of invasive plants impacts soils in both adverse and beneficial ways. Mechanical removal often causes ground disturbance, which can promote germination of invasive plant seeds that are present in the soil (i.e., the seed bank). Many invasive plant species have long-lived seeds, and ground disturbance that results from plant removal can exacerbate the infestation until the seed bank is greatly reduced. Herbicide treatments can be used to avoid ground disturbance; however, herbicide use has its own unique impacts to soils, including changes in soil chemistry and microbial communities. Herbicides usually end up in the soil, either directly during application, or indirectly through a plant (Sheley and Petroff 1999). All herbicides eventually degrade; however, the rates at which individual herbicides degrade vary widely. Half-lives of different herbicides in the soil can range from a few days to six months for the formulations proposed under this alternative. Generally, soils are more likely to degrade herbicides rapidly if they are fertile, well-watered, and support a healthy microbial population. The creation of bare ground as a result of invasive plant removal can cause a short-term increase in erodability before native plants are re-established. Residual impacts from herbicides could result in bare ground for longer than normal periods of time. The impacts from both mechanical and chemical treatment of invasive plants on soils would be extremely localized, short-term, and minor.

Removal of invasive plants and restoration of an area to natural conditions promotes natural ecosystem functions. Soils that are unaltered from invasive plants can better support native plant communities and the wildlife that depends on the area for habitat. Soil microorganisms, soil chemistry, and hydrologic cycles would benefit from restoration of infested areas. Impacts would be long-term and beneficial.

Impacts of Alternative 2 – IPM with Herbicides, on Soils

Under Alternative 2, removal of invasive plants and restoration of natural conditions would have long-term benefits to soils. Beneficial impacts would be similar to those described under Alternative 1, but they would occur on a greater scale as more invasive plant treatments would be implemented. Treatment of some of the larger infestations, such as knotweed and reed canarygrass from riparian zones, or cheatgrass from the Stehekin Valley, would allow impacted areas to recover and to better support natural soil functions. Restoration efforts could speed the recovery process for disturbed sites by returning organic matter, nutrients, and moisture back into the soil. The impacts of non-treatment as described in Alternative 1 would not occur.

Under this alternative, there would be an increase in herbicide treatments and a decrease in ground disturbance impacts compared to Alternative 1. Impacts from herbicides would be similar to those described in Alternative 1, but they would occur more often at first as a greater number of projects are undertaken. With time, as infestations are treated more readily and smaller herbicide applications would be needed, the impacts from herbicides to soils would decrease. Soil disturbance caused by mechanical removal could be minimized in areas that have large non-native seed banks if they are treated with herbicides. Adverse impacts from mechanical and herbicide treatments under this alternative would be short-term and range from minor to moderate.

Impacts of Alternative 3 – IPM without Herbicides, on Soils

The impacts of Alternative 3 on soils would be similar to those described in Alternative 1, except that impacts from herbicide use would not occur, and impacts to soils from invasive plants that are difficult to control without herbicides could increase. Additional mechanical treatments to control or contain some species would increase disturbance to soils compared to the other alternatives, resulting in larger infestations until the seed bank is depleted. Untreated knotweed stands and reed canarygrass could further contribute to soil stabilization in dynamic riparian and wetland areas, resulting in reductions in channel movement and changes in nutrient availability. Overall adverse impacts to soils would be long-term and moderate.

Cumulative Impacts on Soils

Impacts to soils have resulted from the clearing of vegetation and associated soil compaction and/or disturbance created by large machinery for logging, mining, grazing, settlements, water diversions, hydroelectric operations, an airstrip, and park developments. These impacts occur over a small percentage of total Park Complex land area. Current and future impacts to soils are due to ongoing disturbance. Ongoing impacts include soil compaction and disturbance from visitor use; impacts can be found at scenic pullouts, trailheads, campgrounds and campsites, and other attractions that concentrate visitors. Other ongoing impacts are the result of maintenance activities, such as road maintenance, trail building or maintenance, and other earth-moving activities.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to soils. Treatments under all alternatives will improve soil conditions over the long-term.

4.2 Hydrology and Water Quality

Impacts of Alternative 1 – Current Management, on Hydrology and Water Quality

Invasive plants impact hydrology and water quality in a number of ways. They are capable of altering hydrologic flows and conditions, such as altering water table depths, consuming water and nutrient resources, and altering oxygen levels. Often, they shade slower-growing native plants that help to stabilize banks in riparian zones (Donaldson 1997). Moderate bank destabilization can lead to undercut banks and eventually widening of the stream channel. Un-shaded sections of stream will usually increase water temperatures, and in turn reduce aquatic habitat value. Species such as knotweed and reed canarygrass can actually stabilize river and wetland systems and prevent channel migration in an otherwise dynamic system. Invasives can contribute to increased sediment production in waterways by decreasing water infiltration and increasing erosion. On slopes infested with cheatgrass, erosion potential increases, leading to siltation of waterways. Bank and bed erosion usually occurs when invasive tap-rooted plants replace native plants with fibrous root systems, which are less able to withstand high water (flood) events (Donaldson 1997).

Waterways also act as transport mechanisms for the spread of invasive plants. Seeds and plant fragments are transported by high water events to constantly disturbed features such as sandbars and side channels where they rapidly fill open niches.

If left untreated, invasive plants would cause long-term moderate, adverse impacts to hydrology and water quality. Invasive plants growing in riparian zones would continue to impact hydrologic conditions, bank stabilization and sediment loads, and areas yet to be invaded. Primary productivity provided by infested wetlands would decrease, impacting aquatic and terrestrial food webs. The potential for knotweed to spread during extreme changes in stream flow or channel migration is high. For example, surveys conducted of knotweed populations in the Stehekin River drainage in 2004 to 2005 and again in 2009 showed almost a 100% increase in population size and density. Due to the exceptional viability of knotweed rhizomes and canes, vegetative material transported during regular flood events is the most likely cause of this increase. Reed canarygrass would continue to spread during reservoir draw downs on Ross Lake and Lake Chelan, as well as moving up trails and streams into sensitive wetlands, as has already occurred in the Big Beaver drainage. Reed canarygrass populations that are present in shallow wetland areas have demonstrated the capacity to withstand the relatively short period of full-pool on Ross Lake, subsequently recovering enough to set seed in September and October.

Both beneficial and adverse impacts to hydrology and water quality would occur as a result of treatments under this alternative. Restoration of infested areas would have long-term beneficial impacts to hydrology and water quality by improving drainage, reducing siltation and sedimentation, and maintaining hydrological functions and features. Adverse impacts resulting from erosion after plant removal would be negligible due to the small area in which treatments currently occur. Likewise, impacts from a short-term reduction in dissolved oxygen content in closed aquatic systems (ponds, wetlands, etc) would occur from decaying plant matter.

The adverse impacts of herbicide use to water quality would be short-term and minor. Applications that take place in riparian and wetland environments consist of foliar spot herbicide applications of herbicides registered for use in aquatic environments that are made directly to the foliage of targeted vegetation by backpack or other hand-held spray equipment. Only minute amounts of diluted herbicide solutions would be likely to enter the system as a result of over-spray, run-off occurring from the leaves of treated vegetation, or rain events shortly after application that have the potential to wash herbicide solutions off treated vegetation. Water quality monitoring studies conducted by the Washington State Department of Agriculture show either negligible (2.2 ppb) or no detectable levels of glyphosate or imazapyr within 24 hours after foliar applications applied with backpack sprayers (Haubrich and Archibold 2004, Udo and Haubrich 2006). Any herbicide entering surface water or the soil in this fashion would be rapidly decomposed through exposure to sunlight and the soil microbial community. Expected herbicide half-lives in soil and water are summarized in Appendix J, Table J-1.

Projects using terrestrial herbicides near riparian areas, surface waters, and wetlands occur only at sites specified as appropriate on the product label, and take into consideration information presented in US Forest Service Herbicide Risk Assessments (summarized in Appendix J) regarding potential contamination of surface and ground water supplies. The greatest potential for impact to water quality occurs during the mixing and loading of concentrated herbicide products. All mixing and loading of concentrated herbicide products occurs over secondary containment (spill and drip trays) and crews are equipped with the means to contain and clean-up any spills of concentrated herbicide products. Additionally, concentrated herbicide products are transported in containers with a maximum capacity of 2.5 gallons. Of the herbicide products used under Alternative 1, only clopyralid has the half life and solubility to present a concern regarding mobility in the soil. However, given the proposed uses of clopyralid (upland areas away from water sources), and the low rates at which it would be used, the potential for surface and groundwater contamination is minor.

Impacts of Alternative 2 – IPM with Herbicides, on Hydrology and Water Quality

Under Alternative 2, removal of invasive plants and restoration of natural conditions would have long-term benefits to hydrology and water quality. The long-term threats described under Alternative 1 would be minimized and in some cases, eliminated. Beneficial impacts would be similar to those described under Alternative 1, but they would occur on a greater scale as more invasive plant treatments would be implemented. Treatment of some of the larger infestations, such as knotweed and reed canarygrass from riparian zones, or cheatgrass from the Stehekin Valley, would allow impacted areas to recover and to better support natural hydrologic processes and water quality. Removal of knotweed populations would prevent sedimentation in the shallow stream channels often utilized as salmon spawning habitat, and allow native vegetation to dominate stream banks currently infested with knotweed, improving shade and subsequently providing cooler water temperatures. Treatment of expanding populations of cheatgrass would allow the re-establishment of native vegetation and prevent the erosion and subsequent sediment loading of small streams that could result due to a proliferation of annual grasses on steep slopes. The impacts of non-treatment as described in Alternative 1 would not occur.

Under this alternative, there would be an increase in herbicide treatments and a decrease in ground disturbance impacts compared to Alternative 1. Impacts from herbicides would be similar to those described in Alternative 1 (short-term, minor, and adverse), but applications would occur more often at first as a greater number of projects are undertaken. Although the scope of some herbicide applications would be increased and expanded to include more regular foliar broadcast applications of aminopyralid, clopyralid, fluroxypyr, and glyphosate along roadsides, in gravel pits, and other highly disturbed areas, these herbicides would be highly diluted with water, and applications would be made at relatively low use rates.

As described in Alternative 1, herbicide applications proposed along riparian corridors, wetlands, and surface water would only be made with products registered for aquatic applications. Herbicide applications to control knotweed in proximity to surface waters present a minor risk to water quality through the contamination of these waters with herbicide solutions. Water quality monitoring studies conducted by the Washington State Department of Agriculture show either negligible (2.2 ppb) or no detectable levels of glyphosate or imazapyr within 24 hours after foliar applications applied with backpack sprayers (Haubrich and Archibold 2004, Udo and Haubrich 2006).

Based on the information presented in the US Forest Service Herbicide Risk Assessments (summarized in Appendix J), the half-life of these herbicides in the environment would be short and present a slight risk for extensive soil movement or groundwater contamination. With time, as infestations are treated more readily, fewer herbicide applications would be needed.

Impacts of Alternative 3 – IPM without Herbicides, on Hydrology and Water Quality

The impacts of Alternative 3 on hydrology and water quality would be similar to those described in Alternative 1, except that impacts from herbicide use would not occur, and impacts from invasive plants that are difficult to control without herbicides could increase. Additional mechanical treatments to control or contain some species would increase ground disturbance compared to the other alternatives, potentially resulting in greater localized erosion and siltation of waterways (short-term minor, adverse impacts). Untreated knotweed stands and reed canarygrass could further contribute to stabilization in dynamic riparian and wetland areas, resulting in reductions in channel movement and changes in nutrient availability. Overall impacts to hydrology and water quality would be long-term, moderate, and adverse.

Cumulative Impacts on Hydrology and Water Quality

Historic impacts to hydrology and water quality include fish harvest, fish stocking, siltation of waterways from logging activities, removal of large woody debris from waterways, hydroelectric development, filling at the head of Lake Chelan, channelization of the mouth of the Stehekin River, and NPS and private developments. Current ecosystem stress to aquatic resources originates from six fundamental sources: 1) land management activities within and adjacent to the park, 2) the atmospheric deposition of pollutants and nutrients, 3) climate change, 4) aquatic and riparian non-native invasive species, 5) large and small scale hydroelectric projects or dams inside or outside but restricting flow into the Park Complex, and 6) visitor use activities.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to hydrology or water quality. Treatments under all alternatives will restore hydrologic conditions and water quality over the long-term.

4.3 Wetlands

Impacts of Alternative 1 – Current Management, on Wetlands

If left untreated, invasive plants can impact wetlands in a number of ways. Many invasive, non-native wetland species form monocultures, and are responsible for altering habitat structure, lowering biodiversity, changing nutrient cycling and productivity, and modifying food webs. Reed canarygrass and knotweed are high priority weed species within the Park Complex and are of greatest concern for wetland areas. These species in particular displace native wetland vegetation, including canopy species, cause a loss of diversity of wetland plants and aquatic animals; and cause changes in hydrologic regimes by stabilizing soils and reducing channel migration. The majority of wetlands impacted by invasive plants would not be treated under this alternative. Because of their high ecological value yet small area in which wetlands occur, the impacts of not treating invasive plants in or near wetlands would be long-term, adverse, and major.

Treatment of invasive wetland species would occur in two projects under this alternative, Ross Lake Reed Canarygrass and Skagit River Knotweed. Both projects would be treated using foliar spot applications of herbicides registered for use in aquatic environments that are made directly to the foliage of targeted vegetation by backpack or other hand-held spray equipment. Only minute amounts of diluted herbicide solutions would be likely to enter the system as a result of over-spray, run-off occurring from the leaves of treated vegetation, or rain events shortly after application that have the potential to wash herbicide solutions off treated vegetation. Any herbicide entering surface water or the soil in this fashion would be rapidly decomposed through exposure to sunlight and the soil microbial community. Non-target impacts to native wetland plants would be mitigated by surveys prior to treatment to identify and avoid native plant populations, and the use of spot applications. The impact of treatment under this alternative would be short-term, minor and adverse during the herbicide treatment period, and long-term and beneficial as natural wetland functions are restored.

Impacts of Alternative 2 – IPM with Herbicides, on Wetlands

Under Alternative 2, removal of invasive plants and restoration of natural conditions would have long-term benefits to wetlands. The long-term threats described under Alternative 1 would be minimized and in some cases, eliminated. Beneficial impacts would be similar to those described under Alternative 1, but they would occur on a larger scale as more invasive plant treatments would be implemented. Treatment of all of the invasive plant infestations that occur in or near wetlands would allow impacted areas to recover through the restoration of native wetland vegetation, including canopy species. Consequently, wetland plant and animal diversity would improve, and altered hydrologic regimes would be restored.

Both of the priority species that occur in wetlands, reed canary grass and knotweed, are most effectively controlled by herbicides. Under this alternative there would be an increase in herbicide use near wetlands as more projects are undertaken. The use of herbicides would allow resource managers to effectively treat more acres, reduce follow-up treatments, and restore wetlands to natural conditions. With the ability to use herbicides, newly detected populations could be eradicated from wetland systems before they expand into monocultures, changing wetland function, and eventually spreading to other areas. The use of herbicides would also reduce the extent of disturbance of wetland soils by limiting the amount of disturbance created during mechanical removal efforts. The impacts of herbicide use would be similar to those described under Alternative 1, with an increase in the areas that would be treated using chemical techniques. The impact of treatment under this alternative would be short-term, minor and adverse during the herbicide treatment period, and long-term and beneficial as natural wetland functions are restored.

Impacts of Alternative 3 – IPM without Herbicides, on Wetlands

The impacts of Alternative 3 on wetlands would be similar to those described in Alternative 1, except that impacts from herbicide use would not occur, and ecosystem impacts from invasive plants that are difficult to control without herbicides would increase. The majority of wetlands impacted by invasive plants would not be treated under this alternative. Because of their high ecological function and value yet small area in which wetlands occur, the impacts of not treating invasive plants in or near wetlands would be long-term, adverse, and major. Mechanical treatments to control Lake Chelan and Ridley Lake reed canarygrass infestation would result in increased ground disturbance compared to the other alternatives. This technique is considerably less effective, and would require repeated control efforts that could exacerbate ground disturbance and erosion. Because of its greater size, the Lake Chelan treatment could potentially cause localized erosion and siltation of waterways, resulting in short-term minor, adverse impacts.

Cumulative Impacts on Wetlands

Historic impacts to wetlands include historic uses and development, hydroelectric projects, and planting of invasive species such as knotweed and reed canarygrass. Historic uses and developments, such as roads, vegetation removal, and homesteads, have impacted wetlands by filling, diking and diverting water flow. Hydroelectric projects have flooded the Skagit River Valley and the head of Lake Chelan; these projects have restricted and changed normal flow regimes as well as muted flood events and reduced the wetlands associated with riparian channel migration zones. The construction of Ross and Diablo Dams flooded approximately 13,000 acres of wetlands, and riparian and coniferous forest in the upper Skagit Valley. The practice of planting of reed canarygrass for forage and knotweed as an ornamental species has impacted wetlands by displacing native species throughout many of the wetlands within the Park Complex. Tree removal at the Stehekin Airstrip wetland has reduced canopy cover and has resulted in an increase of non-native species such as reed canarygrass and Canada thistle. The mill pond in Stehekin, developed as part of the brick mill and power generation operations on the property, currently hosts a variety of invasive species, the most prevalent of which is Japanese knotweed followed by Himalayan blackberry.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to wetlands. Treatments under all alternatives will protect wetlands over the long-term.

4.4 Vegetation

Impacts of Alternative 1 – Current Management, on Native Vegetation

It is not known what percentage of native plants found in the Park Complex is threatened by invasive species; however, it is estimated that approximately 5,000 of the native plants in the US (29% of all native plants) are at risk of extinction (The Plant Conservation Alliance 2003), and after habitat destruction, the invasion of non-native plants is the greatest threat to native species. Invasives are responsible for disrupting or completely changing ecosystem functions among native vegetation. They are capable of displacing native vegetation by reducing the amount of light, water, and nutrients normally available; they can alter hydrological patterns, soil chemistry, moisture-holding capacity, and erodability; and they can change fire regimes (Randall and Marinelli 2003). Some invasives can change a plant’s genetic makeup by hybridizing with native species. Others can harbor pathogens that impact native plants, and yet others carry toxins that prevent native plant germination and growth.

If left untreated, several invasive plant species could expand and further degrade the ecosystem functions that the NPS is required to protect. Invasive plants that could pose a threat to native ecosystems are often the dominant vegetation along heavily disturbed corridors such as roadways, trailheads, visitor use areas, and construction zones. Species such as Canada thistle, St. Johnswort, oxeye daisy, yellow toadflax, and cheatgrass are of particular concern because they have the potential to invade fragile native plant communities at higher elevations (e.g., above 4,000 feet) throughout the Park Complex. They can spread via seed transported by wildlife or people and quickly claim disturbed areas where native flora has been reduced or eliminated through natural events (e.g., wildfire, rock/debris slides, flooding of high-elevation tributaries, and rapid snow melt), or on trails. Since grasses are flashy, hot-burning fuels, infestations of these species can both alter, and be altered by, fire regimes. Of these, cheatgrass is already so widespread at lower elevations that it would be unfeasible to control, except in isolated populations, without the use of herbicides.

At lower elevations, shade tolerant species such as herb Robert, English holly, English ivy, Japanese clematis, and a number of introduced deciduous tree species are already invading undisturbed areas of the lowland forests along the Skagit and Stehekin River floodplain, and would likely continue to spread under this alternative. In riparian zones of the Stehekin Valley, native vegetation is currently threatened by the spread of Japanese knotweed. Revisits to sites that have been treated by cutting stems show no improvement in controlling knotweed. Reed canarygrass is also a major threat to native vegetation. Its occurrence on Ross Lake and the head of Lake Chelan threatens to reduce plant diversity and is likely to cause extirpation of native plant species (Paveglio and Kilbride 2000). Under this alternative, the impacts of not treating a number of invasive plant infestations would have long-term, moderate adverse impacts, and could result in major long-term adverse impacts if, for example, infestations such as cheatgrass increase to the point that they change native plant community composition and alter fire regimes, resulting in dramatic changes in the landscape and ecosystem integrity.

Invasive plant treatments would also occur under this alternative, resulting in both beneficial and adverse impacts. Treatments at the Stehekin airstrip, park gravel pits and roads, Ross Lake reed canarygrass, and Skagit River knotweed would continue to help restore native vegetation. Since some of these areas are widely used and can serve as pathways by which invasive plants spread into un-infested areas, treatment can help to prevent degradation of more pristine areas. Impacts would be long-term and beneficial.

Because the range of treatment methods under this alternative would include the use of herbicides in treatment areas, there is potential for harm to non-target native plants. While herbicide applications will be made using the most selective formulation when possible, non-selective herbicides will be used in many situations because of treatment effectiveness. Regardless of the herbicide formulation, some native plants are likely to be injured or killed in treatment areas. However, this injury should be limited to individuals that cannot be otherwise avoided during the course of treatment activities, and these effects would be localized and short-term, as native plant species re-colonize treated areas from adjacent untreated habitat. Herbicide applications can also impact non-target native plants through volatilization and drift (Sheley and Petroff 1999). Volatilization occurs when herbicide evaporates from the soil or leaf surface of treated plants and becomes suspended in the atmosphere, subsequently moving onto adjacent vegetation. Drift occurs when herbicide is moved by wind currents and lands on a non-target plant or other surface. With proper mitigation measures, however, these impacts can be minimized by such actions as surveying for sensitive species prior to treatments, application only during appropriate meteorological conditions, and restoration with native plant seeds and/or seedlings. Adverse impacts would be short-term and minor.

Sensitive, Threatened, or Endangered Plants. Six state listed species occur in wetland areas that are currently known to be threatened by invasive, non-native plants. An additional three species that occur in upland areas are also threatened by invasive, non-native plants. If left untreated, invasive species put rare plants at a greater risk of extirpation. Under Alternative 1, continued non-treatment of invasive plants would result in long-term, major adverse impacts to state-listed native species. For example, several state listed sedge species occur in wetlands that contain populations of reed canarygrass or that are vulnerable to reed canarygrass infestation, such as the wetlands in the Big Beaver drainage and at Ridley Lake. These species are at risk of being lost to the increasing reed canarygrass infestation since it would not be treated under this alternative.

Impacts of Alternative 2 – IPM with Herbicides, on Native Vegetation

Under Alternative 2, removal of invasive plants and restoration of natural conditions would have long-term benefits to native vegetation. The long-term threats described under Alternative 1 would be minimized and in some cases, eliminated. Beneficial impacts would be similar to those described under Alternative 1, but they would occur on a larger scale as more invasive plant treatments would be implemented. Treatment of some of the larger infestations, such as knotweed and reed canarygrass from riparian zones, or cheatgrass from the Stehekin Valley, would allow impacted areas to recover and to better support natural ecosystem processes. Recruitment of native plants and an increase in native plant diversity would occur. The impacts of non-treatment as described in Alternative 1 would not occur.

Under this alternative, there would be an increase in herbicide treatments and a decrease in ground disturbance impacts compared to Alternative 1. Impacts from herbicides would be similar to those described in Alternative 1 (short-term, minor, and adverse), but applications would occur more often at first as a greater number of projects are undertaken. Soil disturbance caused by mechanical removal and subsequent proliferation of weeds could be minimized in areas that have large non-native seed banks. Early detection procedures could allow for quick containment and eradication of new invaders. Restoration efforts could speed the recovery process for disturbed sites.

Sensitive, Threatened, or Endangered Plants. Under Alternative 2, the spread of invasive plants into rare plant communities could be minimized. Rare plants would benefit from the removal of invasive species because they would no longer be subject to extirpation through displacement by invasives. Herbicides could have adverse effects if they are accidentally applied to or if they drift onto non-target rare plants. This impact can be minimized with proper mitigation measures. Impacts to state-listed species would be long-term and beneficial.

Impacts of Alternative 3 – IPM without Herbicides, on Native Vegetation

The impacts of Alternative 3 on native vegetation would be similar to those described in Alternative 1, except that impacts from herbicide use would not occur, and impacts from invasive plants that are difficult to control without herbicides would increase. Invasive plant projects that are currently treated with herbicide, such as the Stehekin Airstrip, park gravel pits, roads, Ross Lake reed canarygrass, and Skagit River knotweed, would either not be treated, or would be treated using mechanical removal. Additional mechanical treatments would increase ground disturbance compared to the other alternatives, potentially resulting in localized proliferation of weeds. For those infestations that would not be treated, there would be long-term, moderate to major adverse impacts on native vegetation through a loss of species diversity and reduction in recruitment of native plants.

Sensitive, Threatened, or Endangered Plants. The impacts to rare plants under Alternative 3 are identical to Alternative 1, except that mechanical removal of reed canarygrass at Ridley Lake, if effective, could help to protect state-listed species in the area.

Cumulative Impacts on Native Vegetation

Historic impacts to native vegetation, including rare species, are largely related to past disturbance. Past actions include clearing vegetation for logging, mining, grazing, settlements, gravel pits, water diversions, hydroelectric operations, a golf course, an airstrip, and park developments. Current and future impacts to native vegetation are due to ongoing disturbance. Ongoing actions include trampling and compaction from visitor use at scenic pullouts, trailheads, campgrounds/campsites, and other attractions that concentrate visitors; and from maintenance activities, such as road maintenance, trail building/maintenance, and other earth-moving activities. Clearings from decades ago still contribute to invasive plant problems, as well as current impacts resulting from trampling, erosion, disturbance, and compaction of soil.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to native vegetation. Treatments under all alternatives will improve vegetation conditions over the long-term.

4.5 Fish and Wildlife

Impacts of Alternative 1 – Current Management, on Fish and Wildlife

Invasive plants indirectly affect fish and wildlife by impacting the habitats on which they depend. The riparian zone is the most notable habitat in the Park Complex that is impacted by invasive plants. Studies show that riparian zones contain a greater level of community-level diversity (among riparian classes), as well as species diversity compared to other habitats. For example, more species of breeding birds use riparian areas than any other habitat type in North America (Douglas et al. 1992). Studies in the Cascades have found up to twice the species richness in riparian zones as compared to upland habitat (Gregory et al. 1991). Other studies have found that nearly 70% of vertebrate wildlife species in a region will use riparian corridors in some significant way during their life cycles (Naiman et al. 1993). Riparian zones likely have more diversity due to the dynamic movements of the river and relatively short intervals between disturbances (floods).

Fish habitat in general is directly related to and is highly dependent on vegetation adjacent to the stream. Streamside vegetation is important because it provides cover, controls temperature, protects against erosion, and provides nutrients for aquatic and terrestrial fish food organisms. Japanese knotweed has infested streambanks, sloughs, channels, and islands along the lower Stehekin river drainage, and has the potential to markedly change the riparian zones, resulting in moderate impacts to fish and wildlife. Animal species that have co-evolved with a certain native plant community cannot adapt to a rapidly changing plant community. They respond by a reduction in reproduction or avoiding the infested areas altogether (Sheley and Petroff 1999). Some invasive plant infestations also act as physical barriers to water sources or preferred forage areas. Dense stands can act as barriers to fish movement and spawning by choking channels that were previously open water. For example, knotweed may act to stabilize a naturally dynamic system, and reed canarygrass in the Big Beaver drainage has the potential to impact a highly diverse system that supports sensitive species.

Erosion and siltation of waterways from invasive plant infestations can cause a reduction in sunlight penetration, resulting in adverse impacts to the growth and reproduction of native plants; irritation to the gills of fish, making them prone to disease; interference with feeding and reproduction of bottom-dwelling fish and insects; and reduction in surviving fish eggs deposited on spawning gravels (Donaldson 1997). Recent research also shows that if it becomes dominant, knotweed can fundamentally change nutrient and food quality and availability for aquatic macrophytes (Urgenson et al 2009). Aquatic habitat value could also be reduced by the loss of large woody debris as a valuable input to the stream (due to the prevention of tree establishment near the water's edge).

Upland habitat can also be impacted by invasive plants. For example, cheatgrass can quickly displace native plant communities because of its early growth habits. In addition to impacting native plant diversity, it can also alter fuel structure and fire behavior, resulting in a reduction in recruitment of understory species and habitat quality. As a result, wildlife species that depend on this habitat type for forage and cover are impacted.

If species such as knotweed, cheatgrass, and reed canarygrass continue to go untreated, reductions in habitat quality could occur. Since such a large percentage of species use the riparian zone for cover and forage, the impacts of untreated invasive plants within that zone are moderate and long-term. As invasive plants out-compete and replace native plants, the diversity, quantity, and quality of forage is reduced, resulting in a reduction in long term habitat carrying capacity. Ground cover for ground-nesting birds can also be reduced, which can impact insects.

Several infestations would continue to be treated under this alternative, including Ross Lake reed canarygrass, Skagit River knotweed, and SR 20. Continued treatment of these infestations would help to maintain current habitat conditions in these areas, resulting in long-term beneficial impacts. However, invasive, non-native plant management activities have the potential to impact fish or wildlife based on their location, timing, and the control techniques selected. Impacts would be directly related to the proximity of control activities, the techniques that would be used, and the amount of disturbance created in the environment, such as noise, ground and/or vegetation disturbance, and the introduction of herbicides into the environment. Temporary localized changes in habitat would occur due to the removal of vegetation, such as decreased dissolved oxygen availability after reed canarygrass removal, and changes in forage and cover availability. Additionally, employees conducting invasive plant control activities who are traveling through river or stream channels could disrupt fish spawning beds. This impact would be mitigated by appropriate timing of treatments to avoid spawning areas, and training in the identification of spawning areas.

Seven herbicides (Aminopyralid, 2, 4-D, Clopyralid, Glyphosate, Imazapyr, Sethoxidim, and Triclopyr) would be used under this alternative. Although these herbicides have the potential to adversely impact fish and wildlife and their habitat, the impacts are highly variable and often require site specific field studies to evaluate impacts. Studies that address impacts to specific taxa are often lacking. Laboratory studies, at times, both overestimate negative impacts on wildlife due to toxicity, predicting serious problems that were not observed in the field (Blus et al. 1997), and underestimate negative impacts on wildlife due to inaccurate laboratory replications of natural conditions (Durkin 2001). Many observed effects are not due to toxicity but rather habitat changes. In most instances, decreases in abundance of wildlife are generally short-term and, as habitats recover to the natural state, so too, do the wildlife species that use them.

The impact of herbicides on fish and wildlife varies depending on the properties of the chemical that would be used, the method and timing of applications, and the relative amount of herbicide that would be applied to a given area in order to achieve management objectives. Herbicides would be applied according to their labeling, which specifies appropriate environments they may be utilized in. For example, only herbicides registered for use in aquatic environments (formulations of glyphosate or imazapyr) would be used in riparian, wetland, and other aquatic environments. Other mitigation measures designed to minimize the impacts of herbicide use are listed in Appendix E.

The greatest risk of exposure to herbicides occurs with amphibians that might be seeking cover or forage in a treatment area. Amphibians are most likely to be encountered in riparian, wetland, or other aquatic zones, where only aquatic formulations of herbicides would be used. Aquatic formulations are different from their terrestrial counterparts in that they do not contain pre-mixed surfactants, which can be harmful to amphibians and other aquatic life (Haller and Stocker 2003). In order to minimize the risk of exposure, herbicides applied in aquatic environments would only be used with adjuvants that are approved for aquatic application, and managers would use the least toxic formulations available. See Appendix J for Washington State requirements for use of adjuvants in aquatic environments.

Risks to fish would also be minimized by the use of aquatic formulations near water. The chance for highly diluted herbicide solutions to come into direct contact with surface waters through overspray or drift exists; however, the amount of herbicide that would reach water would be diluted and would pose little to no risk to fish. Indirect contact of herbicides to fish could occur through runoff; however, this risk is minimal considering that neither of the herbicide formulations (glyphosate and imazapyr) proposed for use in riparian environments is considered soil-mobile. These risks would be further minimized by appropriate timing of the application, such as applications that would only occur when forecasts are clear and the chance of rain is extremely low.

There would be little to no risk of direct herbicide exposure to other types of wildlife, including birds or mammals, since treatment activities would likely cause avoidance of the area. Indirect herbicide exposure is possible through ingestion of treated vegetation; however, long-term persistence of herbicides in the food chain, and subsequent toxic effects, is not expected to occur. This is primarily due to the chemicals proposed for use, the rates at which they would be applied, and the quantities proposed to be used. Additionally, the chemicals proposed for use do not contain persistent compounds (e.g., organochlorines) that can cause eggshell thinning and other harmful effects to wildlife.

In summary, when herbicides are used at low toxicity doses and applied in small amounts impacts to wildlife vary from negligible to moderate, and are generally short-term (MacKinnon and Freedman 1993). For more information on the impacts of the proposed herbicides that would be used under any of the alternatives, refer to Appendix J.

Impacts of Alternative 2 – IPM with Herbicides, on Fish and Wildlife

Under Alternative 2, removal of invasive plants and restoration of natural conditions would have long-term benefits to fish and wildlife. The most efficient and effective treatments would be available to control invasive plants, and as a result, the impacts to fish and wildlife that would occur under Alternative 1 due to non-treatment would not occur. Restoration of some of the larger infestations, such as knotweed and reed canarygrass from riparian zones, or cheatgrass from the Stehekin Valley, would allow impacted areas to recover and to better support native fish and wildlife. For example, removal of knotweed populations would prevent sedimentation in the shallow stream channels often utilized as salmon spawning habitat, and allow native vegetation to dominate stream banks currently infested with knotweed, improving shade and subsequently providing cooler water temperatures.

Short-term, adverse impacts as a result of vegetation removal would be similar to those described in Alternative 1; however, more projects would be undertaken, and an additional five herbicides (Chlorsulfuron, Fluroxypyr, Imazapic, Metsulfuron methyl, and Rimsulfuron) could be used, for a total of 12. The impacts of these additional formulations would be the same as described in Alternative 1; there would be no additional impacts to fish or wildlife from the use of these additional formulations, largely because the additional products allowed under this alternative have a greater degree of selectivity and efficacy. None of the five additional herbicides would be used in or near riparian environments, wetlands, or other aquatic resources, and so impacts to fish and other aquatic organisms due to drift or runoff would be minimal. Although a larger area would be treated, impacts would still range from negligible to moderate. Major impacts, defined as "substantial and measurable, highly noticeable, and affecting a large area; changes would not reverse without active management; and entire communities of species would be measurably affected," would not occur.

Additionally, heavy equipment would be used as part of the Lake Chelan Reed Canarygrass project; it has the potential to impact individual amphibian species in the immediate area by being crushed. This impact would be mitigated by minimizing the use of heavy equipment if surveys show amphibians to be present during the treatment period. Depending on the size of the infestation at treatment time, the Stehekin Cheatgrass project may require the use of motorized equipment or a helicopter to supply water for the herbicide treatment. Noise associated with this work would impact wildlife to varying degrees depending on which equipment is used. If the treatment area is small, a water pump powered by a 12-volt battery can be used. This unit produces little noise and is not expected to disturb wildlife. Conversely, a larger infestation would require more water for the treatment and thus a larger water pump would be needed. It is estimated that the pump would be used for about six hours over the course of a week, and from one to two times per year during the treatment period, resulting in temporary localized impacts to wildlife due to noise. If access to water is limited, a helicopter may be needed. The amount of helicopter use is estimated to be from four to eight trips over the course of a day, which is dependent on how much water is needed for the treatment, and from one to two times per year during the treatment period. Noise impacts from these treatment options are expected to be short-term (between one day and one week) and range from negligible to minor.

Overall impacts to fish and wildlife under this alternative would be short-term, adverse, and negligible to moderate.

Impacts of Alternative 3 – IPM without Herbicides, on Fish and Wildlife

The impacts of Alternative 3 on fish and wildlife are similar to those found in Alternative 1 for non-treatment, but there would be greater impacts on fish and wildlife habitat conditions because fewer of the major infestations would be treated. Since a number of perennial rhizomatous species would not be treated under this alternative, there would be long-term, moderate impacts to fish and wildlife habitat. Potential impacts from herbicide use would not occur. Riparian zone habitat that is impacted by knotweed and some of the larger reed canarygrass populations would continue to diminish as they displace native vegetation. Over time, habitat loss would occur and species diversity would diminish.

Beneficial impacts would occur in some of the smaller project areas for which manual and/or mechanical control would be effective.

Cumulative Impacts on Fish and Wildlife

Historic impacts to fish and wildlife (including rare species) include fish harvest, fish stocking (introduction of non-native fish species and other aquatic species), siltation of waterways from logging activities, removal of large woody debris from waterways, over-harvest or intentional elimination of large predator populations, hydroelectric development (large reservoir development and associated removal of habitat), loud and intrusive activities (logging, dam-building, and highway construction), and habitat encroachment. Current or ongoing impacts include vehicle traffic on highways and roadways, increased human presence in the backcountry, fish stocking, degradation of habitat due to acid rain, air pollution, and climate change.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to fish or wildlife. Treatments under all alternatives will improve habitat conditions for fish and wildlife over the long-term.

4.6 Rare, Threatened, or Endangered Fish and Wildlife

Impacts of Alternative 1 – Current Management, on Listed Fish and Wildlife

The impacts of invasive plants, and management actions taken to control them, on listed fish and wildlife could potentially be greater than the impacts to other more abundant species because rare species are more vulnerable to extinction. Impacts to the 26 species listed by the US Fish and Wildlife Service and/or the Washington State Department of Fish and wildlife, along with the three species identified as species of concern for park managers, are variable and are summarized below.

The impacts of implementing Alternative 1 would have the same general impacts to fish and wildlife that were described in Section 4.5. Habitat restoration would result in short-term adverse impacts during treatments and long-term beneficial impacts once areas are restored. Adverse impacts would also result from not treating invasive plants under this alternative.

Amphibians. Listed amphibian species (Cascades frog, Columbia spotted frog, and western toad) would be impacted by infestations that would be left untreated under this alternative, as well as treatment activities that would occur. If left untreated, many invasive plant species, such as cheatgrass, reed canarygrass, and knotweed have the potential to cause long-term impacts on amphibian habitats by changing vegetation communities and associated food webs and cover that amphibians depend upon. For infestations that would be treated, both the Cascades frog and the Columbia spotted frog are most likely to be encountered in riparian, wetland, or other aquatic zones, where only aquatic formulations of herbicides would be used. In these areas, in order to minimize the risk of exposure, herbicides applied in aquatic environments would only be used with surfactants that are approved for aquatic application, and the least toxic formulations would be used. The Columbia spotted frog has not been documented at lower elevations within the Park Complex east of the Cascade Crest. Projects in Stehekin, therefore, are unlikely to impact Columbia spotted frogs. Western toads are widespread and in addition to occupying riparian and wetland zones, they are also known to travel through dry forests. The potential to impact the three amphibian species exists, and impacts would be short-term, minor to moderate, and adverse.

Birds. Because of their mobility, most of the rare birds within the Park Complex would not be impacted by invasive plants or invasive plant treatment activities. These species include: the American peregrine falcon, American white pelican, bald eagle, black-backed woodpecker, black swift, ferruginous hawk, golden eagle, Lewis' woodpecker, marbled murrelet, merlin, northern goshawk, pileated woodpecker, sandhill crane, Vaux's swift, and Western grebe. Although some of these species consume fish, there is no expectation that herbicides would enter surface water in sufficient quantities to be detectable in fish. One species, the northern spotted owl, could be impacted by disturbance during surveys or treatments. This impact would be mitigated by prohibiting activities within 65 yards of nesting birds. Impacts to spotted owls would be short-term, negligible, and adverse.

Fish. Westslope cutthroat trout occur in the lower Stehekin River, but are fewer in number than farther upstream. The presence of knotweed and other riparian weeds in the Stehekin Valley likely have a minor impact on the species currently, but if left untreated, impacts related to loss of cover along streambanks as the species proliferate would increase.

The impacts to bull trout, Puget Sound Chinook salmon, and steelhead would be similar in nature. All species occupy the Skagit River and bull trout and Chinook have designated critical habitat within the Skagit watershed. In addition Bull trout also occupy and have designated critical habitat within Ross Lake and some of the surrounding tributaries. While the spawning run times of these fish differ in timing and run size, the potential impacts from Alternative 1 would be similar for both species.

If left untreated, invasive plants can impact bull trout, Chinook salmon, and steelhead. For example, an increase in sedimentation and/or an increase in stream temperature from a dense infestation of an invasive plant like reed canarygrass is likely to adversely affect bull trout. Bull trout need well-vegetated streambanks, abundant instream cover, and productive insect populations. They are sensitive to human activities, and are extremely sensitive to changes in water quality, particularly increases in stream sedimentation and temperature. Similarly, Chinook salmon and steelhead are sensitive to changes in sediment and temperature affecting spawning and rearing habitat. The impacts of not treating invasive plants such as reed canarygrass or other riparian weeds would result in long-term moderate adverse impacts to these fish species.

Treatment and restoration would have long-term beneficial impacts by promoting the reestablishment of native vegetation, and short-term adverse impacts from vegetation removal and treatments. Manual and mechanical treatments could result in impacts to water quality due to the increased potential for erosion of loose soil into water as runoff during rain events. However, all treatments under this alternative would small in size, and erosion, if it occurred, would be extremely localized.

Risk of herbicide exposure to bull trout, Chinook salmon, and steelhead would be minimized by the use of aquatic formulations near water. The chance for direct contact with surface water through overspray or drift of herbicides exists; however, the amount of herbicide that would reach water would be diluted and would pose little to no risk to fish. Indirect contact of herbicides to fish could occur through runoff; however, this risk is minimal considering that neither of the herbicide formulations (glyphosate and imazapyr) proposed for use in riparian environments is considered soil-mobile. These risks would be further minimized by appropriate timing of the application, such as applications that would only occur when forecasts are clear and the chance of rain is extremely low, or limiting applications that would occur around or near the spawning of listed fish species. Impacts of invasive plant treatments on bull trout, Chinook salmon, and steelhead would be short-term, minor, and adverse.

Mammals. Listed mammal species include the California wolverine, Canada lynx, gray wolf, grizzly bear, Pacific fisher, Townsend's big-eared bat, and western gray squirrel. If left untreated, invasive plants can impact habitat quality for most of the rare mammals within the Park Complex; however, none of the current untreated infestations are large enough to significantly impact any of the listed species. Because of their mobility and avoidance of areas disturbed by human activities (which coincide with invasive plant treatment areas), rare mammals could experience minor short-term adverse impacts during invasive plant treatment activities.

Impacts of Alternative 2 – IPM with Herbicides, on Listed Fish and Wildlife

The impacts of implementing Alternative 2 would have similar impacts to listed fish and wildlife as those described under Alternative 1, except that adverse impacts from not treating invasive plants would not occur. Habitat restoration would result in short-term adverse impacts during treatments and long-term beneficial impacts once areas are restored. Impacts to listed species are summarized below.

Amphibians. Impacts would be similar to those described under Alternative 1, except that more projects would be undertaken that could potentially impact amphibians, including reed canarygrass treatments at Big Beaver, Ridley Lake, and Lake Chelan and knotweed and other riparian weed treatments in Stehekin. All three amphibian species (Cascades frog, Columbia spotted frog, and western toad) have been documented in the lower Big Beaver Valley, and the Cascades frog and western toad have been documented in the Stehekin Valley, so invasive plant treatments have the potential to impact individual members of each of the species populations. Though additional herbicide formulations would be used under this alternative, there would be no additional impacts to amphibians from the use of these additional formulations. Additionally, heavy equipment would be used as part of the Lake Chelan reed canarygrass project; it has the potential to impact individual amphibian species in the immediate area by being crushed. This impact would be mitigated by minimizing the use of heavy equipment if surveys show amphibians to be present during the treatment period. Impacts to the three amphibian species would be short-term, minor to moderate, and adverse.

Birds. Impacts to birds would be identical to those described under Alternative 1.

Fish. Impacts to fish would be similar to those described under Alternative 1, except that impacts from non-treatment would not occur, and herbicide treatments of Stehekin knotweed and riparian weeds have the potential to impact westslope cutthroat trout. Treatment and restoration along the Stehekin River would have long-term beneficial impacts to westslope cutthroat trout by promoting the reestablishment of native vegetation, and short-term adverse impacts from vegetation removal and herbicide treatments. Risk of herbicide exposure to westslope cutthroat trout would be minimized by the use of aquatic formulations near water, and by appropriate timing of the application, such as applications that would only occur when forecasts are clear and the chance of rain is extremely low, or limiting applications that would occur around or near spawning areas. Though additional herbicide formulations would be used under this alternative, there would be no additional impacts to bull trout, Chinook salmon, or steelhead from the use of these additional formulations. Impacts of invasive plant treatments on westslope cutthroat trout, bull trout, Chinook salmon, and steelhead would be short-term, minor, and adverse.

Mammals. Impacts would be similar to those described under Alternative 1, except that impacts from non-treatment would not occur.

Impacts of Alternative 3 – IPM without Herbicides, on Listed Fish and Wildlife

The impacts of Alternative 3 on listed fish and wildlife are similar to those found in Alternative 1 for non-treatment, but there would be greater impacts on rare fish and wildlife habitat conditions because fewer of the major infestations would be treated. Since a number of perennial rhizomatous species would not be treated under this alternative, there would be long-term, moderate impacts to listed fish and wildlife habitat. Potential impacts from herbicide use would not occur. Riparian zone habitat that is impacted by knotweed and some of the larger reed canarygrass populations would continue to diminish as they displace native vegetation. Over time, habitat loss would occur and species diversity would diminish. Beneficial impacts would occur in some of the smaller project areas for which manual and/or mechanical control would be effective.

Amphibians. Impacts to listed amphibians would largely result from a loss or degradation of habitat due to growing infestations of untreated invasive plants that crowd native species out. For example, reed canarygrass, if left untreated, has the potential to degrade habitat quality for listed amphibian species by becoming a monoculture that supports fewer of the insects that amphibians feed on.

Birds. Adverse impacts to listed birds would occur over time as many of the larger infestations would continue to grow, thus degrading habitat conditions for listed species.

Fish. Adverse impacts to fish would occur as a result of not treating many of the riparian/wetland infestations, such as reed canarygrass and knotweed. Impacts would be similar to those described under Alternative 1 for non-treatment.

Mammals. Adverse impacts to listed mammals would occur over time as many of the larger infestations would continue to grow, thus degrading habitat conditions for listed species.

Cumulative Impacts on Listed Fish and Wildlife

Historic impacts to fish and wildlife (including rare species) are the same as those described in Section 4.5, and include fish harvest, fish stocking (introduction of non-native fish species and other aquatic species), siltation of waterways from logging activities, removal of large woody debris from waterways, over-harvest or intentional elimination of large predator populations, hydroelectric development (large reservoir development and associated removal of habitat), loud and intrusive activities (logging, dam-building, and highway construction), and habitat encroachment. Current or ongoing impacts include vehicle traffic on highways and roadways, increased human presence in the backcountry, fish stocking, degradation of habitat due to acid rain, air pollution, and climate change.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to listed fish or wildlife. Treatments under all alternatives will improve habitat conditions for listed fish and wildlife over the long-term.

4.7 Natural Soundscapes

Impacts of Alternative 1 – Current Management, on Natural Soundscapes

Invasive plant management activities that would be implemented under this alternative would include hand-pulling and use of hand tools to mechanically remove invasive plants, as well as herbicide applications. The amount of noise generated from these activities would be small, and would occur during working hours (7 am to 5:30 pm). Most activities under this alternative would occur within or near developed areas, and the additional noise created from these activities would be small compared to existing ambient sound levels. Even in undeveloped areas, such as the shoreline of Ross Lake, additional noise inputs from herbicide applications would be extremely small. Therefore, the impacts to natural soundscapes would be short-term and negligible.

Impacts of Alternative 2 – IPM with Herbicides, on Natural Soundscapes

Impacts to natural soundscapes under Alternative 2 would be similar to those described under Alternative 1, plus there would be additional impacts as a result of implementation of the Stehekin Cheatgrass project. Depending on the size of the infestation at treatment time, the Stehekin Cheatgrass project may require the use of a water pump or helicopter to supply water for the herbicide treatment. If the treatment area is small, a water pump powered by a 12-volt battery can be used. This unit produces little noise and is not expected to impact the natural soundscape. A larger infestation, however, would require more water for the treatment and thus a larger water pump would be needed. A Mark 3 water pump is estimated to produce sound levels of 85 decibels at 20 feet, which is comparable to the noise levels produced from a chainsaw. It is estimated that the pump would be used for about six hours over the course of a week, and from one to two times per year during the treatment period.

If access to water is limited, a helicopter may be needed to deliver water to the site. Helicopter noise is difficult to quantify because noise levels depend on the type of ship, the distance from the listener, and the flight path. It is estimated that noise from the helicopter would be louder than the water pump when listeners are directly under it, but impacts would diminish on the ground as the helicopter moves away from the site. The amount of helicopter use is estimated to be from four to eight trips over the course of a day, which is dependent on how much water is needed for the treatment, and from one to two times per year during the treatment period. Helicopter noise impacts would occur over a shorter period of time than the water pump, but during that time they would be louder. Because of the transitory nature of the noise, impacts to natural soundscapes would be short-term and minor.

Impacts of Alternative 3 – IPM without Herbicides, on Natural Soundscapes

The impacts of Alternative 3 on natural soundscapes would be similar to Alternative 1, except that noise impacts would not occur from herbicide treatments. Additional mechanical removal using hand tools is not expected to further impact natural soundscapes under this alternative. Impacts would be short-term and negligible.

Cumulative Impacts on Natural Soundscapes

Other ongoing impacts to natural soundscapes within the Park Complex occur from the three major sources of noise intrusion: vehicles, aircraft, and motorboats. Vehicle noise is largely concentrated along SR 20 within Ross Lake National Recreation Area. Aircraft noise occurs throughout the Park Complex. Motorboat noise occurs on the reservoirs and Lake Chelan. Fire management throughout the Park Complex, which can include chainsaws, water pumps, and helicopters, can create large impacts on natural soundscapes. Additional localized noise impacts occur along park trails from the use of chainsaws during trail maintenance activities. The use of helicopters during search and rescue incidents can also impact natural soundscapes.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to natural soundscapes.

4.8 Cultural Resources

The thresholds of change for duration and intensity of impact on cultural resources are different from the general impact topic thresholds described at the beginning of this chapter. They are defined as:

Duration of Impact

Short term: An effect that within five years would no longer be detectable as the resource returned to its predisturbance condition or appearance (e.g. trash and other items removed or vegetation trampled, but not denuded)

Long term: A change in a resource or its condition that would not return to predisturbance condition or appearance and for all practical purposes would be considered permanent (e.g. damage to elements or removal of artifacts)

Intensity of Impact

Negligible: Impact is at the lowest levels of detection with neither adverse nor beneficial consequences. For purposes of Section 106, determination of effect would be “no historic properties affected”

Minor: (Adverse) Disturbance of an archeological or historic resource(s) results in little, if any, loss of integrity. For purposes of Section 106, determination of effect would be “no adverse effect”

(Beneficial) Maintenance and preservation of an archeological or historic resource(s). For purposes of Section 106, determination of effect would be “no adverse effect”

Moderate: (Adverse) Disturbance of an archeological or historic resource(s) results in loss of integrity and detection of artifact depletion or displacement (based on baseline information), and effects to elements having research potential or increased instability of site landscape. For purposes of Section 106, determination of effect would be “adverse effect.” A memorandum of agreement (MOA) is executed among National Park Service and applicable state or tribal historic preservation officer and, if necessary, the Advisory Council on Historic Preservation in accordance with 36 CFR 800.6(b). Measures are identified in the MOA to minimize or mitigate adverse impacts

(Beneficial) Stabilization of an archeological or historic resource(s). For purposes of Section 106, determination of effect would be “no adverse effect”

Major: (Adverse) Disturbance of an archeological or historic resource(s) results in loss of overall integrity and changes to character-defining, cultural or structural elements to the extent the property would no longer be eligible for inclusion in the National Register. For purposes of Section 106, the determination of effect would be “adverse effect.” Measures to minimize or mitigate adverse impacts cannot be agreed on and the National Park Service and applicable state or tribal historic preservation officer and/or Advisory Council are unable to negotiate or execute a MOA in accordance with 36 CFR 800.6(b)

(Beneficial) Active intervention is undertaken to preserve the site. For purposes of Section 106, determination of effect would be “no adverse effect”

Impacts of Alternative 1 – Current Management, on Cultural Resources

Impacts to cultural resources can occur when invasive plants are not treated as well as when they are treated. When invasive plants are not treated, cultural resource sites can suffer a loss of integrity of setting and association of the cultural landscape. Under Alternative 1, there is one project that contains known cultural resources and would not be undertaken: the Stehekin Landing. Two other projects would be undertaken but would not address all of the invasive plant issues present: Buckner Homestead Historic District and the Marblemount Ranger Station. The toadflax infestation at the Buckner Homestead is a growing problem for which mowing has helped to contain the population, but has only been effective at reducing seed production and not the spread via rhizomes. At the Marblemount Ranger Station, only two of the 11 invasive species present would be treated under this alternative. Invasive plants at these sites would continue to spread and degrade the cultural landscape, resulting in long-term moderate adverse impacts.

When invasive plants are treated, impacts to cultural resources can occur when herbicides are applied, which can cause chemical contamination of organic and non-organic artifacts and remains; and when manual or mechanical plant removal takes places, which can cause physical disturbance to site sedimentary matrices that contain artifacts and other cultural remains. These impacts would be mitigated, however, by cultural resource surveys prior to treatment. If a cultural resource is damaged due to invasive plant treatment, impacts could be long-term, minor to moderate, and adverse.

Impacts of Alternative 2 – IPM with Herbicides, on Cultural Resources

Under Alternative 2, invasive plants would be treated at all three of the identified cultural resource sites. Other invasive plant project locations would undergo a cultural resource survey prior to treatment in order to prevent impacts to undiscovered cultural sites. Impacts would be similar to those described in Alternative 1 for treatment of invasive plants, with an increase in herbicide use compared to Alternative 1. Impacts associated with mechanical removal of invasive plants and the resulting ground disturbance could be avoided by using herbicides to control invasive plants in culturally sensitive areas. Mowing at the orchard that is timed to better contain yellow toadflax would occur; however, this species would still impact the landscape. Treatment of oak trees on the Marblemount compound would be restricted to areas outside of the historic planting footprint, thus not impacting the cultural landscape. If a cultural resource is damaged due to invasive plant treatment, impacts could be long-term, minor to moderate, and adverse.

Impacts of Alternative 3 – IPM without Herbicides, on Cultural Resources

Invasive plant management without the use of herbicides would have impacts resulting from non-treatment in some areas and from manual/mechanical removal in others. In some instances, invasive plant projects would not be undertaken without the use of herbicides because alternative treatments are ineffective. In these areas, invasive plants would spread, causing further degradation of cultural resource sites and resulting in long-term moderate adverse impacts. Under this alternative only two species at the Marblemount Ranger Station would be treated and manual/mechanical treatments would be used to control or contain species from spreading at the Buckner Homestead and Stehekin Landing. Physical disturbance from manual/mechanical removal would be greater under this alternative compared to Alternative 2; however, surveys prior to treatment would help to mitigate adverse impacts to potential cultural resource sites. If a cultural resource is damaged due to invasive plant treatment, impacts could be long-term, minor to moderate, and adverse.

Cumulative Impacts on Cultural Resources

Ongoing impacts to cultural resources include weathering and aging of historic structures and features, and of prehistoric sites; wear and tear from frequent visitor concentration; and occasional vandalism.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to cultural resources.

4.9 Wilderness Character

This analysis is based on the Minimum Requirements Analysis (MRA) that can be found in Appendix C. As stated in the Purpose and Need (Chapter 1) and confirmed in the MRA, the NPS concluded that treatment of invasive plants within wilderness is a necessary action, and therefore meets the minimum requirement for administration of the area as wilderness. Step 2 of the MRA involves an analysis of potential "tools" to accomplish invasive plant management within wilderness. A combination of *Option D: Mechanical/herbicide treatments using human/stock transport and motorized equipment* (water pumps) and *Option E: Mechanical/herbicide treatments using helicopter transport and motorized equipment* (water pumps), reflects proposed actions in Alternative 2; these options were determined to be the minimum tool. These options are the minimum tool because they best protect and restore the natural quality of wilderness character while minimizing impacts to the other three qualities. If not treated, some invasive plants could permanently impact ecosystem components and processes. This risk was compared with the impacts of treatment on the other qualities. The NPS has determined that the long-term benefits of restoring ecosystem processes outweigh the short-term adverse impacts to the qualities of untrammeled, undeveloped, and opportunities for solitude or primitive and unconfined recreation.

The impacts of each alternative are analyzed using the four qualities of wilderness character as described in Chapter 3. The untrammeled quality of wilderness character is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness. The undeveloped quality of wilderness character is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport that increases people's ability to occupy or modify the environment. The natural quality of wilderness character is degraded by intended or unintended effects of modern civilization on the ecological systems inside the wilderness. Opportunities for solitude or a primitive and unconfined type of recreation is a quality of wilderness character that is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Impacts of Alternative 1 – Current Management, on Wilderness Character

If current management of invasive plants continues, no treatments would occur within designated wilderness except for occasional manual removal of invasive plants along park trails. Under this alternative, the following three qualities of wilderness character would not be impacted: untrammeled, undeveloped, and opportunities for solitude or primitive and unconfined recreation. The natural quality of wilderness character would be impacted; since the majority of invasive plant infestations within wilderness would go untreated, the potential for long-term--even permanent--damage to natural ecosystem processes is high. As invasive plants are allowed to spread, they displace native vegetation along with the wildlife populations that rely on native vegetation communities for habitat. They can affect water quality by reducing or depleting water levels or altering runoff patterns and soil erosion. Some invasive plants are allelopathic, releasing toxins that don't allow native plants to grow. Others are nitrogen-fixing, allowing other non-natives to outcompete native plants that have evolved in nutrient-poor soils. Finally, others can alter fire regimes and drastically change a landscape. Because of the far-reaching consequences of not treating the majority of invasive plants within designated wilderness, this alternative would result in moderate, long-term adverse impacts to wilderness character. There is, however, uncertainty about the nature and extent of future impacts, and it is possible that there could be major long-term adverse impacts if, for example, infestations such as cheatgrass increase to the point that they change native plant community composition and alter fire regimes, resulting in dramatic changes in the landscape and in ecosystem integrity.

Impacts of Alternative 2 – IPM with Herbicides, on Wilderness Character

Under this alternative, seven identified projects would be undertaken within designated wilderness: Stehekin Valley Cheatgrass, Stehekin Knotweed (less than one percent occurs within wilderness), Big Beaver Creek Reed Canarygrass, Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lakes Road, and Park-wide Trails. Treatment of invasive species at each of these sites would include the use of herbicides, except for some manual removal along park trails. Transport of equipment would generally be on foot, with occasional stock support for heavier loads. Depending on the level of cheatgrass infestation encountered during initial surveys of the Rainbow Bridge Fire, stock support or a helicopter may be necessary to deliver supplies, equipment, and water to the treatment area. Additionally, the sporadic use of a motorized pump and hose-lay may be necessary to provide water needed to conduct herbicide applications. If a small amount of water is needed, then a water pump powered by a 12-volt battery could be used; however, if larger amounts of water are needed, then a gas-powered water pump would be used.

Short-term, moderate impacts to the untrammeled quality of wilderness character would occur, primarily because the Stehekin Cheatgrass project is relatively large in scope (almost 2,000 gross infested acres, a subset of which would be spot treated with herbicide). Evidence of human control or manipulation would be obvious after treatment, but temporary because as vegetation communities are restored, evidence of the project activities would disappear.

The use of a motorized water pump and a helicopter for the Stehekin Cheatgrass project would have temporary yet moderate impacts on the undeveloped quality of wilderness character. The impact from use of the water pump will be localized and temporary, since the pump would only be used to fill water storage containers. It is estimated that the pump would be used for about six hours over the course of a week, and from one to two times per year during the treatment period. If a greater amount of water is needed because the cheatgrass infestation is larger than expected, a helicopter would be used to deliver water instead of the water pump. The amount of helicopter use is estimated to be from four to eight trips over the course of a day, which is dependent on how much water is needed for the treatment, and from one to two times per year during the treatment period. The impact from helicopter use would occur over a larger area and it would be more noticeable to people in the wilderness.

Opportunities for solitude or a primitive and unconfined type of recreation would experience negligible impacts. The largest number of invasive plant treatments would occur under this alternative, but most would go largely un-noticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Long-term beneficial impacts to the natural quality of wilderness character would occur under this alternative, as all infestations would be treated. These infestations would be eradicated and prevented from spreading further into wilderness, thus protecting naturalness.

In summary, short-term adverse impacts ranging from negligible to moderate would occur to untrammeled, undeveloped, and opportunities for solitude or unconfined recreation, whereas long-term beneficial impacts would occur to the natural quality.

Impacts of Alternative 3 – IPM without Herbicides, on Wilderness Character

Under Alternative 3, three identified projects would be undertaken using manual and mechanical treatments where feasible: Ridley Lake Reed Canarygrass, Park-wide Trails, and Thornton Lakes Road (only knapweed would be manually treated). Stehekin Cheatgrass, Stehekin Knotweed, Big Beaver Reed Canarygrass, and Ruby Pasture projects would not be undertaken.

Short-term, negligible impacts to the untrammeled quality of wilderness character would occur. Impacts would be insignificant under this alternative because the infestations that would be treated using manual/mechanical methods are small in size. Evidence of human control or manipulation would be extremely localized and temporary.

The undeveloped quality of wilderness character would not be impacted.

Impacts to the natural quality of wilderness character would be very similar to those described under Alternative 1 (no action) because many infestations, especially those of large size (e.g., Stehekin Cheatgrass), would not be treated. Natural ecosystem processes would be impacted as invasive plants are allowed to spread. Conversely, species that can be effectively treated using manual/mechanical control methods would be treated under this option. These infestations would be eradicated and prevented from spreading further into wilderness, and improvements to the natural quality would occur. Overall, impacts to naturalness would be long-term, moderate, and adverse. As in Alternative 1, it could result in major long-term adverse impacts if, for example, infestations such as cheatgrass increase to the point that they change native plant community composition and alter fire regimes, resulting in dramatic changes in the landscape and in ecosystem integrity.

Short-term, negligible impacts to opportunities for solitude or a primitive and unconfined type of recreation would occur. The few number of invasive plant treatments that would be undertaken would go largely un-noticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Cumulative Impacts on Wilderness Character

Cumulative impacts to wilderness character are described in Chapter 3, and are briefly outlined in this section. The untrammeled quality of wilderness character is currently impacted by three sources of human manipulation: fish stocking and removal, fire suppression, and illegal marijuana growing operations. The natural quality of wilderness character is impacted by a number of issues; affected components can be grouped into plant and animal species and communities, physical resources, and biophysical processes. Threats to plant and animal species and communities include white pine blister rust, mountain pine beetle outbreaks, and non-native birds and fish. Physical resources are primarily threatened by atmospheric pollutants. Biophysical process have been impacted by fire suppression, creation of the reservoirs and SR 20 (resulting in impacts to habitat connectivity), and climate change. The undeveloped quality of wilderness character is impacted by a number of installations, historic structures, motorized equipment use, and helicopter use. Opportunities for solitude or primitive and unconfined recreation are impacted by noise intrusions, facilities that decrease self-reliant recreation, and management restrictions on visitor use activities.

Impairment Determination

None of the actions contained in the alternatives or cumulative impacts would result in impairment to wilderness character. Treatments under all alternatives will protect and/or restore wilderness character over the long-term.

4.10 Visitor Use and Experience

Impacts of Alternative 1 – Current Management, on Visitor Use and Experience

If current management of invasive plants continues, there could be both beneficial and adverse impacts to visitor use and experience. Treatment of infestations would protect and restore natural conditions and scenery, resulting in long-term minor beneficial impacts to visitor experience. The continued presence of resource staff working in high-use areas or conducting surveys in the backcountry could be seen by some as a positive encounter and a learning opportunity about invasive plant management activities, while others might interpret an encounter as a negative impact to solitude. The use of herbicides could degrade visitor experience due to real or perceived health threats associated with the use of herbicides, and area closures during treatment periods would reduce access, resulting in short-term, minor adverse impacts.

The impacts of not treating invasive species could have adverse impacts to visitor use and experience, as access becomes reduced over time due to thick infestations, or vegetation communities change the scenic character of an area. For example Japanese knotweed could reduce the quality of visitor experience by reducing access, limiting the view shed, and reducing the diversity of observable native species and/or habitat. Non-treatment would result in long-term, moderate adverse impacts to visitor use and experience.

Weed-free feed requirements could result in some users choosing to use other state-owned or private lands that do not have weed-free requirements. Impacts would be long-term, moderate and adverse.

Impacts of Alternative 2 – IPM with Herbicides, on Visitor Use and Experience

Impacts would be similar to those described in Alternative 1 for treatments. More projects would be undertaken, however, so the potential to impact more visitors is possible under this alternative. As described in Alternative 1, long-term beneficial impacts would result by protecting and restoring natural conditions and scenery. The benefits of treatments would be larger under this alternative, since some large infestations would be treated, such as Stehekin cheatgrass and Stehekin River knotweed. Adverse impacts would be short-term and minor, and would include area closures during herbicide treatments, a degraded experience because of real or perceived health threats of herbicides, a greater chance of encounters with staff that could impact solitude, and noise impacts from the Stehekin Cheatgrass project. Impacts related to weed-free feed requirements would be the same as those described in Alternative 1: long-term, moderate, and adverse.

Impacts of Alternative 3 – IPM without Herbicides, on Visitor Use and Experience

Impacts would be similar to those described in Alternative 1 for non-treatment. There are several large infestations that would not be treated under this alternative, including knotweed, cheatgrass, and reed canarygrass. The potential for these infestations to change vegetation communities is high and would result in long-term, moderate adverse impacts to visitor use and experience by reducing access, changing natural scenery, and reducing the diversity of observable native species and/or habitat.

For those species that would be manually, mechanically, or culturally treated under this alternative, an increased presence of uniformed personnel would have beneficial impacts to some and adverse impacts to others who are seeking solitude. Impacts would be short-term, minor and both beneficial and adverse.

Impacts related to weed-free feed requirements would be the same as those described in Alternative 1: long-term, moderate, and adverse.

Cumulative Impacts on Visitor Use and Experience

Potential cumulative impacts on visitor use might involve other limitations to access, such as the closing of a trail for maintenance, wildfire management, or other safety concerns; or the closing of a road for road maintenance or construction. Other impacts to visitor experience could result from additional encounters with uniformed staff in the area, administrative or other use of aircraft or other motorized equipment, and the quality of facilities, including trails and other visitor use areas.

4.11 Human Health and Safety

Impacts of Alternative 1 – Current Management, on Human Health and Safety

Although there are a number of invasive plant infestations that would not be treated under this alternative, none of the species that currently exist within the Park Complex would pose direct human health and safety risks. For those infestations that would be inventoried or treated, there are risks to human health and safety. The majority of risks, or impacts, would occur with invasive plant management employees who are working in the field. Employees use a suite of tools to treat invasive plants under varying weather and terrain conditions. Tools used for digging or pulling, or power tools could cause flying debris and/or bodily injury. Even though several projects under this alternative would be inventory only, they occur on steep hillsides or along river banks and side channels that contain dense vegetation, where falling or tripping is possible. Other projects occur along busy roads or highways or in other high-use areas, where motor vehicle accidents could occur. All of these scenarios present risk of injury to employees in the field. Safety protocols that include job hazard analyses, proper equipment training, and the use of personal protective equipment, would be followed to minimize risks to employees.

Another risk that is relevant to both employees and the public is the risk of exposure to herbicides. Employees have a much greater risk of exposure than the general public due to frequent use of herbicides. The most significant employee safety risk while working with herbicides is exposure during mixing and loading because they are working with concentrated products. If the public is exposed, the herbicides would consist of diluted product rather than concentrated product. Public herbicide exposure is most likely to happen when people enter a treated area too soon. Although a potential risk to humans would occur if they ingested ripe fruit from treated blackberry plants, a BMP will be followed that prohibits the spraying of blackberries in fruit, effectively eliminating this risk. For those who may drink directly out of a river or lake after an herbicide application was made to the riparian zone, the risk of ingesting herbicides in the water is extremely low. As described in the Water Quality section, only minute amounts of diluted herbicide solutions would be likely to enter the system as a result of over-spray, run-off occurring from the leaves of treated vegetation, or rain events shortly after application that have the potential to wash herbicide solutions off treated vegetation. Water quality monitoring studies conducted by the Washington State Department of Agriculture show either negligible (2.2 ppb) or no detectable levels of glyphosate or imazapyr within 24 hours after foliar applications applied with back-pack sprayers (Haubrich and Archibold 2004, Udo and Haubrich 2006). Any herbicide entering surface water or the soil in this fashion would be rapidly decomposed through exposure to sunlight and the soil microbial community. Expected herbicide half-lives in soil and water are summarized in Appendix J, Table J-1.

There are seven herbicide formulations that are proposed for invasive plant treatment under this alternative. Appendix J summarizes evaluations of potential human health effects from herbicide exposure. Impacts to human health from acute exposure to concentrated herbicide formulations (i.e., that which employees could be exposed to during mixing and loading) are generally expected to be short-term and transitory with a few exceptions. Several of the herbicide formulations proposed for use have the potential to cause serious but temporary eye injury and moderate skin irritation. Acute and chronic effects of exposure to concentrated formulations have been well-studied in laboratory animals for all seven herbicides during the US EPA product registration process. With the use of recommended personal protective equipment, risk of exposure to herbicide applicators can be significantly minimized. With the exception of 2, 4-D none of the herbicides proposed for use are classified by the US EPA as carcinogens; however, in many cases there is not a sufficient body of research to determine long-term cumulative effects that may lead to chronic conditions from worker exposure to herbicide formulations.

Based on the actions proposed under this alternative, and the corresponding exposure scenarios examined in US Forest Service herbicide risk assessments there is negligible risk of exposure to the general public during herbicide applications, except in the case of sensitive individuals. To minimize this exposure, herbicide applications made in areas of high visitor use or near public facilities would be clearly marked during the application, including information regarding the herbicide formulation in use.

A number of BMPs would be implemented to minimize the impacts of herbicides on human health and safety. These are described in detail in Appendix E. Using the BMPs and safety protocols, the impacts of Alternative 1 on human health and safety would be short-term, negligible to minor and adverse.

Impacts of Alternative 2 – IPM with Herbicides, on Human Health and Safety

Impacts under this alternative would be similar to those described in Alternative 1. Employees would be exposed to the same risks; however, they would be applying herbicides more often and in more areas. The risk of public exposure would also increase due to the increase in treatment, especially in Stehekin, where cheatgrass and knotweed removal would occur. As described in Alternative 1, herbicide applications would be clearly marked to minimize exposure. Additionally, public notices would be posted to inform residents and visitors of upcoming applications.

An additional five herbicide formulations could be used under this alternative (for a total of 12). Potential human health effects are evaluated in Appendix J. The impacts of these additional formulations would be the same as described in Alternative 1; there would be no additional impacts to human health from the use of these additional formulations.

As described in Alternative 1, a number of BMPs and safety protocols would be implemented to minimize the impacts of invasive plant management on human health and safety. Using the BMPs and safety protocols, the impacts of Alternative 2 on human health and safety would be short-term, minor and adverse.

Impacts of Alternative 3 – IPM without Herbicides, on Human Health and Safety

Impacts under this alternative would be the same as Alternative 1, except that herbicides would not be used. Employees would be subject to health and safety risks from working in the field on rugged terrain, using different digging, pulling, and power tools, and working in busy or developed areas. Use of safety protocols would minimize risk of injury, resulting in short-term, minor adverse impacts to human health and safety.

4.12 Socioeconomics

Impacts of Alternative 1 – Current Management, on Socioeconomics

Weed-free feed requirements can minimally increase the cost of using horses and other pack stock if hay is used because weed-free hay can be more expensive to purchase, distribution locations for weed-free hay may be limited, and pack stock users may have to plan ahead to obtain the hay. However in recent years processed weed-free products, such as pellets or cubes, have become widely available and comparable in cost to other types of processed feed. Participation with Washington State's weed-free feed certification program has steadily increased each year since it began in 2008, and it is anticipated that costs of certified products will continue to become more competitive with products that are not certified.

Although weed-free feed use would be encouraged 24 hours prior to entry onto park lands, it would only be required to be used while traveling on park lands. The precise measure of the impact is not known, but if stock users choose to use hay rather than processed feed when traveling in the Park Complex, the availability and cost of weed-free hay compared to conventional hay costs could be an additional financial burden. This requirement is expected to be implementable over time, and may require some phase in time as weed-free hay certification, distribution and use becomes more widespread.

In Stehekin, where the majority of feed for commercial and private stock use is already barged in, the additional financial burden would occur for those who regularly travel with stock and carry feed on NPS lands and therefore would need to use certified products. However, commercial pack stock operators in Stehekin are already using certified feed on pack trips, so there would be no additional financial burden for the operators. The financial burden would be greatest for private Stehekin stock users who carry feed on park lands. It is estimated that impacts would be short-term and minor to moderate.

Some stock users may choose to use other state-owned or private lands that do not have weed-free feed requirements. Many stock users already comply with weed-free feed requirements as a part of special use permits or private use on National Forest lands. Additionally, the Backcountry Horsemen of Washington recommend in their Backcountry Horse Use Skills and Ethics Booklet (http://www.bchw.org/lnt/lntbk.htm), which contains *Leave No Trace* principles, to avoid packing in uncertified hay or unprocessed grain. For these users, this requirement will have negligible, short-term impacts since they are already accustomed to procuring weed-free feed.

Impacts of Alternative 2 – IPM with Herbicides, on Socioeconomics

The impacts of Alternative 2 on Socioeconomics would be identical to those described under Alternative 1.

Impacts of Alternative 3 – IPM without Herbicides, on Socioeconomics

The impacts of Alternative 3 on Socioeconomics would be identical to those described under Alternative 1.

Cumulative Impacts on Socioeconomics

Weed free feed use is common but not required throughout the Pacific Northwest. No additional restrictions on pack stock and other livestock users are foreseeable. Regardless of which alternative is implemented, pack stock and other recreational uses would continue to be a source of invasive plant spread within the Park Complex, but prevention measures and rapid response to infestations would help to minimize the degree to which invasive plants impact the Park Complex.

4.13 Park and Partner Operations

Impacts of Alternative 1 – Current Management, on Operations

The impact of invasive plant management on park and partner operations is largely a function of both the number and extent of control activities that are undertaken and the degree to which prevention efforts are implemented. These actions can directly influence the number of personnel that are needed to effectively meet the goals and objectives of the plan. Under all alternatives, efforts to prevent the spread of invasive plants or new infestations would be undertaken, such as implementation of BMPs, education of park employees, partners, and contractors, and coordination with park partners. These efforts would help to mitigate the impacts of activities that can exacerbate invasive plant infestations. Personnel levels would stay the same as current levels under this alternative, resulting in a negligible impact on park and partner operations.

Impacts of Alternative 2 – IPM with Herbicides, on Operations

The impacts of invasive plant management on park and partner operations would be similar to those described in Alternative 1, except that there would be a short-term increase in personnel needs. Since more projects would be undertaken, there would be an increase in the number of personnel needed to accomplish the work. It is anticipated that once existing larger infestations are controlled and new prevention and rapid response efforts are followed, that the number of personnel needed to accomplish work objectives would taper off and be similar to or less than current levels. The short-term increase in personnel needs, followed by a decrease that would be similar to current levels, would result in a minor impact on park and partner operations.

Impacts of Alternative 3 – IPM without Herbicides, on Operations

The impacts of invasive plant management on park and partner operations would be similar to those described in Alternative 1, except that there would be a long-term increase in personnel needs. Although fewer projects would be undertaken, many would require long-term maintenance to contain populations that cannot be controlled using manual, mechanical, cultural, or biological methods. These projects would require maintenance to keep infestations from spreading outside of their current boundaries. Additionally, some infestations that can be controlled manually or mechanically would take more time and additional personnel to physically remove each plant. Personnel levels would increase, resulting in a moderate impact on park and partner operations.

Cumulative Impacts on Operations

Other impacts on operations include implementation of other plans, such as the Ross Lake National Recreation Area General Management Plan, and the Fire management Plan. Potential future budgetary restrictions could also impact the ability to effectively manage invasive plants within and adjacent to the Park Complex.

4.14 Summary of Impacts of Alternative 1 – Current Management

Under current management, many of the resources described in Chapter 3 – Affected Environment have been impacted by invasive plants, and would continue to be impacted upon implementation of this alternative as a result of non-treatment. Resources would continue to be degraded if further actions are not taken to control invasive plants and restore natural ecosystem processes. Native vegetation is most at risk for long-term changes in plant species diversity, causing a cascade of indirect impacts. With a loss of native vegetation, impacts to soils are likely, including changes in soil properties and increased erosion in some cases. Siltation of waterways could result, adversely impacting native plants, aquatic insects, and fish. Riparian zones would become impacted as invasive plants change the amount of light, water, and nutrients available. In some riparian areas, which are naturally dynamic, species such as knotweed and reed canarygrass would reduce channel migration and input of nutrients to waterways. Wildlife habitat, including habitat of rare, threatened, or endangered species, could in turn be impacted as the diversity, quantity, and quality of forage is reduced and habitat carrying capacity is diminished. For infestations within designated wilderness, the natural quality of wilderness character would be impacted.

If left untreated, invasive plants could impact cultural resources by altering the character of historic places. Large infestations of invasive plants might impact visitor use by reducing access, limiting the view shed, and reducing the diversity of observable native species and/or habitat. There would be negligible impacts to park and partner operations.

There are also impacts resulting from invasive plant treatments that would occur under this alternative. Long-term benefits to natural resources would occur in treatment areas; however, many infestations would still be untreated and would continue to impact natural ecosystem processes. Short-term adverse impacts would occur to many resources as a result of treatment activities. Manual/mechanical treatments and herbicide treatments are most likely to impact natural resources; however BMPs would be implemented to minimize impacts. Other potential impacts to cultural resources, human health and safety, and visitor use and experience would be mitigated by using measures designed to protect or minimize impacts.

4.15 Summary of Impacts of Alternative 2 – IPM with Herbicides

Under Alternative 2, the Preferred Alternative, actions would be taken to control or contain priority invasive plants within the Park Complex. Most of the adverse impacts that result from invasive plants would be reduced or eliminated under this alternative once areas are treated and restored. Control of invasives and follow-up restoration efforts would move native plant communities closer to historic natural conditions and processes. Rare, threatened, and endangered plants, fish, and wildlife would benefit from the restoration of degraded areas, especially in riparian zones. This alternative would have the most beneficial impact on long-term health of park resources and the natural quality of wilderness character. Beneficial impacts to visitor use could result from removal of invasive vegetation by opening up the impacted area to native vegetation and native wildlife, and by increasing the view shed and improving access.

There are short-term environmental risks associated with the use of herbicides, however. Most of the risks can be minimized or eliminated if proper application techniques and mitigation measures are followed. Non-target impacts to native plants, water, wildlife, soils, and human health can be minimized or avoided if herbicide is applied according to label instructions. Visitor use could be impacted for a short time if access was limited during herbicide application. The untrammeled quality of wilderness character would be impacted under this alternative; however impacts would be short-term as restored areas recover.

4.16 Summary of Impacts of Alternative 3 – IPM without Herbicides

Under Alternative 3, an IPM program would be implemented that excludes the use of herbicides as a treatment option. If implemented, this program would not be effective at controlling several invasive plant species that are found in the Park Complex. Although this alternative eliminates the potential impacts related to herbicide use under Alternative 2, it could result in long-term adverse impacts to many park resources. Some of the major problematic infestations and priority species would not be treated, including knotweed, most reed canarygrass infestations, cheatgrass, hawkweed, common tansy, and oxeye daisy. Major riparian zones, including the Stehekin River and Skagit River, are at risk of becoming choked with knotweed and other perennial rhizomatous species. Thick infestations of knapweed, Scotch broom, and herb Robert would also prove difficult to control without herbicide in some places due to persistent seed banks. The cascading effects under this alternative would be similar to those outlined under the Alternative 1 Summary; however, they would occur over a larger area and would result in long-term, far-reaching impacts.

The reduction or eradication of some invasive plant species is possible with non-herbicide control methods. Although fewer projects would be undertaken under this alternative, many would require long-term maintenance to contain populations that cannot be controlled using manual, mechanical, cultural, or biological methods. These projects would require maintenance to keep infestations from spreading outside of their current boundaries. Additionally, some infestations that can be controlled manually or mechanically would take more time and additional personnel to physically remove each plant. Personnel levels would increase, resulting in a moderate impact on park and partner operations.

4.17 Summary Table of Environmental Consequences

Table 4-1. Summary Table of Environmental Consequences

Impact Topic	Actions	Environmental Consequences
Soils		
Alternative 1	**Non-treatment**: Few infestations would be treated. Stehekin knotweed, cheatgrass, and some reed canarygrass and herb Robert populations would not be treated	• Changes in soil chemistry by increasing nitrogen levels where native plants are adapted to low-nitrogen soils, and allelopathy-giving invasives a competitive advantage • Increases in surface runoff and less organic matter where monocultures exist • Stabilization of dynamic wetland/riverine systems by species such as knotweed • Reduction of organic layer from more frequent fires (cheatgrass) LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Limited herbicide use, including Stehekin airstrip, SR 20, Skagit knotweed, and Ross Lake reed canarygrass; ground disturbance from mechanical removal	• Changes in soil chemistry and microbial communities as a result of herbicide application • Increase in erodability on areas of bare ground as a result of herbicide application and/or disturbance from mechanical removal • Residual impacts resulting in bare ground • Recovery of soil function, organization, and structure SHORT-TERM, MINOR ADVERSE IMPACTS, AND LONG-TERM BENEFICIAL IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1, but there would be an increase in impacts resulting from more herbicide treatments, a decrease in ground disturbance impacts, and the impacts of non-treatments would not occur SHORT-TERM, MINOR TO MODERATE ADVERSE IMPACTS, AND LONG-TERM BENEFICIAL IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1; in addition to those already listed for non-treatment under Alt. 1, Skagit knotweed, Ross Lake reed canarygrass, and most species at the Stehekin airstrip and SR 20 would not be treated	• Impacts would be similar to those described in Alt. 1, under non-treatment, with additional species and infestations that would not be treated • Knotweed and reed canarygrass would increase the potential to change from a dynamic to a more stable system and be more likely to create small impoundments, reduced channel movement, and changes in nutrient availability LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Increase in soil disturbance from mechanical removal, resulting in an increase in erosion SHORT-TERM, MINOR ADVERSE IMPACTS

Hydrology & Water Quality		
Alternative 1	**Non-treatment**: Fewer infestations would be treated. Stehekin knotweed, cheatgrass, and some reed canarygrass and herb Robert populations would not be treated	• Stabilization of dynamic wetland/riverine systems by species such as knotweed and reed canary-grass • Decrease in recruitment of canopy species, resulting in increased stream temperatures • Potential for increased erosion on steep slopes that could contribute to increased siltation to waterways, should cheatgrass become dominant LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Limited herbicide use, including Stehekin airstrip, SR 20, Skagit knotweed, and Ross Lake reed canary-grass; ground disturbance from mechanical removal	• Most significant potential impact to water quality is spilling of herbicides; impacts from drift, overspray, and volatilization post negligible impact • Short-term reduction in dissolved oxygen content in closed aquatic systems from decaying plant matter • Beneficial impacts by improving drainage, reducing siltation, and maintaining hydrological functions and features; long-term improvements would occur by becoming more consistent with plant control and therefore reducing the amount of chemical inputs or mechanical disturbance over time SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1 treatment impacts, with more projects being undertaken; there would be greater potential for spills, drift, and overspray, and greater improvement in natural conditions as more projects are undertaken SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1; in addition to those already listed for non-treatment under Alt. 1, Skagit knotweed, Ross Lake reed canarygrass, and most species at the Stehekin airstrip and SR 20 would not be treated	• Impacts would be similar to Alt. 1 non-treatment impacts, with more infestations not being treated, resulting in greater impacts to hydrology and water quality LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Increase in soil disturbance from mechanical removal, resulting in an increase in siltation in waterways SHORT-TERM, MINOR ADVERSE IMPACTS
Wetlands		
Alternative 1	**Non-treatment**: Fewer infestations would be treated. Stehekin knotweed, cheatgrass, and some reed canarygrass and herb Robert populations would	• Displacement of native wetland vegetation, including canopy species; loss of diversity of wetland plants and aquatic animals; changes in hydrologic regimes by stabilization of soils and reduced channel migration LONG-TERM, MAJOR ADVERSE IMPACTS

	not be treated	
	Treatment: Limited herbicide use, including Stehekin airstrip, SR 20, Skagit knotweed, and Ross Lake reed canarygrass; ground disturbance from mechanical removal	• Recovery of wetland vegetation and species diversity in treated areas around Ross Lake • Quality of wetlands along Skagit River would improve • Herbicide impacts would be similar to those that would occur to hydrology and water quality • Potential for non-target damage to native wetland vegetation from herbicide use exists but would be minimized by using spot applications and surveys prior to treatment to identify native plant populations within treatment area SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1 treatment impacts, with more projects being undertaken; there would be greater potential for spills, drift, and overspray, and greater improvement in/recovery of natural conditions of wetlands as more projects are undertaken SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1; in addition to those already listed for non-treatment under Alt. 1, Skagit knotweed, Ross Lake reed canarygrass, and most species at the Stehekin airstrip and SR 20 would not be treated	• Impacts would be similar to Alt. 1 non-treatment impacts, with more infestations not being treated, resulting in greater impacts to wetlands • Mechanical treatments could result in localized erosion and siltation LONG-TERM, MINOR TO MAJOR ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Increase in soil disturbance, leading to erosion and siltation at the head of Lake Chelan for reed canarygrass mechanical work SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Vegetation		
Alternative 1	**Non-treatment**: Fewer infestations would be treated. Stehekin knotweed, cheatgrass, and some reed canarygrass and herb Robert populations would not be treated	• Competition (for light, nutrients, water, space) and chemical influences like allelopathy change ability for recruitment of native species; reduce diversity; and change understory vegetation • Risk of extirpation of state-listed species, especially in wetland environments LONG-TERM, MODERATE TO MAJOR ADVERSE IMPACTS
	Treatment: Limited herbicide use, including Stehekin airstrip, SR 20, Skagit knotweed, and Ross Lake reed canarygrass; ground disturbance from mechanical removal	• Potential for non-target herbicide damage to native vegetation exists but would be minimized by surveying prior to treatment to identify native plant populations within treatment area, using spot applications, and selective herbicides • Ground disturbance from mechanical removal can cause increase in weeds from the seed bank • Reduction in density of non-native species and recovery of native species as a result of some current treatments SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS

Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1 treatment impacts, with more projects being undertaken, resulting in further reduction in density of non-native species and recovery of native species SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1; in addition to those already listed for non-treatment under Alt. 1, Skagit knotweed, Ross Lake reed canarygrass, and most species at the Stehekin airstrip and SR 20 would not be treated	• Impacts would be similar to Alt. 1 non-treatment impacts, with more infestations not being treated, resulting in greater impacts to native vegetation LONG-TERM, MODERATE TO MAJOR ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Increase in ground disturbance, leading to an increase in weeds from the seed bank SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Fish & Wildlife, Including Listed Species		
Alternative 1	**Non-treatment**: Fewer infestations would be treated. Stehekin knotweed, cheatgrass, and some reed canarygrass and herb Robert populations would not be treated	• Changes in habitat quality as a result of not treating several infestations, such as the riparian zone in Stehekin (knotweed), the big beaver wetlands (reed canarygrass), subalpine habitat near Cascade Pass (oxeye daisy), and Stehekin valley walls (cheatgrass) LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Limited herbicide use, including Stehekin airstrip, SR 20, Skagit knotweed, and Ross Lake reed canarygrass; ground disturbance from mechanical removal	• Temporary localized changes in habitat due to the removal of vegetation, such as decreased dissolved oxygen availability after reed canarygrass removal (along Ross Lake), or changes in forage availability and cover • Seven herbicides would be used in limited areas, resulting in negligible to moderate short-term impacts • Long-term improvements to habitat would occur through removal of invasive plants and restoration with natives SHORT-TERM, NEGLIGLIBLE TO MODERATE ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1 treatment impacts, with more projects being undertaken • Temporary habitat changes as a result of vegetation removal (described in Alt. 1) would occur to a greater extent as more projects are undertaken • Five additional herbicides would be used (for a total of 12), resulting in negligible to moderate short-term impacts • Long-term improvements to habitat would occur through removal of invasives, and coordinated restoration/revegetation of native species after treatments SHORT-TERM, NEGLIGLIBLE TO MODERATE ADVERSE IMPACTS AND LONG-TERM BENEFICIAL

		IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1; in addition to those already listed for non-treatment under Alt. 1, Skagit knotweed, Ross Lake reed canarygrass, and most species at the Stehekin airstrip and SR 20 would not be treated	• Impacts would be similar to Alt. 1 non-treatment impacts, with more infestations being untreated, resulting in greater impacts to habitat quality LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Although some species would be controlled, and others would be contained, habitat loss and loss of species diversity would still occur because major infestations would not be treated LONG-TERM, MINOR BENEFICIAL IMPACTS
Natural Soundscapes		
Alternative 1	Fewer infestations would be treated	• Invasive plant management activities, such as hand-pulling and use of hand tools, and herbicide applications would produce small amounts of noise SHORT-TERM, NEGLIGIBLE ADVERSE IMPACTS
Alternative 2	All infestations would be treated	• Impacts would be similar to Alt. 1, plus additional noise impacts would be generated from water pump and helicopter use for the Stehekin Cheatgrass project SHORT-TERM, MINOR ADVERSE IMPACTS
Alternative 3	Fewer infestations would be treated than Alt. 1	• Impacts would be similar to Alt. 1, without noise generated during herbicide applications SHORT-TERM, NEGLIGIBLE ADVERSE IMPACTS
Cultural Resources		
Alternative 1	**Non-treatment**: Fewer infestations would be treated. Stehekin Landing would not be treated	• When invasive plants are not treated, cultural resource sites can suffer a loss of integrity of setting and association of the cultural landscape LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Limited herbicide use and ground disturbance from mechanical removal at Buckner Homestead and Marblemount Ranger Station	• Herbicides can cause chemical contamination of organic and non-organic artifacts and remains • Manual/ mechanical plant removal can cause physical disturbance to site sedimentary matrices that contain artifacts and other cultural remains • Impacts would be mitigated by cultural resource surveys prior to treatment LONG-TERM, MINOR ADVERSE IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use and less ground disturbance than Alt. 1	• Impacts would be similar to Alt. 1 treatment actions, with the potential for a larger number of cultural resource sites to be impacted since a greater number of invasive plant treatments would be undertaken LONG-TERM, MINOR ADVERSE IMPACTS

Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1	• Impacts would be similar to Alt. 1 non-treatment LONG-TERM, MINOR ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Manual/ mechanical plant removal can cause physical disturbance to site sedimentary matrices that contain artifacts and other cultural remains • Impacts would be mitigated by cultural resource surveys prior to treatment LONG-TERM, MINOR ADVERSE IMPACTS
Wilderness Character		
Alternative 1	No treatments would take place within wilderness, other than occasional manual pulling of invasives along park trails	• No impacts to untrammeled, undeveloped, or opportunities for solitude and unconfined recreation • Impacts to naturalness would include the potential for long-term, permanent impacts to natural ecosystem processes LONG-TERM, MODERATE TO MAJOR ADVERSE IMPACTS
Alternative 2	Seven treatments would take place within wilderness: Big Beaver Creek and Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lakes Road, Stehekin Cheatgrass, Stehekin Knotweed, and Park-wide Trails. Most would use herbicides and one would use motorized equipment	• Short-term moderate impacts to untrammeled would occur as a result of undertaking large invasive plant treatments in wilderness, especially Stehekin Cheatgrass. Impacts would become unnoticeable as native plant communities are restored • Short-term moderate impacts to undeveloped would occur due to the use of a motorized water pump and helicopter • Short-term negligible impacts to opportunities for solitude and unconfined recreation would occur during treatment • Long-term beneficial impacts to naturalness would include restoration and protection of natural ecosystem processes SHORT-TERM, NEGLIGIBLE TO MODERATE ADVERSE IMPACTS & LONG-TERM BENEFICIAL IMPACTS
Alternative 3	Stehekin Cheatgrass, Stehekin Knotweed, Big Beaver Reed Canarygrass, and Ruby Pasture would not be treated, and only knapweed would be treated (manually) on Thornton Lakes Road; Ridley Lake Reed Canarygrass and Park-wide Trails would be treated manually/mechanically	• Short-term negligible impacts to untrammeled would occur as a result of undertaking small invasive plant treatments in wilderness. Impacts would largely be unnoticeable • No impacts to undeveloped • Short-term negligible impacts to opportunities for solitude and unconfined recreation would occur during treatment • Impacts to naturalness would include the potential for long-term, permanent impacts to natural ecosystem processes since most projects wouldn't be treated SHORT-TERM, MODERATE TO MAJOR ADVERSE IMPACTS & LONG-TERM BENEFICIAL IMPACTS
Visitor Use & Experience		
Alternative 1	**Non-treatment**: Few infestations would be treated	• The impacts of not treating invasive species could have adverse impacts to visitor use and experience, as access is reduced over time due to thick infestations and/or vegetation communities change the scenic character of an area LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Limited herbicide use and	• Visitor use: Area closures during treatment would impact visitor access, but for short amounts of

	manual/mechanical removal	time during closure period • Visitor experience: Treatment of infestations may improve visitor experience by protecting/restoring native ecosystems and natural scenery; herbicide use may degrade visitor experience due to real or perceived health risks associated with the use of herbicides; uniformed presence, especially in wilderness, could impact solitude for some visitors and be seen as a positive encounter for other visitors SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 2	**Treatment**: All infestations would be treated in the most effective way, resulting in more herbicide use than Alt. 1	• Impacts would be similar to Alt. 1 treatment impacts. More projects would be treated, so potential to impact more visitors is possible SHORT-TERM, MINOR ADVERSE IMPACTS AND LONG-TERM BENEFICIAL IMPACTS
Alternative 3	**Non-treatment**: Fewer infestations would be treated than Alt. 1	• Impacts would be similar to Alt. 1 non-treatment impacts. Knotweed, reed canarygrass, and cheatgrass would have greatest potential to change vegetation communities and impact natural scenery LONG-TERM, MODERATE ADVERSE IMPACTS
	Treatment: Treatment would consist of increased manual/ mechanical and cultural efforts	• Impacts would result from the increased uniformed presence of personnel performing manual/mechanical removal for longer periods of time SHORT-TERM, MINOR ADVERSE IMPACTS
Human Health & Safety		
Alternative 1	**Treatment**: some infestations would be treated with herbicides and/or manual/mechanical tools	• Impacts to public health and safety include potential exposure to herbicides if they enter the treatment area too soon; these impacts would be mitigated by area closures and warnings to visitors. Exposure from drinking water near an area that was recently sprayed with herbicide is unlikely due to the speed at which the chemicals decompose and are diluted by water • Impacts to employees include herbicide exposure while working with chemicals (mixing, loading, transport, application, etc.); working in rough terrain and harsh weather conditions; working along busy roads, highways, and developed areas; and working with hand tools and motorized equipment and vehicles SHORT-TERM, NEGLIGIBLE TO MINOR ADVERSE IMPACTS
Alternative 2	**Treatment**: all infestations would be treated with herbicides and/or manual/mechanical tools	• Impacts would similar to Alt. 1. There would be an increase in the number of projects undertaken, and an increase in the chance of exposure to dangerous situations SHORT-TERM, MINOR ADVERSE IMPACTS
Alternative 3	**Treatment**: some infestations would be treated with manual/ mechanical tools	• There would be no impact to public health and safety, and impacts to employees would result from working in rough terrain and harsh weather conditions; working along busy roads, highways, and developed areas; and working with hand tools and motorized equipment and vehicles SHORT-TERM, MINOR ADVERSE IMPACTS
Socioeconomics		
Alternative 1	**BMPs:** require weed-free feed for all	• Impacts would range from negligible for operators who are accustomed to procuring weed-free

	stock use in the Park Complex, and encourage weed-free feed use 24 hours prior to visiting park lands with stock	feed for use on adjacent US Forest Service lands, and minor to moderate for other users (especially those in Stehekin) who will need to procure large amounts of weed-free feed; impacts are expected to decrease over time as weed-free feed becomes more widely available SHORT-TERM, NEGLIGIBLE TO MODERATE ADVERSE IMPACTS
Alternative 2	**Same as Alt. 1.**	**Same as Alt. 1.**
Alternative 3	**Same as Alt. 1.**	**Same as Alt. 1.**
Park & Partner Operations		
Alternative 1	**Projects:** same number of current projects would continue in the future	• Due to increased prevention efforts, such as implementing BMPs, and cooperation and coordination with park partners, the impacts of activities that can exacerbate invasive plant infestations would be mitigated • Personnel levels would stay the same as current levels
Alternative 2	**Projects:** More projects would be undertaken	• Impacts would be similar to Alt. 1, except that there would be a short-term increase in personnel needs that would taper off as larger infestations are controlled
Alternative 3	**Projects:** Fewer projects would be undertaken; however, available methods would be more time-consuming	• Impacts would be similar to Alt. 1, except there would be a long-term increase in personnel needs to contain on-going infestations that would never be eradicated because they cannot effectively be controlled without the use of herbicides

5 CONSULTATION AND COORDINATION

5.1 History of Public Involvement

The public scoping process was initiated on two separate occasions through letters and media releases issued by the NPS in writing and electronically. On April 10, 2002, a letter was issued from the park superintendent to interested parties seeking input regarding invasive non-native plant management. The letter provided information about the threat of invasive plants in the Park Complex and a brief synopsis of the proposed actions. The deadline for public comment was May 15, 2002. The letter inviting public participation was sent to private individuals who had indicated an interest in invasive plant management as well as the Noxious Weed Control Boards for Chelan, Okanogan, Skagit and Whatcom Counties, The National Parks and Conservation Association, The Mountaineers (Bellingham and Seattle), Sierra Club (Cascades Chapter), North Cascades Conservation Council, Friends of the Earth, U.S. Forest Service (Okanogan National Forest and Mt. Baker-Snoqualmie National Forest), Department of Natural Resources (Sedro-Woolley, WA), Washington Department of Fish and Wildlife (Olympia and Mill Creek, WA), Seattle City Light (Seattle and Rockport, WA), Colville Confederated Tribes, Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, the Upper Skagit Tribal Council, the Yakima Nation, Department of Archeology and Historic Preservation, and Signpost Magazine.

Shortly after the public scoping process ended and preliminary development of the Environmental Assessment took place, a number of winter storms and fire events occurred that directed NPS personnel away from completion of the document and final public review. Finally, in 2007 and 2008 NPS personnel were able to revisit the document, reinitiate public scoping, and work toward completion of the document. On December 18, 2007, a letter from the Park Superintendent and media release invited further public comment until January 30, 2008.

Public Response

A total of 16 comments were received via mail, email and phone during the two scoping periods; four from 2002 and 12 from 2007-08. Many of the comments were multifaceted and feedback was received from unaffiliated individuals as well as groups or agencies such as the Noxious Weed Control Board of Whatcom County, Seattle City Light, Washington Native Plant Society, and National Parks Conservation Association. In general, the comments reflected a consensus that invasive plants are a serious problem in the Park Complex and warrant a program to manage and attempt to control their growing populations. Several comments articulated strong concerns regarding the potential use of herbicides as a control method due to the potential safety hazard for humans and native flora and fauna. Some of the comments suggested other means of weed control, such as using goats to eat the vegetation, hand-pulling or hand-digging, cutting, burning, or a combination of methods (some including and some excluding the use of herbicides). Additional information was requested on various herbicides, their toxicity, and proposed use as well as the known populations of invasive plants, their means of spread, and the measured viability of various control methods. Other concerns included the cost of control methods and port of entry for invasive weed seeds. Comments generated through public scoping are summarized in Table 5-1 and are addressed more extensively throughout this document.

Table 5-1. Public Scoping Concern Statements

Public Concern Statements Regarding Planning Process and Policy
▪ A program to control invasive plants should be attempted. ▪ Is killing Japanese knotweed a realistic goal to entertain? ▪ In favor of weed control and what the Park is doing.

Public Concern Statements Regarding the Scope of the Plan
▪ Stehekin "emergency" landing strip is a significant port of entry for invasive plants and profound environmental scar that should also be addressed. ▪ Use of herbicides prevents serious engagement with more important environmental problems facing the Park Complex. ▪ Limiting the examination to a no-action and a preferred alternative will not appear to meet NEPA requirements; present a wide range of alternatives. ▪ Provide complete information on any proposed herbicide including the toxicity level, how long toxicity is active and as much information is possible on side effects associated with its use, how effective has it been in controlling targeted species, at what dosages and how often. Is re-application necessary? How frequently and how often? ▪ Periodic review should be written into the program to assess effectiveness of treatments and test residual herbicides on the water. ▪ Present all variations on methods and application of herbicides with pros and cons of each method. ▪ Provide equal attention to the dangers (both direct and indirect) to the proposed cure. ▪ Provide information on the collateral damage; e.g., what effects herbicides have had on water which humans use to drink and grow their food and on fish and wildlife. ▪ Consider adding the following notoriously aggressive species to your exotic plant management program: Dalmatian toadflax (*Linaria dalmatica* sp *dalmatica*), non-native yellow hawkweeds (*Hieracium caespetosum* and *H. sabaudum*), butterfly bush (*Buddleia* sp.), sulfur cinquefoil (*Potentilla recta*), and tansy ragwort (*Senecio jacobaea).* ▪ Consider monitoring the following invasive species that may enter the Park Complex from east of the Cascades: puncturevine (*Terribus terrestris*), Russian knapweed (*Acroptilon repens*), leafy spurge (E*uphorbia esula*), and yellow star thistle (*Centaurea solsitialis*). ▪ Provide information from inventories and maps, such as how quickly a plant seems to be spreading, into what type of area, and how it spreads (e.g. by rhizomes). ▪ Can knotweed be controlled by burning the root system?
Public Concern Statements Regarding Methods and Techniques
▪ Use goats to eat the vegetation. ▪ Use volunteers to hand-pull weeds. ▪ Herbicides are the least desirable method; use as a last resort. ▪ Herbicides should not be used for any reason in the Park or Recreation Areas. ▪ Herbicides pose unwarranted danger to flora and fauna; pursue safer solutions. ▪ Utilize all control options available to stop spread of invasive plants. ▪ Don't waste taxpayer dollars on hand-pulling weeds when chemical control is available. ▪ Use of contact herbicides in a manner that minimizes damage to native species while controlling non-native species (spot spraying) should be encouraged. ▪ Use of herbicides is supported if used in a responsible manner that will not affect other ecological processes and is deemed most effective form of treatment after fully evaluating the impacts and possible alternatives. ▪ Eradicate these weeds based primarily on the application of herbicides supplemented by hand pulling. ▪ Numerous research findings indicate that cutting back Japanese knotweed regularly is only effective in conjunction with injections of weed killer into the cane stumps, not spraying over the top. ▪ Explore possibilities of using volunteer youth groups to cut knotweed at least once (one season) before any herbicide is used. ▪ Once use of herbicides is begun, would it be perpetual? ▪ Particularly concerned with cutting plant and pouring poison into the hollow core. ▪ Spraying herbicides will not work, nor will hand-pulling ▪ Spray of herbicides will drift to nearby river or creeks and contaminate the water. ▪ Japanese knotweed can be eradicated only if there is a consistently vigilant plan that takes into consideration the ecological and environmental factors. ▪ Bag cuttings and dig up/bag rhizome clumps of Japanese knotweed multiple times to prevent re-sprouting and weaken remaining.

- Herbicides are too risky to use based on evidence of a few years' use to prove that they don't cause damage now or in the future.
- Use an integrated weed management approach tailored for each species and site characteristics.

5.2 Agencies and Tribes Consulted

Chelan County Noxious Weed Control Board. In July 2010, park staff and members of the Chelan County Noxious Weed Control Board met to discuss progress on the Park Complex's Invasive, Non-native Plant Management Environmental Assessment, and to discuss the county's process of working with landowners to control knotweed (a Class B weed) throughout Chelan County. Ongoing discussions about developing ways to coordinate knotweed control efforts on private and public land in the Stehekin Valley have occurred, and will continue throughout this planning effort.

Native American Tribes. Park-associated, federally-recognized tribes include the Colville Confederated Tribes, Nooksack Tribe, Sauk-Suiattle Tribe, Swinomish Indian Tribal Community, Upper Skagit Tribe, and Yakama Nation. Representatives for each of these groups were given the opportunity to comment during the public scoping period. Though no comments from tribal representatives were received during the public scoping period, other opportunities will be forthcoming during both the public/agency review of the EA, and later, in those cases in which proposed projects to control or contain invasive plants become undertakings.

State Historic Preservation Office (SHPO). This environmental assessment will be sent to the Washington State Department of Archaeological and Historical Preservation (DAHP) for review and comment in compliance with National Historic Preservation Act regulations. The SHPO will also be contacted to initiate consultation if any proposed projects become undertakings. At this time, there is not enough information to identify an undertaking-determined area of potential effect (APE) or make a determination of effect consistent with section 106 of the National Historic Preservation Act of 1966 (as amended, 16 U.S.C. 470-470w-6) for the actions related to historic properties. Once identified, undertakings that have the potential to affect cultural resources eligible for or listed on the National Register of Historic Places will fulfill all procedural requirements specified in 36 CFR 800 (as amended in August, 2004).

U.S. Department of Fish and Wildlife and National Marine Fisheries Service. Park staff discussed the proposed list of federally endangered and threatened species to be considered with USFWS and NMFS. The agreed upon list appears in the EA in Table 3-1. A separate, more detailed biological assessment that evaluates the effects of the preferred alternative on listed species has been submitted to USFWS and NMFS. Biological opinions from both agencies are pending.

5.3 List of Recipients

Table 5-2. Recipient List

Agencies	
Chelan County Dept of Community Development	San Juan National Historical Park
Chelan County Noxious Weed Board	Skagit County Noxious Weed Control Board
Chelan County PUD	US Fish and Wildlife Service
City of Seattle—Seattle City Light	WA Department of Archeology and Historic Preservation
Ebey's Landing National Historical Reserve	WA Department of Fish and Wildlife
Fort Vancouver National Historic Site	WA State Department of Agriculture
Lewis & Clark National Historical Park	WA State Department of Ecology
Mount Baker-Snoqualmie National Forest	WA State Department of Transportation

Mount Rainier National Park	WA State DOT, Aviation Division
National Marine Fisheries Service	WA State Noxious Weed Control Board
NPS – Biological Resources Division	WSU Mt. Vernon Research & Extension Unit
NPS – Water Resources Division	WSU Skagit County Extension
Olympic National Park	Whatcom County Noxious Weed Control Board
Okanogan-Wenatchee National Forest	
Native American Tribes	
Nooksack Tribe	Swinomish Indian Tribal Community
Colville Confederated Tribes	Upper Skagit Tribal Council
Sauk-Suiattle Indian Tribe	Yakama Nation
Organizations	
Backcountry Horsemen of WA State	Skagit Land Trust
Conservation Northwest	Student Conservation Assn. Inc.
Earth Justice Legal Defense Fund	The Henry M. Jackson Foundation
Fidalgo Fly Fishers	The Mountaineers – Bellingham, Seattle
National Parks Conservation Association	The Nature Conservancy
North Cascades Conservation Council	The Wilderness Society
North Cascades Institute	WA Native Plant Society
North Central WA Audubon Society	WA Trails Association
REI – Bellingham, Lynnwood, Redmond, Seattle	WA Trout
Sierra Club - Cascades Chapter	WA Wilderness Coalition
Skagit Conservation District	Wild Fish Conservancy
Skagit Fisheries Enhancement Group	Wilderness Watch

5.4 List of Preparers

The following Park Complex personnel helped to prepare this document.

Table 5-3. List of Preparers

Name	Title	Responsibility
Cathi Jones Winings	Natural Resource Program Manager	Primary author; Compliance lead
Mignonne Bivin	Plant Ecologist	Project lead
Todd Neel	Exotic Plant Management Specialist	Project lead
Vicki Gempko	Natural Resource Program Manager	Technical specialist
Andrea Weiser	Archeologist	Editor; Technical specialist
Dan Campbell	Exotic Plant Management Specialist	Map production
Sharon Brady	Physical Science Technician	Technical specialist
Reed Glesne	Aquatic Ecologist	Technical specialist
Jesse Kennedy	Cultural Resource Specialist	Technical specialist
Robert Kuntz	Wildlife Biologist	Technical specialist
Bob Mierendorf	Archeology	Technical specialist

6 GLOSSARY

Adaptive management: In adaptive management, information about the resources managed, in this case, invasive plants, is continuously developed, and used to adjust management approaches.

Adjuvant: A substance mixed with an herbicide that increases the effectiveness of the herbicide. "Surfactants" are one class of adjuvants. Other adjuvants include pH modifiers, wetting agents, and gelling agents.

Exotic species: An introduced, non-native species, or a species that is the result of direct or indirect, deliberate or accidental introduction of the species by humans, and for which introduction permitted it to cross a natural barrier to dispersal. In North America, exotic often refers to those species not present in a bioregion before the entry of Europeans in the 16th century, or those present in later parts of that region and later introduced to an ecosystem by human-mediated mechanisms.

Gross infested area: Gross infested area can be defined as the outer perimeter of an infestation. It contains target species and the spaces between populations or individual plants. Therefore, the gross infested area of a project describes the furthest known extent of the infested area. Treatments generally would not be applied to the full gross infested area, but rather the fraction of the area that contains individual plants or populations.

Herbicide: Pesticide that specifically targets vegetation.

Invasive species: Generally, this term refers to a subset of plants or animals that is introduced to an area, survives, and reproduces, and causes harm economically or environmentally within the new area of introduction. Invasive species displace native species and may have the ability to cause large-scale changes in an ecosystem.

Integrated pest management: Focus upon long-term prevention or suppression of pests. The integrated approach to weed management incorporates the best suited cultural, biological, and chemical controls that have minimum impact on the environment and on people.

Mitigation: Activities that will avoid, reduce the severity of, or eliminate an adverse environmental impact.

Monoculture: A plant community (forest, range) consisting of only one species; uniform throughout.

Native species: A species that occurs naturally in an area, and that has not been introduced by humans either intentionally or unintentionally. A synonym for indigenous species.

Non-native species: Along with "introduced species" and "non-indigenous species," this is one of the most commonly used terms to describe a plant or animal species that is not originally from the area in which it occurs. Similar terms include "alien species," "exotic species," and "foreign species." This term has also been defined as a species whose presence is due to intentional or unintentional introduction as a result of human activity.

Non-selective herbicide: A non-selective herbicide kills all plants it comes in contact with, as opposed to selective herbicides, which kill only certain plants.

Noxious weed: This term is frequently a legal term in State code, denoting a special-status of the plant as, for example, prohibited or restricted. Noxious weeds are aggressive non-native plants or plant products that injure or cause damage to interests of agriculture, irrigation, navigation, natural resources, public health, or the environment. Implies a species' adverse effects on humans—either directly (e.g., species that produce toxins that are harmful to humans) or indirectly (e.g., species that infest nature reserves). Any species of plants—annual, biennial, or perennial—reproduced by seed, root, underground stem, or bulblet, which, when established, is or may become destructive and difficult to control.

Perennial: A plant that lives for three or more years.

Pesticide: A chemical or biological agent intended to prevent, destroy, repel, or mitigate plant or animal life, and any substance intended for use as a plant regulator, defoliant, or desiccant. Includes insecticides, fungicides, rodenticides, herbicides, nematocides, and biocides.

Population: A group of potentially inter-breeding individuals of the same species found in the same place at the same time.

Propagule: A cutting, seed, or spore that can grow or reproduce.

Seed bank: Seeds that become incorporated into the soil, often remain dormant, and may germinate many years later.

Selective herbicide: Selective herbicides kill specific weeds while leaving other desired plants relatively unharmed.

Species: A class of individuals having common attributes and designated by a common name; a category of biological classification ranking immediately below the genus or subgenus; comprising related organisms or populations potentially capable of interbreeding.

Spot herbicide application: A dilute herbicide solution is delivered to the foliage of target plants by means of a manually pressurized backpack or hand-held sprayer. In some cases, this treatment may also be made to the soil of infested areas prior to seed germination.

Staging area: Staging areas are locations set aside for materials and equipment storage for specific construction projects and/or places that are used for many years or decades for ongoing projects and park operations. Examples of staging areas include roadside pullouts, parking lots, and sites where infrastructure once existed such as abandoned roads. Larger staging areas include former quarries, borrow pits, abandoned roads, and infrastructure. Often, surplus project-generated materials such as rock and soil will remain at such areas for future park uses.

Surfactants: A supplemental aid to herbicides for adherence and penetration.

Understory: The trees and woody shrubs growing beneath branches and foliage formed collectively by the upper portions of adjacent trees.

Vector: Mode by which a species establishes in a new environment.

7 ACRONYMS AND ABBREVIATIONS

Table 7-1. List of Acronyms and Abbreviations

APHIS	Animal and Plant Health Inspection Service
ATV	All-Terrain Vehicle
BMP	Best Management Practices
CWA	Clean Water Act
DM	Departmental Manual
DOI	Department of the Interior
EA	Environmental Assessment
EPA	Environmental Protection Agency
EPMT	Exotic Plant Management Team
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GPS	Global Positioning System
IDT	Inter-Disciplinary Team
IPM	Integrated Pest Management
LACH	Lake Chelan National Recreation Area
MSDS	Material Safety Data Sheet
NCCN	North Coast and Cascades Network
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOCA	North Cascades National Park Service Complex (includes ROLA and LACH)
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRA	National Recreation Area
NRI	Nationwide Rivers Inventory
OSHA	Occupational Safety and Health Administration
RM	Reference Manual (e.g. RM 77-7)
ROLA	Ross Lake National Recreation Area
SCL	City of Seattle, Seattle City Light Department
SHPO	State Historic Preservation Office
USFWS	US Fish and Wildlife Service

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Appendix A. Non-native Plants Documented Within the Park Complex

Table A-1 lists all non-native plant species currently known to occur within the Park Complex. There are 225 species, all of which have been ranked using the Decision-making Tool (Appendix B). For more information about each species, go to any of the following websites: www.invasive.org, www.invasivespeciesinfo.gov/plants, or http://www.nwcb.wa.gov/INDEX.htm.

Priority Ranking Key: **1 = Highest Priority; 2 = Medium-High Priority; 3 = Medium Priority;**
4 = Last Priority (treatment generally would not occur except opportunistically when the species occurs among other priority infestations).

Table A-1. Non-native Plant List and Priority Rankings under the Action Alternatives

Latin Name	Common Name	Decision Tool Priority Ranking
Acer negundo	box elder	4
Agropyron cristatum	crested wheatgrass	4
Agrostemma githago	cockle	4
Agrostis capillaris	colonial bentgrass	4
Agrostis gigantea	black bent	4
Agrostis interrupta	interupted apera	4
Agrostis stolenifera	creeping bentgrass	4
Argostis tenius	bentgrass	4
Aira caryophyllea	silver hairgrass	4
Aira praecox	yellow hairgrass	4
Ajuga repens	common bugle	4
Alcea rosea	holly hock	4
Aloepecurus pratensis	meadow foxtail	4
Amaranthus albus	pigweed	4
Amoracia rutsticana	horseradish	4
Anthemis cotula	chamomile	4
Anthoxanthum ordoratum	sweet vernal grass	4
Antirrhium majus	snapdragon	4
Aphanes arvensis	field parsley piert	4
Arabidopsis thaliana	mouse-ear cress	4
Arctium lappa	burdock	4
Arctium minus	lesser burdock	4
Arenaria serpyllifolia	thyme-leaved sandwort	4
Artemisia absinthium	**absinth wormwood**	**1**

Latin Name	Common Name	Decision Tool Priority Ranking
Asparagus officinalis	asparagus	4
Asperugo procumbens	German mugwort	4
Barbarea vulgaris	garden yellow-rocket	4
Bellis perennis	English daisy	4
Brassica rapa. Var. *rapa*	field mustard	4
Bromus hordeaceus	soft brome	4
Bromus inermis	smooth brome	4
Bromus japonicus	field brome	4
Bromus tectorum	**cheatgrass**	**2**
Buddleja davidii	**butterfly bush**	**1**
Campanula rapunculoides	harebell	4
Capsella bursa-pastoris	shepherd’s purse	4
Cardaria draba	hoary pepperwort	4
Castanea crenata	Japanese chestnut	4
Centaurea biebersteinii	**spotted knapweed**	**2**
Centaurea cyanus	bachelor buttons	4
Centaurea diffusa	**diffuse knapweed**	**2**
Centaurea montana	perennial cornflower	4
Centaurium erythraea	European centaury	4
Cerastium fontanum var. *vulgare*	common mouse-ear	4
Cerastium glomeratum	sticky chickweed	4
Chenopodium album	lambs quarters	4
Chenopodium botrys	Jerusalem oak	4
Chondrilla juncea	**rush skeletonweed**	**2**
Cirsium arvense	**Canada thistle**	**2**
Cirsium vulgare	**bull thistle**	**2**
Clematis vitalba	**traveler’s joy**	**1**
Conium maculatum	**poison hemlock**	**1**
Convallaria majalis	lily of the valley	4
Convolvulus arvensis	bindweed	4
Convolvulus sepium	hedge bindweed	4
Crataegus monogyna	hawthorn	4
Crepis capillaris	hawk's-beard	4
Cytisus scoparius	**Scotch broom**	**2**
Dactylus glomerata	orchardgrass	4

Latin Name	Common Name	Decision Tool Priority Ranking
Daucus carota	Queen Anne's lace	4
Dianthus armeria	Deptford pink	4
Dianthus barbatus	sweet William	4
Dianthus deltoides	maiden pink	4
Digitalis purpurea	foxglove	4
Elytrigia repens	quack grass	4
Erodium cicutarium	cranes bill	4
Euphorbia cyparissias	cypress spurge	4
Euphorbia myrsinites	**Myrtle spurge**	**1**
Euphorbia oblongata	**eggleaf spurge**	**1**
Euphorbia peplus	petty spurge	4
Featuca arundinaceae	giant fescue	4
Festuca rubra	redtop fescue	4
Galeopsis tetrahit	bristlestem hempnettle	4
Galium odoratum	sweetscented bedstraw	4
Geranium molle	crane's bill	4
Geranium pusillum	small flowered cranes bill	4
Geranium robertianum	**herb Robert**	**2**
Gnaphalium uliginosum	low cudweed	4
Glecoma hederacea	ground ivy	4
Gypsophila paniculata	baby's breath	4
Hedera helix	**English ivy**	**1**
Hesperis matronalis	dame rocket	4
Hieracium aurantiacum	orange hawkweed	4
Hieracium pilosella	**mouse-ear hawkweed**	**2**
Hieracium triste	woolly hawkweed	4
Holcus lanatus	velvet grass	4
Hordeum vulgare	rye	4
Humulus lupulus	hops	4
Hypericum perforatum	**St. Johnswort**	**3**
Hypochaeris radicata	hairy cat's-ear	4
Ilex aquafolium	**English holly**	**1**
Impatiens granulifera	policeman's helmet	4
Juglans cinerea	**butternut**	**1**
Juncus effusus var. *conglomeratus*	common rush	4

Latin Name	Common Name	Decision Tool Priority Ranking
Lactuca serriola	prickly lettuce	4
Lamium purpureum	purple dead nettle	4
Lamiun maculatum	spotted dead nettle	4
Lapsana communis	common nipplewort	4
Lathyrus latifolius	**evergreen pea**	**1**
Lavandula augustifolia	lavender	4
Leontodon autumnalis	fall dandelion	4
Lepidium perfoliatum	clasping pepperweed	4
Leucanthemum vulgare	**oxeye daisy**	**3**
Linaria dalmatica	**Dalmatian toadflax**	**1**
Linaria vulgaris	**yellow toadflax (butter-and-eggs)**	**1**
Logfia arvensis	field cottonrose	4
Lolium arundinaceum	tall fescue	4
Lolium multiflorum	annual ryegrass	4
Lolium perenne	perennial ryegrass	4
Lolium temulentum	darnel ryegrass	4
Lonicera japonica	Japanese honeysuckle	4
Lunaria annua	annual honesty	4
Lychnis coronaria	rose campion	4
Lychnis alba	white campion	4
Malva neglecta	cheeseweed	4
Matricaria discoidea	pineapple weed	4
Medicago lupulina	black medic	4
Medicago sativa	alfalfa	4
Melilotus alba	**white sweetclover**	**2**
Melilotus indica	yellow sweetclover	4
Melissa officinalis	common balm	4
Menta spicata	spearmint	4
Mentha X *piperia*	peppermint	4
Monarda didyma	Oswego tea	4
Mycelis muralis	wall lettuce	4
Myosotis arvensis	forget me not	4
Myosotis discolor	changing forget-me-not	4
Myosotis scorpiodes	true forget-me-not	4
Myosotis stricta	strict forget-me-not	4

Latin Name	Common Name	Decision Tool Priority Ranking
Myriophyllum spicatum	Eurasian watermilfoil	4
Nepeta cataria	catnip	4
Oxalis corniculata	wood sorrel	4
Panicum miliaceum	broomcorn millet	4
Pennisetum glaucum	pearl millet	4
Petasites japonicus	Japanese sweet coltsfoot	4
Phalaris arundinaceae	**reed canarygrass**	**2**
Phleum pretense	timothy	4
Plantago lanceolata	English plantain	4
Plantago major	common plantain	4
Poa annua	annual bluegrass	4
Poa bulbosa	bulbous bluegrass	4
Poa compressa	compressed bluegrass	4
Poa palustris	fowl bluegrass	4
Poa pretense	perennial bluegrass	4
Poa trivialis	Rough bluegrass	4
Polygonum arviculare	prostrate knotweed	4
Polygonum convolvulus	ivy bindweed	4
Polygonum cuspidatum	**Japanese knotweed**	**2**
Polygonum hydropiper	smartweed	4
Polygonum sachalinense	**giant knotweed**	**2**
Potentilla recta	**sulfur cinquefoil**	**1**
Prunella vulgaris	self heal	4
Pyrus communis	common pear	4
Quercus robur	**English oak**	**1**
Ranunculus acris	meadow buttercup	4
Ranunculus repens	creeping buttercup	4
Robinia hispida	**bristly locust**	**1**
Robinia pseudo-acacia	**black locust**	**1**
Rubus discolor	**Himalayan blackberry**	**2**
Rubus laciniatus	**cutleaf blackberry**	**2**
Rudbeckia hirta	black-eyed Susan	4
Rudbeckia lacinata	rudbeckia	4
Rumex acetocella	sheep sorrel	4
Rumex conglomeratus	broad leaf dock	4

Latin Name	Common Name	Decision Tool Priority Ranking
Rumex crispus	curly dock	4
Rumex obtusifolius	bitter dock	4
Rumex sanguineus	redvein dock	4
Sagina procumbens	birdeye pearlwort	4
Sambucus cerulea var. *cerulea*	blue elderberry	4
Saponaria officinales	bouncing bet	4
Sceranthus annuus	knawel	4
Senecio jacobaea	**tansy ragwort**	**1**
Senecio sylvaticus	woodland ragwort	4
Senecio vulgaris	common groundsel	4
Setaria viridis	bottlegrass	4
Silene armeria	sweet William silene	4
Silene cserei	Balkan catchfly	4
Silene gallica	common catchfly	4
Silene latifolia	bladder campion	4
Silene noctiflora	nightflowering silene	4
Silene vulgaris	maidenstears	4
Sisymbrium altissimum	Jim Hill mustard	4
Sisymbrium loeselii	tumble mustard	4
Sisymbrium officinale	hedge mustard	4
Solanum dulcamara	bittersweet nightshade	4
Solanum physalifolium	ground-cherry nightshade	4
Sonchus arvensis	sow thistle	4
Sonchus asper	prickly sow thistle	4
Sonchus oleraceus	annual sow thistle	4
Sorbus auucuparia	European mountain ash	4
Spergula arvensis	cornspurry	4
Spergularia rubra	red sand spurry	4
Stellaria graminea	grass leaf starwort	4
Stellaria media	chickweed	4
Symphytum officinale	common comfrey	4
Tanacetum parthenium	feverfew	4
Tanacetum vulgare	**common tansy**	**2**
Taraxacum laevigatum	rock dandelion	4
Taraxacum officinale	common dandelion	4

Latin Name	Common Name	Decision Tool Priority Ranking
Thinopyron intermedium	intermediate wheatgrass	4
Thymus serpyllum	thyme	4
Tragopogon dubius	yellow salsify	4
Tragopogon porrifolius	purple salsify	4
Trifolium arevense	hare's foot clover	4
Trifolium aureum	golden clover	4
Trifolium campestre	field clover	4
Trifolium dubium	hop clover	4
Trifolium hybridum	alsike clover	4
Trifolium pratense	red clover	4
Trifolium repens	white clover	4
Verbascum blattaria	moth mullein	4
Verbascum thapsus	**common mullein**	**1**
Veronica arvensis	corn speedwell	4
Veronica biloba	bilobed speedwell	4
Veronica officinalis	Common gypsyweed	4
Veronica serpyllifolia	thyme leaved speedwell	4
Vicia cracca	bird vetch	4
Vicia hirsute	tiny vetch	4
Vicia sativa ssp *nigra*	garden vetch	4
Vicia sativa ssp. *sativa*	common vetch	4
Vicia tetrasperma	slender vetch	4
Vicia villosa	hairy vetch	4
Vinca major	**periwinkle**	**2**
Viola arvensis	wild pansy	4
Vulpia microstachys	six week brome	4

Appendix B. Decision-making Tool

The Decision-making Tool assists resource managers in determining management priorities based on potential impacts to park resources and the potential for controlling the invasive plant. Invasive plants that are listed as county, state, or federal noxious weeds are considered a general management priority. Relative management priorities for each invasive plant can be determined using either a quantitative or qualitative process. The NPS has developed a planning resource called the Alien Plant Ranking System to quantitatively determine invasive plant management priorities. However, in some situations, resource managers may already have sufficient knowledge of or enough information and data about an invasive plant species to make the use of the Alien Plant Ranking System cumbersome or redundant in evaluating local needs. To address this potential need, a qualitative system was also developed to allow resource managers to qualitatively determine invasive plant management priorities (this system was adapted from the Northern Great Plains Exotic Plant Management Plan and Environmental Assessment, 2005).

Resource managers can use the Alien Plant Ranking System to sort invasive plants according to the plant's current level of impact and its innate ability to become a pest. This information is then weighed against the perceived feasibility or ease of control. The Alien Plant Ranking System also helps the resource manager identify those species that are not presently a serious threat but have the potential to become a threat and, thus, should be monitored closely or managed aggressively before they become established. The potential cost of delaying any action is also considered in this analysis. The Alien Plant Ranking System can be downloaded at:
http://sbsc.wr.usgs.gov/research/projects/swepic/aprs/ranking.asp. The qualitative Decision-making Tool is posted on the next page.

The results of either the qualitative or quantitative rankings are used to determine relative management priorities. In accordance with NPS management policies, highest priority is given to management of disruptive invasive plants that have, or potentially have, a substantial impact on park resources, and can reasonably be expected to be controlled. Disruptive species typically have one or more of the following characteristics:

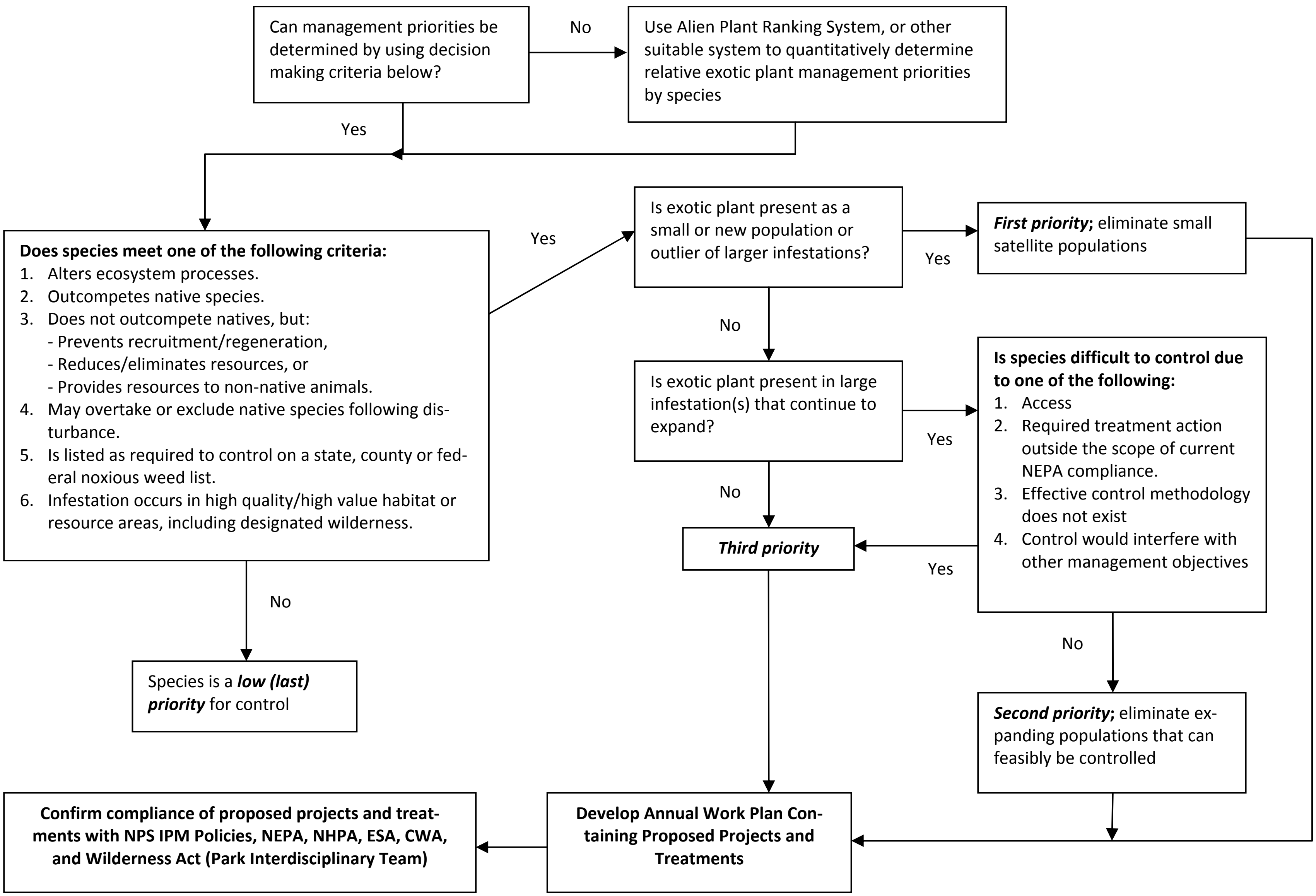
- Have community level or ecosystem level effects and significantly alter natural processes such as: fire regimes, nutrient cycling, hydrology, or successional patterns;
- Alter species composition and reduce populations of native species;
- Alter genetic variability through hybridization with native species;
- Affect localized resources, such as archaeological or scenic qualities.

Lower priority is given to innocuous non-native plants that have almost no impact on park resources or that probably cannot be successfully controlled. Innocuous species do not significantly harm park resources and are therefore usually a lower management priority. Most innocuous species do not invade native ecosystems without human-caused disturbance, and their populations generally do not expand within the park. Some innocuous species may invade native ecosystems, but do not displace native species to a significant extent.

Whether a species is disruptive or innocuous depends on a number of factors, including the invasive plant's life history, environmental conditions, and the health of native ecosystems. An invasive plant may be disruptive in native ecosystems that are highly disturbed, but may be innocuous in a healthy native ecosystem. The ranking system allows the resource manager to account for each species' life history, environmental conditions, and the health of native ecosystems when determining relative invasive plant management priorities.

For each non-native plant listed in Appendix A, the Park Botanist used the qualitative Decision-making Tool, the Alien Plant Ranking System, or a combination of both, to determine priorities for management. The results of this exercise are found in Appendix A.

Decision-making Tool: Guidance for Setting Invasive Plant Management Priorities



Appendix C. Draft Minimum Requirements Analysis

The Stephen Mather Wilderness encompasses 94% of North Cascades National Park Service Complex. Consistent with NPS policies, all management actions affecting the Stephen Mather Wilderness must comply with the minimum requirement concept in the Wilderness Act of 1964. This concept, derived from section 4(c) of the Wilderness Act, prohibits certain nonconforming uses of wilderness “except as necessary to meet the minimum requirements for the administration of the area.” To determine the minimum requirement for management of wilderness areas, NPS Management Policies require a Minimum Requirements Analysis before taking action.

The 2010 “Minimum Requirements Decision Guide,” developed by the Arthur Carhart National Wilderness Training Center, was used to guide this analysis. The Minimum Requirements Analysis is a two-step process used to document whether administrative activities affecting wilderness resources or values are necessary, and how to best minimize impacts. Step one analyzes whether the proposed action is appropriate or necessary for administration of the area as wilderness. Step two evaluates techniques and types of equipment needed for the action to ensure that impact to wilderness resources and character is minimized. This second step is often referred to as a "minimum tool" analysis.

Step 1: Determine if any administrative action is <u>necessary</u>.

Description: Briefly describe the situation that may prompt action

The Stephen Mather Wilderness is largely free from invasive, non-native plants; however, approximately 40 non-native species are known to exist in the wilderness, 12 of which are invasive and targeted for control (bull thistle, Canada thistle, cheatgrass, common tansy, cut leaf blackberry, knapweed, mullein, oxeye daisy, reed canarygrass, St. Johnswort, white sweetclover, and yellow toadflax). Non-native plants with invasive characteristics have the ability to impact the natural quality of wilderness character. For example, they can displace native vegetation, alter runoff, change soil chemistry, and alter fire regimes. There are numerous pathways (i.e., roads and trails) within the Park Complex that allow invasive plants to establish in wilderness. Vectors that can carry invasive plant seeds or plant parts into wilderness include humans, stock, wildlife, wind, water, and helicopters. Disturbances such as fire, flooding, or landslides can also exacerbate invasive plant infestations.

The Park Complex proposes to treat several invasive plant infestations within the Stephen Mather Wilderness. Projects include Big Beaver Creek and Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lakes Road, Stehekin Cheatgrass, Stehekin Knotweed, and Park-wide Trails. Other unknown infestations may be discovered in the future, or new infestations may develop over time. Treatment of new infestations would be covered under this MRA as long as all project elements are similar in scope to existing projects.

All invasive plants would be managed using an Integrated Pest Management (IPM) approach. IPM is a form of adaptive management, which involves a system of management practices based on clearly identified outcomes, monitoring to determine if management practices are meeting outcomes, and if they are not, facilitating management changes that would best ensure that outcomes are met.

To determine if administrative action is <u>necessary</u>, answer the questions listed in A - F by answering Yes, No, or Not Applicable and providing an explanation.

A. Describe Options Outside of Wilderness

Is action necessary <u>within</u> wilderness?

Yes: ☒ **No:** ☐

Several invasive plant infestations occur within wilderness, so treatment would be required in those locations. Although treatment of other infestations outside of wilderness will help to limit the likelihood of spread within wilderness, these actions would not be sufficient since invasive plants already exist and are spreading within wilderness boundaries.

B. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in <u>wilderness legislation</u> (the Wilderness Act of 1964 or subsequent wilderness laws) that <u>allows</u> or <u>requires</u> consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

There are no special provisions that apply in the Wilderness Act.

C. Describe Requirements of Other Legislation

Is action necessary to meet the requirements of <u>other laws</u>?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Executive Order 13112 – Invasive Species, signed February 1999, directs federal agencies to identify actions that may affect the status of invasive species and to take action to prevent their introduction, detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner, monitor invasive species populations accurately and reliably, and provide for restoration of native species and habitat conditions in ecosystems that have been invaded, among other things.

Section 2814 of the Federal Noxious Weed Act of 1974 (superseded by the Plant Protection Act of 2000, except Sec. 2814) requires federal agencies to develop and fund an exotic plant management program to control noxious weeds on federal lands and establish integrated management systems to control or contain exotic plant species.

Section 7 of the Endangered Species Act (ESA) of 1973 charges federal agencies to aid in the conservation of listed species and requires federal agencies to ensure that their activities will not jeopardize the continued existence of listed species or adversely modify designated critical habitats. In order to meet the requirements of this law, control of invasive plant species that threaten native listed species or their habitat is a necessary action.

D. Describe Other Guidance

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state and local governments or other federal agencies?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

The Department of Interior has two Departmental Manuals (DM) pertaining to invasive plant management policy: DM 517 and DM 609. The NPS has a strong and clear policy on managing invasive plants in the parks. Parks are guided by NPS Management Policies 2006 and park-specific management plans.

DM 517 Integrated Pest Management Policy. The Department's policy is to manage pests and use IPM principles in a manner that reduces risks from both the pests and associated pest management activities. Bureaus will accomplish pest management through cost-effective means that pose the least risk to humans, natural and cultural resources, and the environment. Bureaus will conserve and promote beneficial organisms and natural processes that would inherently suppress potential pest populations, and design and maintain the stability of structures, developed landscapes, and natural areas to prevent and reduce conditions conducive to pests.

DM 609 Weed Control Program. It is DOI's policy to control undesirable plants on the lands, waters, or facilities under its jurisdiction, to the extent economically practicable and as needed for resource/environmental protection and enhancement, as well as the accomplishment of resource management objectives and the protection of human health.

NPS Management Policies 2006, Section 4.4.4 - Management of Exotic Species. NPS units are required to manage exotic species to prevent the displacement of native species. This section states, "Exotic species will not be allowed to displace native species if displacement can be prevented." Management of exotic species within park units is allowed given the following conditions: "All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed - up to and including eradication - if (1) control is prudent and feasible, and (2) the exotic species:

- interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or
- disrupts the genetic integrity of native species, or
- disrupts the accurate presentation of a cultural landscape, or
- damages cultural resources, or
- significantly hampers the management of park or adjacent lands, or
- poses a public health hazard as advised by the US Public Health Service (which includes the Centers for Disease Control and the NPS public health program), or
- creates a hazard to public safety.

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.

Programs to manage exotic species will be designed to avoid causing significant damage to native species, natural ecological communities, natural ecological processes, cultural resources, and human health and safety.

Park Specific Management Plans. Several North Cascades National Park Service Complex planning documents provide further guidance on the management of invasive plants. The 1988 General Management Plan states that the NPS will evaluate, monitor, and mitigate environmental impacts, including invasions by exotic species (NPS 1988). The 1995 LACH General Management Plan states that the NPS will monitor and attempt to protect incoming gravel, soil, and firewood from non-native plants, and would control selected non-native species (e.g., knapweed, common mullein, knotweed, rush skeletonweed) that threaten to spread and adversely affect national recreation area resources (NPS 1995). The draft ROLA General Management Plan and EIS states that the NPS will prioritize according to the ecological threat posed by invasive species and/or threats to high quality and high value habitats; eradicate invasive non-native species where feasible, and use containment strategies when eradication is infeasible; and collaborate with adjacent landowners and jurisdictions on cooperative weed management, such as working with the Washington State Department of Transportation to replace invasive non-native species with native species (NPS 2010).

The 1999 Resource Management Plan calls for the continued treatment of priority species, including rush skeletonweed, knapweed, Scotch broom, and Japanese knotweed. The plan calls for the infestations to be mapped, monitored, and restored, as well as continued monitoring for invasive plants in wilderness (NPS 1999). The plan also calls for the creation of a comprehensive management plan for invasive plant control at the Stehekin Airstrip. The Wilderness Management Plan, approved in March of 1989, serves as the primary guidance for management of the Stephen Mather Wilderness. Although the plan does not specifically identify actions related to invasive plant management, it calls to manage indigenous plant and animal communities to sustain natural processes, assuring that levels of human use are compatible rather than detrimental, with emphasis on preserving endangered and threatened species (NPS 1989).

The Pacific Northwest Region of the NPS has signed a Memorandum of Understanding with the Washington State Department of Agriculture and the Washington State Noxious Weed Control Board, to, “coordinate the management of exotic plant species listed as ‘noxious weeds’ on National Park Service lands and adjoining state and private lands in Washington.”

E. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character including: Untrammeled, Undeveloped, Natural, Outstanding opportunities for solitude or a primitive and unconfined type of recreation, or other unique components that reflect the character of this wilderness area?

Untrammeled: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Taking action to control invasive non-native plants would impact the untrammeled quality by intentionally manipulating natural conditions in wilderness.

Undeveloped: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

The undeveloped quality may be impacted if a helicopter is used to transport equipment or if motorized equipment (such as a water pump) is used within wilderness. This impact should only last for the duration of the helicopter use/motorized equipment use at the project site. There is currently only one project (Stehekin Cheatgrass) that has the potential to use a helicopter and/or motorized equipment to assist in the treatment of invasive plants.

Natural: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Action is necessary to restore naturalness in areas infested with weeds. This action will also help to preserve natural conditions in areas that are currently free from weed infestations.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Actions are not expected to enhance opportunities for solitude or unconfined recreation, as the species that would be treated do not currently impact these qualities. Loss of opportunities for solitude during the treatment period would be short-term, of small magnitude, and will be lessened by mitigations such as treatments during the shoulder seasons and on weekdays, when visitation is low.

Other unique components that reflect the character of this wilderness:

Yes: ☐ **No:** ☐ **Not Applicable:** ☒

F. Describe Effects to the Public Purposes of Wilderness

Is action necessary to be consistent with one or more of the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreation, scenic, scientific, education, conservation, and historical use?

Recreation: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Scenic: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Action is necessary because infestations have the potential to change the scenic quality of an area.

Scientific: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Action is necessary because if left unchecked, invasive plants can impact Research Natural Areas, which were established to provide examples of undisturbed ecosystems for scientific research, and long-term monitoring associated with the NPS Inventory and Monitoring Program.

Education: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Conservation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Action is necessary because infestations can impact native habitats and species that are dependent on healthy ecosystems.

Historical use: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Step 1 Decision: **Is any administrative action <u>necessary</u> in wilderness?**

Yes: ☒ **No:** ☐ **More information needed:** ☐

All of the responses to the questions in Step 1 have been evaluated, and it appears as though action is necessary. Though some control efforts can take place outside of wilderness, those actions do not address invasive plant infestations within wilderness. If populations of invasive species are left untreated in wilderness, natural conditions will worsen over time, threatening native plants, fish, wildlife, and ecosystems processes. There is other legislation that requires the NPS to act, including Executive Order 13112, the Federal Noxious Weed Act, and the Endangered Species Act. There are also Department of Interior and NPS policies that direct action to control invasive species, as well as park-specific management plans.

Of the four qualities of wilderness character, this action attempts to preserve and restore naturalness. The remaining three qualities will be impacted to varying degrees. The untrammeled quality will be most impacted, because actions to remove invasive plants are considered direct manipulation. Over time and with restoration, however, the evidence of human manipulation should diminish, as native vegetation and natural ecosystem processes recover. By taking action now, the area that would be trammeled in order to control existing infestations is small compared to the total area of designated wilderness; conversely, deferring treatment would increase the area that would need treatment in the future as infestations grow. The undeveloped quality will also be impacted, though to a lesser extent and for a shorter time period, because only one project may require helicopter assistance for the delivery of equipment (Stehekin Cheatgrass) and a motorized water pump. This impact should only last for the duration of the helicopter time/water pump use at the project site. Opportunities for solitude will be impacted during the project treatment period, but will be mitigated by conducting treatments during the shoulder season and on weekdays when visitation is lower.

Finally, action is also necessary in order to be consistent with several public purposes for wilderness, including scenic use, scientific use, and conservation use. Control of invasive plants will benefit each of these uses.

In conclusion, based on the findings of this analysis, actions to control invasive non-native plants within the Stephen Mather Wilderness are necessary, and are found to be the minimum requirement for administration of the area.

If action is <u>necessary</u>, proceed to Step 2 to determine the <u>minimum</u> activity.

Step 2: Determine the minimum activity.

Description of Options

In Step 2, five options for treating invasive non-native plants are reviewed. A no action option is included in order to confirm that action in wilderness is necessary. The other four options range from mechanical treatment using primitive transport and non-motorized equipment, to herbicide treatment using helicopter transport and motorized equipment. The options were developed in order to explore a full range of reasonable activities that could be used to control invasive plants. Some of the options include Section 4(c) prohibited uses, while others do not. Section 4(c) prohibited uses include: mechanical transport, landing of aircraft, motorized equipment, temporary roads, motor vehicles, structures or installations, and motorboats. The five options include:

Option A: No Action – no treatments would occur within wilderness
Option B: Mechanical treatments with human and/or stock equipment transport
Option C: Mechanical/herbicide treatments with human and/or stock equipment transport
Option D: Mechanical/herbicide treatments with human and/or stock equipment transport and motorized equipment (battery-operated water pumps)
Option E: Mechanical/herbicide treatments with helicopter equipment transport and motorized equipment (gas-powered water pump)

For each option, the methods and techniques that would be used are described, along with when the activity would take place, where the activity would take place, necessary mitigation measures, and the general effects to the wilderness resource and character.

Option A – No Action (no treatments in wilderness)

DESCRIPTION: Invasive plant treatments in wilderness would not occur and invasive plants would be allowed to spread. This option would impact the following seven current projects identified for treatment: Big Beaver Creek and Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lakes Road, Stehekin Cheatgrass, Stehekin Knotweed, and Park-wide Trails. None of these projects or future invasive plant treatments within wilderness would be implemented under this option.

EFFECTS:
Wilderness Character

Untrammeled: No effect.

Undeveloped: No effect.

Natural: If no actions are taken to control invasive plant infestations, natural ecosystem processes will be permanently impacted. As invasive plants are allowed to spread, they displace native vegetation along with the wildlife populations that rely on native vegetation communities for habitat. They can affect water quality by reducing or depleting water levels or altering runoff patterns and soil erosion. Some invasive plants are allelopathic, releasing toxins that don't allow native plants to grow. Others are nitrogen-fixing, allowing other non-natives to outcompete native plants that have evolved in nutrient-poor soils. Finally, others can alter fire regimes and drastically change a landscape. For these reasons, invasive, non-native plants threaten the ecological integrity of wilderness.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: No effect. The invasive species that currently exist in wilderness do not affect this quality.

Heritage and Cultural Resources: There is currently one project that occurs within a cultural resource site within wilderness: Ruby Pasture. If invasive plants are not treated at this site, they will continue to adversely impact the cultural landscape.

Maintaining Traditional Skills: No effect.

Economics and Timing Constraints: Proliferation of certain invasive species that influence the frequency and magnitude of wildfires could lead to more costly fire-fighting responses.

Safety of Visitors, Personnel, and Contractors: Proliferation of certain invasive species that influence the frequency and magnitude of wildfires could put visitors and employees at risk during wildfire season.

Option B – Mechanical treatments with human/stock transport

DESCRIPTION: Invasive plant treatments would be undertaken within wilderness using manual/mechanical removal techniques such as hand pulling, digging, or using a weed wrench. Transport to project sites would generally be achieved on foot, but occasional stock support could be used on stock-designated trails if necessary. A number of perennial, rhizomatous plant species would not be treated under this option because manual/mechanical removal would be ineffective, and in some cases it would exacerbate the infestation.

EFFECTS:
Wilderness Character

Untrammeled: Impacts to the untrammeled quality would be insignificant under this option because the infestations that would be treated using manual/mechanical methods are small in size. Evidence of human control or manipulation would be extremely localized and temporary.

Undeveloped: No effect.

Natural: Impacts to the natural quality would be very similar to those described under Option A (no treatment) because many infestations, especially those of large size (e.g., Stehekin Cheatgrass), would not be treated. Natural ecosystem processes would be impacted as invasive plants are allowed to spread. Conversely, species that can be effectively treated using manual/mechanical control methods (e.g., some species on park-wide trails) would be treated under this option. These infestations would be eradicated and prevented from spreading further into wilderness, and improvements to the natural quality would occur.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: The few number of invasive plant treatments that would occur under this option would go largely un-noticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the day when fewer visitors are in the backcountry.

Heritage and Cultural Resources: Impacts to cultural resources are the same as those described under Option A. If invasive plants are not treated at Ruby Pasture, they will continue to adversely impact the cultural landscape.

Maintaining Traditional Skills: This option would help to maintain traditional skills by the use of foot travel and occasional stock transport.

Economics and Timing Constraints: This option provides a low-cost means to treat invasive plants; however, many of the worst infestations would not be treated. Future additional costs may be incurred if it is later decided that infestations need to be treated as they affect more and more areas of wilderness.

Safety of Visitors, Personnel, and Contractors: There would be negligible risk to visitor safety under this option. Risks to personnel would result from hiking in rugged terrain, inclement weather, and improper use of tools. These risks would be mitigated by conducting Job Hazard Analyses, wearing proper personal protective equipment (PPE), and ensuring proper equipment training.

Option C – Mechanical/herbicide treatments with human/stock transport

DESCRIPTION: Invasive plant treatments would be undertaken within wilderness using manual/mechanical treatments where they are effective and herbicides where they are not effective. Manual and mechanical treatments are not always effective because they can cause ground disturbance that allows weed seeds to germinate, they can leave root fragments in the ground that resprout and make the infestation worse, and they can result in trampling of native vegetation. Herbicides can be an effective alternative to manual or mechanical treatments when these issues are a concern. Transport to project sites would generally be achieved on foot, but occasional stock support could be used on stock-designated trails if necessary. A greater number of projects would be undertaken compared to Option B because the perennial, rhizomatous plant species would be treated. Without the use of motorized equipment, however, projects such as Stehekin Cheatgrass would not be undertaken because it would require a water pump.

EFFECTS:
Wilderness Character

Untrammeled: Impacts to the untrammeled quality would occur but would still be insignificant under this option because the infestations that would be treated are small in size. Evidence of human control or manipulation would be extremely localized and temporary.

Undeveloped: No effect.

Natural: Natural quality would improve as a number of infestations would be treated under this option. These infestations would be eradicated and prevented from spreading further into wilderness, thus protecting naturalness. However, non-treatment of Stehekin Cheatgrass would lead to continued alteration of the landscape, adversely affecting naturalness.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: More invasive plant treatments would occur under this option than in Option B, however they would still go largely unnoticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Heritage and Cultural Resources: Invasive plant treatments would protect cultural resources by treating the infestation at Ruby Pasture.

Maintaining Traditional Skills: This option would help to maintain traditional skills by the use of foot travel and occasional stock transport.

Economics and Timing Constraints: This option would cost slightly more than Option B, as there would generally be more person-hours involved in treating more infestations, along with the additional expense of herbicides and associated equipment.

Safety of Visitors, Personnel, and Contractors: There would be an increased risk to visitor safety under this option compared to Option B because of herbicide use. The risk of public exposure to herbicides would be mitigated by proper signage/closures, warnings, and timing of treatments during the shoulder seasons and weekdays. Risks to personnel would result from hiking in rugged terrain, inclement weather, improper use of tools, and herbicide application. These risks would be mitigated by conducting Job Hazard Analyses, wearing proper personal protective equipment (PPE), and ensuring proper equipment and herbicide training.

Option D – Mechanical/herbicide treatments with human/stock transport & motorized equipment

DESCRIPTION: This option is identical to Option C, plus it would incorporate motorized equipment use. As described in Option C, invasive plant treatments would be undertaken within wilderness using manual/mechanical treatments where they are effective and herbicides where they are not effective. Transport to project sites would generally be achieved on foot, but occasional stock support could be used on stock-designated trails if necessary. A greater number of projects would be undertaken compared to Option B because the perennial, rhizomatous plant species would be treated, and compared to Option C, this option would include one additional project (Stehekin Cheatgrass). This option would include the additional use of a motorized water pump powered by a 12 volt battery. The water pump would supply water for the Stehekin Cheatgrass project, which would require several hundred gallons of water for the herbicide application.

EFFECTS:
Wilderness Character

Untrammeled: Impacts to the untrammeled quality would occur and would be greater than the other options because the Stehekin Cheatgrass project is relatively large in scope. Evidence of human control or manipulation would be more obvious, but it would still be temporary. As vegetation communities are restored, evidence of the project activities would disappear.

Undeveloped: The use of a motorized water pump will impact the undeveloped quality. This impact will be extremely localized and temporary, since the pump produces little noise and would only be used to fill water storage containers.

Natural: Natural quality would improve the most under this option, as all infestations would be treated. These infestations would be eradicated and prevented from spreading further into wilderness, thus protecting naturalness.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: The largest number of invasive plant treatments would occur under this option, but most would go largely unnoticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Heritage and Cultural Resources: Invasive plant treatments would protect cultural resources by treating the infestation at Ruby Pasture.

Maintaining Traditional Skills: This option would help to maintain traditional skills by the use of foot travel and occasional stock transport.

Economics and Timing Constraints: This option would cost more than Option C, as there would be an increase in person-hours involved in treating more infestations (especially Stehekin Cheatgrass), along with the additional expense of herbicides and associated equipment.

Safety of Visitors, Personnel, and Contractors: Safety impacts would be the same as those described in Option C. The risk of public exposure to herbicides would be mitigated by proper signage/closures, warnings, and timing of treatments during the shoulder seasons and weekdays. Risks to personnel would result from hiking in rugged terrain, inclement weather, improper use of tools, and improper herbicide application. These risks would be mitigated by conducting Job Hazard Analyses, wearing proper personal protective equipment (PPE), and ensuring proper equipment and herbicide training.

Option E – Mechanical/herbicide treatments with helicopter transport & motorized equipment

DESCRIPTION: This option is similar to Option D, except that equipment transport would be accomplished using a helicopter instead of stock, and a gas-powered water pump would be used instead of a battery-powered water pump. As described in Option D, invasive plant treatments would be undertaken within wilderness using manual/mechanical treatments where they are effective and herbicides where they are not effective. The same number of projects would be undertaken in this option as in Option D. Transport to project sites would generally be achieved on foot, but heavy loads for the Stehekin Cheatgrass project would be transported via helicopter rather than stock, and water could either be delivered via helicopter or using a gas-powered water pump. This option was developed in case cheatgrass recruitment exceeds current expectations, thus requiring larger amounts of water which could either be delivered via helicopter or obtained on-site using a gas-powered water pump.

EFFECTS:
Wilderness Character

Untrammeled: Impacts to the untrammeled quality would occur and would be the same as described under Option D. Impacts would be greater than Options A-C because the Stehekin Cheatgrass project is relatively large in scope. Evidence of human control or manipulation would be more obvious, but it would still be temporary. As vegetation communities are restored, evidence of the project activities would disappear.

Undeveloped: The use of a gas-powered water pump or helicopter transport will impact the undeveloped quality. The impact from use of the water pump will be localized and temporary, since the pump would only be used to fill water storage containers. It is estimated that the pump would be used for about six hours over the course of a week, and from one to two times per year during the treatment period. If a greater amount of water is needed because the cheatgrass infestation is larger than expected, a helicopter would be used to deliver water instead of the water pump. The amount of helicopter use is estimated to be from four to eight trips over the course of a day, which is dependent on how much water is needed for the treatment, and from one to two times per year during the treatment period. The impact from helicopter use would occur over a larger area and it would be more noticeable to people in the wilderness.

Natural: Impacts to the natural quality would be the same as those described in Option D. Natural quality would improve the most under both Options D and E, since all infestations would be treated. These infestations would be eradicated and prevented from spreading further into wilderness, thus protecting naturalness.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation: The largest number of invasive plant treatments would occur under this option, but most would go largely unnoticed by most visitors. The one big exception would be the use of helicopters or a motorized water pump to transport water; noise impacts would likely be noticed by anyone who is in the immediate drainage that the helicopter is traveling in, and potentially adjacent drainages as well. These impacts would be partially mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Heritage and Cultural Resources: Invasive plant treatments would protect cultural resources by treating the infestation at Ruby Pasture.

Maintaining Traditional Skills: This option would not help to maintain traditional skills.

Economics and Timing Constraints: This option would cost the most; in addition to the large number of person-hours involved in treating more infestations (especially Stehekin Cheatgrass) and the expense of herbicides and associated equipment, helicopter rental time would substantially increase the cost.

Safety of Visitors, Personnel, and Contractors: Safety impacts would be similar to those described in Options C and D, with the additional safety risk of helicopter use. This risk would be mitigated by following proper safety procedures for helicopter use.

Step 2 Decision: What is the Minimum Activity?

Selected alternatives:
Option D – Mechanical/herbicide treatments with human/stock transport and motorized equipment;
Option E – Mechanical/herbicide treatments with helicopter transport and motorized equipment

Invasive plant treatments would be undertaken within wilderness using manual/mechanical treatments where they are effective and herbicides where they are not effective. Transport to project sites would generally be achieved on foot, but occasional stock support could be used on stock-designated trails if necessary. The Stehekin Cheatgrass project will be implemented using Option D (stock support and use of a motorized water pump powered by a 12 volt battery), unless the infestation becomes larger than expected and a greater amount of water is necessary to perform the treatment. In this case, Option E would be chosen, which could use either a gas-powered water pump or a helicopter to deliver water. For all other projects other than the Stehekin Cheatgrass project, Option D would be implemented.

A greater number of projects would be undertaken compared to Option B because the perennial, rhizomatous plant species would be treated, and compared to Option C, these options would include one additional project (Stehekin Cheatgrass).

Rationale for selecting this alternative: Options D and E were chosen as the minimum tool because they best protect and restore the natural quality of wilderness character while minimizing impacts to the other three qualities. If not treated, invasive plants could permanently impact ecosystem components and processes. This risk was compared with the impacts of treatment on the other qualities. The NPS has determined that the long-term benefits of restoring ecosystem processes outweigh the short-term adverse impacts to the qualities of untrammeled, undeveloped, and opportunities for solitude or primitive and unconfined recreation.

Monitoring and reporting requirements: All invasive plant projects will be monitored for effectiveness and adaptively managed so that if more effective or efficient methods are identified they can be implemented. All actions in wilderness will be reviewed annually by the Wilderness and Aviation Committee, and any Section 4(c) uses will be recorded.

Check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☐ mechanical transport
- ☒ motorized equipment
- ☐ motor vehicles
- ☐ motorboats
- ☐ landing of aircraft
- ☐ temporary road
- ☐ structure or installation

Record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

Approvals	Signature	Name	Position	Date
Prepared by:	/s/Cathi Winings	Cathi Jones Winings	Natural Resource Manager	03/23/11
Recommended:	/s/Kelly Bush	Kelly Bush	Wilderness Commit-tee Co-chair	05/28/11
Recommended:	/s/Roy Zipp	Roy Zipp	Wilderness Commit-tee Co-chair	05/25/11
Approved:		Palmer (Chip) Jenkins	Superintendent	

Appendix D. Washington State Noxious Weed List and Monitor List

To help protect the State's resources and economy, the Washington State Noxious Weed Control Board adopts a State Noxious Weed List each year (WAC 16-750). The list is intended to help public and private landowners prioritize the control of invasive plants and comply with state law requirements to protect and enhance Washington's agriculture and natural areas in a cost effective manner. The official list is updated annually and published by the Washington State Noxious Weed Control Board, which can be accessed at www.nwcb.wa.gov.

This list places weeds into three major classes – A, B, and C – based on the stage of invasion of each species and the seriousness of the threat they pose to Washington State. This classification system is designed to:

- Prevent small infestations from expanding by eradicating them when they are first detected
- Restrict already established weed populations to regions of the state where they occur and prevent their movement to un-infested areas
- Allow flexibility of weed control at the local level for weeds that are already widespread.

Class A Weeds: Non-native species whose distribution in Washington is still limited. Preventing new infestations and eradicating existing infestations are the highest priority. Eradication of Class A plants is required by law.

Class B Weeds: Non-native species presently limited to portions of the State. Species are designated for control in regions where they are not yet widespread. Preventing new infestations in these areas is a high priority. In regions where a Class B species is already abundant, control is decided at the local level, with containment as the primary goal. Please contact your County Noxious Weed Control Coordinator to learn which species are designated in your area.

Class C Weeds: Noxious weeds which are already widespread in WA or are of special interest to the state's agricultural industry. The Class C status allows counties to enforce control if locally desired. Other counties may choose to provide education or technical consultation.

Monitor List Weeds: The purpose of the "monitor list" is to gather more information on suspect weeds, as well as monitor for occurrence or spread. Information collected may be used to justify future inclusion on the state noxious weed list. There is no legal or regulatory aspect to this list (WAC 16-750-025). For the most recent (2008) state of Washington monitor list, refer to Table D-2.

Table D-1. 2010 Washington State Noxious Weed List

Class A Weeds ***Eradication Required***		**Class A Weeds (continued)** ***Eradication Required***
Buffalobur *Solanum rostratum*		Kudzu *Pueraria montana* var. *lobata*
Common crupina *Crupina vulgaris*		Meadow clary *Salvia pratensis*
Cordgrass, common *Spartina anglica*		Purple starthistle *Centaurea calcitrapa*
Cordgrass, dense flower *Spartina densiflora*		Reed sweetgrass *Glyceria maxima*
Cordgrass, salt meadow *Spartina patens*		Ricefield bulrush *Schoenoplectus mucronatus*
Cordgrass, smooth *Spartina alterniflora*		Sage, clary *Salvia sclarea*
Dyers wood *Isatis tinctoria*		Sage, Mediterranean *Salvia aethiopis*
Eggleaf spurge *Euphorbia oblongata*		Shiny geranium *Geranium lucidum*
False brome *Brachypodium sylvaticum*		Silverleaf nightshade *Solanum elaeagnifolium*
Floating primrose-willow *Ludwigia peploides*		Spanish broom *Spartium junceum*
Flowering rush *Butomus umbellatus*		Spurge flax *Thymelaea passerina*
Garlic mustard *Alliaria petiolata*		Syrian bean-caper *Zygophyllum fabago*
Giant hogweed *Heracleum mantegazzianum*		Texas blueweed *Helianthus cilaris*
Goatsrue *Galega officinalis*		Thistle, Italian *Carduus pycnocephalus*
Hawkweed, European *Hieracium sabaudum*		Thistle, milk *Silybum marianum*
Hawkweed, yellow devil *Hieracium floribundum*		Thistle, slenderflower *Carduus tenuiflorus*
Hydrila *Hydrila verticilata*		Variable-leaf milfoil *Myriophyllum heterophyllum*
Johnsongrass *Sorghum halepense*		Velvetleaf *Abutilon theophrasti*
Knapweed, bighead *Centaurea macrocephala*		Wild for o'clock *Mirabilis nyctaginea*
Knapweed,Vochin *Centaurea nigrescens*		

Class B Weeds		**Class B Weeds (continued)**
Austrian fieldcress *Rorippa austriaca*		Knotweed, Himalayan *Polygonum polystachyum*
Blackgrass *Alopecurus myosuroides*		Knotweed, Japanese *Polygonum cuspidatum*
Blueweed *Echium vulgare*		Kochia *Kochia scoparia*
Brazilian elodea *Egeria densa*		Lawnweed *Soliva sessilis*
Bugloss, annual *Anchusa arvensis*		Lepyrodiclis *Lepyrodiclis holosteoides*
Bugloss, common *Anchusa officinalis*		Longspine sandbur *Cenchrus longispinus*
Butterfly bush *Buddleja davidii*		Loosestrife, garden *Lysimachia vulgaris*
Camelthorn *Alhagi maurorum*		Loosestrife, purple *Lythrum salicaria*
Common catsear *Hypochaeris radicata*		Loosestrife, wand *Lythrum virgatum*
Common fennel *Foeniculum vulgare*		Oxeye daisy *Leucanthemum vulgare*
Common reed (nonnative genotypes) *Phragmites australis*		Parrotfeather *Myriophyllum aquaticum*
Dalmatian toadflax *Linaria dalmatica* ssp. *dalmatica*		Perennial pepperweed *Lepidium latifolium*
Eurasian watermilfoil *Myriophyllum spicatum*		Perennial sowthistle *Sonchus arvensis* ssp *arvensis*
Fanwort *Cabomba caroliniana*		Policeman's helmet *Impatiens glandulifera*
Gorse *Ulex europaeus*		Poison-hemlock *Conium maculatum*
Grass-leaved arrowhead *Sagittaria graminea*		Puncturevine *Tribulus terrestris*
Hawkweed oxtongue *Picris hieracioides*		Rush skeletonweed *Chondrilla juncea*
Hawkweed, mouseear *Hieracium pilosella*		Saltcedar *Tamarix ramosissima*
Hawkweed, orange *Hieracium aurantiacum*		Scotch broom *Cytisus scoparius*
Hawkweed, polar *Hieracium atratum*		Spurge laurel *Daphne laureola*
Hawkweed, queen-devil *Hieracium golmeratum*		Spurge, leafy *Euphorbia esula*

Hawkweed, smooth *Hieracium laevigatum*		Spurge, myrtle *Euphorbia myrsinites*
Hawkweed, yellow *Hieracium caespitosum*		Sulfur cinquefoil *Potentilla recta*
Herb-Robert *Geranium robertainum*		Swainsonpea *Sphaerophysa salsula*
Hoary alyssum *Berteroa incana*		Tansy ragwort *Senecio jacobaea*
Houndstongue *Cynoglossum officinale*		Thistle, musk *Carduus nutans*
Indigobush *Amorpha fruticosa*		Thistle, plumeless *Carduus acanthoides*
Knapweed, black *Centaurea nigra*		Thistle, Scotch *Onopordum acanthium*
Knapweed, brown *Centaurea jacea*		Water primrose *Ludwigia hexapetala*
Knapweed, diffuse *Centaurea diffusa*		Wild carrot *Daucus carota*
Knapweed, meadow *Centaurea jacea* x *nigra*		Wild chervil *Anthriscus sylvestris*
Knapweed, Russian *Acroptilon repens*		Yellow floating heart *Nymphoides peltata*
Knapweed, spotted *Centaurea stoebe*		Yellow nutsedge *Cyperus esculentus*
Knotweed, Bohemian *Polygonum bohemicum*		Yellow starthistle *Centaurea solstitialis*
Knotweed, giant *Polygonum sachalinense*		
Class C Weeds		**Class C Weeds (continued)**
Absinth wormwood *Artemisia absinthium*		Himalayan blackberry *Rubus armeniacus*
Babysbreath *Gypsophila paniculata*		Hoary cress *Cardaria draba*
Black henbane *Hyoscyamus niger*		Jointed goatgrass *Aegilops cylindrica*
Cereal rye *Secale cereale*		Old man's beard (traveler's joy) *Clematis vitalba*
Common groundsel *Senecio vulgaris*		Reed canarygrass *Phalaris arundinacea*
Common St. Johnswort *Hypericum perforatum*		Scentless mayweed *Matricaria perforata*
Common tansy		Smoothseed alfalfa dodder

Tanacetum vulgare		*Cuscuta approximata*
Curly-leaf pondweed *Potamogeton crispus*		Spikeweed *Hemizonia pungens*
English ivy – four cultivars only *Hedera helix* 'Baltica', 'Pittsburgh', and 'Star'; *H. hibernica* 'Hibernica'		Spiny cocklebur *Xanthium spinosum*
Evergreen blackberry *Rubus laciniatus*		Thistle, bull *Cirsium vulgare*
Field bindweed *Convolvulus arvensis*		Thistle, Canada *Cirsium arvense*
Fragrant water lily *Nymphaea odorata*		White cockle *Silene latifolia* ssp. *alba*
Hairy whitetop *Cardaria pubescens*		Yellow archangel *Lamiastrum galeobdolon*
Hairy willow-herb *Epilobium hirsutum*		Yellow flag iris *Iris pseudacorus*
Hawkweed, common *Hieracium lachenalii*		Yellow toadflax *Linaria vulgaris*
Hawkweeds, nonnative and invasive species not listed elsewhere *Hieracium* spp.		

Table D-2. Washington State Noxious Weed Monitor List (July 2008)

Species Name		Species Name (continued)
Bladderwort, swollen *Utricularia inflata*		Green alkanet *Pentaglottis sempervirens*
Blooddrops *Adonis annua*		Inula *Inula helenium*
Bursage, skeletonleaf *Ambrosia tomentosa*		Knapweed, featherhead *Centaurea tricocephala*
Catchfly, Balkan *Silene csereii*		Mallow, venice *Hibiscus trionum*
Cattail, lesser *Typha angustifolia*		Pampas grass *Cortaderia spp.*
Celandine, lesser *Ficaria verna*		Sedge, lovegrass *Cyperus eragrostis*
Cinquefoil, silvery *Potentilla argentea*		Teasel, common *Dipsacus fullonum*
Clematis, Chinese *Clematis orientalis*		Thistle, distaff *Carthamus lanatus*
Crosswort, narrowleaved *Crucianella angustifolia*		Unicorn-plant *Proboscidea louisianica*
Fieldcress, creeping *Rorippa sylvestris*		Verbena, tall *Verbena bonariensis*

Flowering Rush *Butomus umbellatus*		Vine, silverlace *Polygonum albertii*
Frogs-bit, Eurasian *Hydrocharis morsus-ranae*		Watercress *Rorippa nasturtium-aquaticum*
Giant Reed *Arundo donax*		Waterhyacinth *Eichhornia crassipes*

Appendix E. Best Management Practices

On September 22-23, 2009, the Park Complex conducted a workshop entitled "Working Together Against Weeds," which examined park operations and identified potential sources for introduction of invasive non-native plant species. As a result of the workshop, Best Management Practices (BMPs) were developed to prevent the spread of invasive plants. Prevention is the most efficient and cost-effective way to minimize the impacts of invasive plants. The following BMPs are aimed at maximizing prevention through the integration of these principles throughout all park activities. Prevention is impossible without everyone's participation; putting these into practice will help ensure the long-term health of our national parks.

There are eight over-arching goals of BMPs for invasive plant management. These include:

1) Increase awareness of weed prevention practices in all park programs
2) Avoid creating soil conditions that promote weed establishment (e.g. unnecessary disturbance)
3) Avoid creating canopy conditions that promote weed establishment (i.e. maintain natural levels of canopy closure whenever possible)
4) Avoid introducing weed seeds and propagules
5) Avoid moving weeds from infested areas into un-infested areas
6) Establish and maintain the framework for early detection of weed introductions and rapid response to control them
7) Be prepared to adapt management to changes in expectations and conditions
8) Strive for new levels of cooperation, communication, and information-sharing

These BMPs help to address three primary administrative activities that occur within the Park Complex: 1) Maintenance and construction; 2) Wilderness activities; and 3) Fire management.

Maintenance and Construction

Potential pathways for invasion through the movement of gravel and fill include the following: importing material from foreign sources, equipment (backhoes, bull dozers, mowers, etc.), stockpiled local materials, side casting, imported sand and gravel used along SR 20 by WSDOT, construction activities, and emergency reconstruction (e.g., floods and other stochastic events). Organized by practices that should be followed during the planning phase of project development and those that should be followed during implementation or day to day operations, the BMPs include:

1. Planning
    a. As maintenance staff and other divisional staff annually propose new projects in PMIS, project leads will work with resource management staff to address potential invasive species management costs that would be associated with implementation of each project.
    b. Incorporate weed prevention and control in plans for projects that will include ground or vegetation-disturbing activities.
    c. Identify project-specific risks of invasive plant introduction and spread and project-specific prevention practices. Identify needs and treatments at the onset of project planning.
    d. Prior to the project, conduct invasive plant surveys within the project site, and access routes during the planning process. Develop treatment plans for existing invasive plant populations.
    e. Identify staging areas that are free of invasive plants during the project planning stages.

   f. A staging area standard operating procedure will be developed for each staging area in the park to identify how and where materials stored or taken from a staging area can be used throughout the park.
2. Operations
   a. Minimize/eliminate ground disturbance.
   b. Utilize fresh shot rock when available and applicable.
   c. Avoid stockpiling or bin/contain/treat stock piles and cover between uses.
   d. Require contractors to cover loads when traveling through the park.
   e. Before any equipment is brought into the park, it will be pressure or steam washed to remove seed-containing soil.
   f. Contracts for park projects will include language to ensure that all equipment will be inspected and cleaned prior to working in the park.
   g. Staff will wash equipment that has been off-road or working in an infested site at the Marblemount wash rack facility or with a power washer in Stehekin before moving it from place to place within the park.
   h. Construction and restoration materials will be free of invasive weed seeds or other propagative plant parts. Such materials include boulders, soil, sand, gravel, rock, road base, straw, and silt and erosion control materials. Eliminating invasive plant seeds may raise the cost of some projects, but will prevent much more costly and prolonged invasive plant control efforts in the future.
   i. Vegetation management staff will inspect proposed quarries or source sites for presence of invasive plants annually and provide evaluations and recommendations for sources to maintenance staff, park contracting officers, and contractors.
   j. In cases of emergency reconstruction (e.g., floods and other stochastic events) materials will be acquired from pre-approved (by Vegetation Management staff) vendors and pits.
   k. After completing construction, bare areas will be revegetated or bare soil will be covered with local litter and duff mulch as soon as possible. Mulch will provide a source of seeds to reestablish native vegetation and reduce the risk of non-native seeds germinating. Ideally, the litter and duff should be collected from the construction zone prior to disturbance. Otherwise collect from surrounding areas but do not denude the collection area. Leave at least 50 percent of the material in place and don't disturb vegetation.
   l. Vegetation Management staff will work with the Washington State Department of Transportation and Seattle City Light to encourage the use of clean sand and gravel imported along the highway and along the powerline corridor.
   m. Commercial users that disturb established vegetation will be required to provide bonds that are retained until sites are returned to a specified condition.
   n. Vegetation Management Staff will monitor and treat disturbed sites post project.

Wilderness Activities
Potential pathways for spreading weeds into wilderness through park operations include: administrative centers/staging areas (Marblemount, Stehekin), pack stock operations, native plant nursery operations, helicopter operations, administrative camps, Seattle City Light Properties/historic plantings, and Trailheads/access points.
1. Administrative centers/staging areas
   a. Develop concrete pads and covered storage for staging areas for both Marblemount and Stehekin.
   b. Consolidate and remove excess materials stored in the Marblemount bone yard to reduce the footprint of the storage area.

   c. Develop a boot cleaning station and informational exhibit at the leading edge of the cheatgrass invasion in the Stehekin area.
   d. Provide boot cleaning equipment for trail crew, wilderness rangers and resource staff to be used prior to entering the backcountry for field visits.
2. Pack stock operations
   a. A pasture rehabilitation plan will be developed and implemented. This will create pasture with fewer aggressive weed species which are transported into the wilderness via stock, and reduce the need for imported hay.
   b. Continue early detection surveys in Marblemount pasture initiated by the EPMT program.
   c. A monitoring plan will be developed for early detection of invasive plants in areas frequented by pack stock that would occur in conjunction with trail surveys.
   d. Encourage the use of weed-free feed 24 hours prior to entering the park with stock.
   e. Require the use of weed-free feed for all stock use within the park (day use and overnight stays).
   f. Include weed-free feed requirement language in commercial use permits.
   g. Brush horses and pack animals thoroughly and have their hooves cleaned before entering the Park Complex.
   h. Train park packers in identification of common weeds and ensure sightings are communicated to Vegetation Management staff.
   i. Provide technical assistance to stock owners in finding weed-free feed sources, and in weed-free pasture management and certification in Stehekin.
3. Nursery operations
   a. Use bare root plants when feasible to reduce amount of potting soil, which may contain weeds or weed seeds, being transported into the field.
   b. Evaluate feasibility of implementing a spray regime in the nursery to reduce the possibility of contamination from the areas surrounding the greenhouse.
   c. Consider replacing gravel pads with concrete or wooden walkways to discourage weed germination.
   d. Continue using soil-less propagation mixes.
4. Helicopter operations
   a. Follow protocols outlined in fire operations section, e.g. nets, buckets, lines will be inspected and cleaned to prevent inadvertent seed spread.

Fire Suppression Activities

Potential pathways for spreading weeds through fire operations include exposed soils (hand line, high fire severity, etc.), firefighters, including interagency crews (e.g., smokejumpers, helitack, Fire Modules), vehicles, hose, tools (including chainsaws), helicopters – nets and buckets, staging areas, helipads, and retardant. BMPs for fire suppression activities include:

1. Bare soil that results from hand lines will be rehabbed by pulling duff, litter, and cut material back over lines as soon as possible. Mulch will provide a source of seeds to reestablish native vegetation and reduce the risk of non-native seeds germinating.
2. Firefighters, including interagency crews (e.g., smokejumpers, helitack, Fire Modules) can transport weed propagules from site to site and fire to fire. Resource advisors will contact crews to review BMPs with NPS and interagency crews.
3. Use gators/duct tape over shoe laces and boots for crews that hike between parks and infestations (e.g., fire effects crews) unless prohibited by helitack requirements. Clean boots, pants, packs and other personal equipment of seeds and soil when moving between infested sites or other parks.
4. Before any equipment is brought into the park, it will be pressure or steam washed to remove seed-containing soil. Equipment that has traveled off-road, such as backhoes, tractors, loaders, excava-

tors, dozers, bobcats, wheeled compressors, or trucks and trailers may be contaminated. This restriction will not apply to equipment responding to initial attack of wildland fire where fire spread is threatening life or property. Staff is encouraged to wash equipment that has been off-road before moving it from place to place within the park, particularly when moving from lower to higher elevations.

5. Fire hoses that have been determined to have the potential to introduce terrestrial or aquatic pests are shipped to NIFC to be cleaned. Fire staff will document where hoses have been used and they will not be transported from contaminated sites to uncontaminated sites.
6. Fire tools and hand equipment will be inspected and cleaned accordingly.
7. Helicopter nets will be inspected for weed seeds. They will be bundled and stored in a weed free environment. Nets will be spread on clean tarps prior to loading to prevent contamination from the helipad. Consider the construction or use of existing concrete or asphalt pads so nets can be inspected, loaded and bundled up for storage and in a weed-free state.
8. Helicopter buckets should be inspected and washed accordingly. Inquiries should be made as to where the buckets have been used previously and park staff should be made aware of potential sources of aquatic invasive species. The park will provide clean buckets and supporting equipment for contractors and outside agencies involved in suppression activities.
9. Staging areas will be maintained in a weed free state.
10. Retardant is used with superintendent approval only. These areas should be mapped as a part of daily operations and surveyed in the following years for the potential introduction and spread of exotic plant species.
11. For all fire activity (wildland and prescribed fire), maps of all fire staging areas, observation points, sling load sites, and hand line will be provided to resource staff for prioritization and long term monitoring.

Prescribed Fire Activities

Several cheat grass infestations have been found within proposed prescribed burn unit boundaries. If not treated, or mitigated, these infestations will spread after burning. BMPs include:

1. Infestations should be surveyed and mapped prior to burning.
2. If spraying herbicides, infestations should be treated prior to burning.
3. Alter burn prescription so that high fire severity is minimized in infested areas.
4. Consider seeding the infested area with native species post-fire to outcompete cheat grass and other non-natives.

Other Best Management Practices Designed to Protect Resources

1. Non-native species and cultural resources. Where non-native species are features of park developments or National Register eligible cultural landscapes, NPS staff assess the ecological risk of these species (for example, the ability to spread into adjacent landscapes) and the cost of maintaining the cultural landscape and preventing their spread outside this boundary
    a. Non-native plants that pose no significant threat or nuisance in surrounding natural areas are exempt from control efforts within the boundaries of developments and cultural landscapes
    b. Non-native (invasive) plants that pose a threat or are a nuisance will be managed as appropriate, taking cultural and historic resource needs into account, to prevent further natural resource management problems, and Resource Management staff will work with the local and regional historic landscape specialist to replace non-native invasive species with native species that maintain the appearance of the historic landscape
2. Invasive plant treatments in or near wetlands

   a. Treatments in seasonally flooded wetlands and riparian areas will be scheduled during the dry or low water phase of the year, or during reservoir draw down
   b. Appropriately labeled herbicide formulations will be used in wetlands and within 10 feet of standing and moving water.
3. Invasive plant activities that involve water crossings
   a. Personnel will time surveys and treatments to avoid spawning, and/or be trained to identify spawning areas in order to avoid them.
4. Invasive plant treatment of blackberries
   a. Blackberry herbicide treatments will occur when plants are not in fruit in order to avoid consumption of treated berries.

Best Management Practices for Herbicide Use

These practices will be followed to ensure that the overall effectiveness of herbicides is maximized and the potential for impacts is minimized.

1. Herbicides will be selected to maximize the effectiveness of the treatment on the target invasive plant and to minimize the potential effects on non-target plants.
2. Herbicides will be applied according to application rates specified on the product label. Reduced application rates will be used wherever possible. Reduced application rates are often more effective than higher application rates because translocation is enhanced prior to loss of physiologic function. Higher rates may burn off leaves and reduce translocation.
3. Herbicides will be applied as near to the target plant as possible.
4. Herbicide application will account for meteorological factors such as wind speed, wind direction, inversions, humidity, and precipitation in relation to the presence of sensitive resources near the treatment area and direction provided on labels. Herbicides will only be applied when meteorological conditions at the treatment site allow for complete and even coverage and would prevent drift or volatilization of spray onto non-target sensitive resources or areas used by humans.
5. Herbicides will be applied using coarse sprays to minimize the potential for drift. Avoid combinations of pressure and nozzle type that would result in fine particles (mist). Add thickeners if the product label permits.
6. Herbicides will be applied at the appropriate time based on the herbicide's mode of action, and plant growth stage. Poor timing of application can reduce the effectiveness of herbicides and can increase the impact on non-target plants.
7. Highly water-soluble herbicides will not be used in areas where there is potential to affect surface water or ground water resources.
8. Herbicides with longer persistence will be applied with less frequency to limit the potential for accumulation of herbicides in soils.
9. As needed to protect the efficacy of the herbicide, water will be buffered, depending on hardness, pH, and other factors.
10. Safety protocols for storing, mixing, transporting, handling spills, and disposing of unused herbicides and containers will be followed at all times.
11. All product labels will be read and followed by herbicide applicators. It is a violation of federal law to use an herbicide in a manner that is inconsistent with its label. All federal, state, and local regulations regarding herbicide use will be followed at all times.
12. Herbicide applicators will obtain any certifications or licenses required by the state and/or county, or they will be under the immediate supervision of a licensed applicator.
13. NPS policy requires that only herbicides that are expected to be used in a 1-year period can be purchased at one time. Therefore, herbicides will not be stored for periods greater than one year.

Herbicide efficacy is lost over time. This practice of purchasing no more than a one-year supply will maintain herbicide efficacy that would otherwise be reduced by longer storage.

14. Equipment will be maintained and calibrated prior to each application of herbicides.
15. Work crews use herbicides to control specific invasive plant populations when management objectives cannot be met with the use of the other (manual/mechanical, cultural, biological) control techniques.

To minimize the potential impact of herbicides on surface water and ground water resources, the following BMPs will be implemented:

1. Only herbicides that are registered for use in or near water will be used in those areas.
2. Only those herbicides that have a low potential toxicity, such as glyphosate (Roundup Pro and Rodeo), imazapyr (Habitat, Arsenal), and aminopyralid (Milestone) will be used within areas near surface waters or in areas with a high leaching potential. Glyphosate is strongly adsorbed into soil, with little potential for leaching to ground water. Microbes in the soil readily and completely degrade it even in low temperatures. It tends to adhere to sediments when released to water and does not accumulate in aquatic life.
3. Applications of herbicides will be avoided during periods and in areas where seasonal precipitation or excess irrigation water is likely to wash residual herbicides into waterways.
4. Application of herbicides where treated vegetation may overhang surface waters or be present as aquatic emergent vegetation will take into account the spawning and reproductive cycles of sensitive fish species.
5. The Park Complex currently monitors potable drinking water quality. This monitoring will continue to confirm that potable water meets drinking water standards as outlined by the Safe Drinking Water Act (SDWA).
6. When recommended from the Regional IPM Coordinator, vertical buffer zones to ground water will be used.

Appendix F. Example of a Restoration Plan

Elements of a Restoration Project
A good restoration project includes three elements: a plan, documentation of the project, and monitoring to assess whether goals of the plan were met.

THE PLAN
Each restoration project should have a written plan prior to implementation. The plan should identify and clearly state the goals of the project, include a thorough site description, and describe the actions and materials needed to reach the goals.

Goals: The basic goal of a restoration plan (developed in association with an invasive plant removal project) is typically to provide native plant cover to reduce the re-introduction of invasive non-native plants to the project area. Other restoration goals may involve slope stabilization or wildlife habitat enhancement, for example. Identified goals will direct the course of action during the implementation phase as well as guide the monitoring and subsequent future treatments of the site. Expected results should also be outlined. Include specifics like total cover, number of live plants, species diversity, and slope stabilization.

Site Description: A description of the existing site conditions should include physical attributes of the project area as well as the overall setting and history of the site. See Figure 1 for a complete list of attributes that should be included in the plan.

Actions and Materials: Plans should describe specific actions to be taken and the materials that will be needed. Examples of actions and materials include:

- weed removal activities, including methods
- a planting plan that specifies the plant materials (seeds or plants) needed, quantities, and the spacing of plants
- amounts of mulch, soil, or gravel needed
- a watering plan, if needed, that specifies how and when water will be delivered to the site
- who will accomplish the tasks

FIGURE 1: SITE ATTRIBUTES

- **Location**
- **Setting**
- **Site history**
- **Site area**
- **Slope**
- **Aspect**
- **Elevation**
- **Total area of site**
- **Current vegetation (if any)**
- **Total native plant cover**
- **Plant species abundance**
- **Current types of disturbance**
- **Special conditions (e.g. thin soil)**
- **Surrounding plant community**

DOCUMENTATION
Documentation of the process is critical to provide for a record of the activities and the successes and failures of a given project. Establish a reporting schedule and guidelines for documentation (including photo documentation). Make recommendations and identify action items. This information is especially useful when planning how to improve future actions. The project documentation also provides legacy information for future managers.

MONITORING

An important part of a restoration plan is a guideline for monitoring. Ideally, monitoring will determine the overall success of the project, identify problems or potential issues, and help guide a response so that the project can be successful. The plan for monitoring should include a reporting schedule, the methods to be used for monitoring, the frequency and duration of the monitoring, and a set of criteria to measure success of the project. The success criteria might include things like the total native plant cover, number of native species and individuals, and the reduction of non-native to an acceptable percent cover. Information collected through monitoring also creates the primary basis for predicting which methods, techniques, and materials are effective in various settings. Monitoring of the project will allow staff to evaluate the changing conditions and plant communities, to augment native species planting if necessary, and to serve as a feedback mechanism for managers on successes and failures of projects.

EXAMPLE OF A RESTORATION PLAN

The following is an example of a restoration plan with a primary goal of enhancing wildlife habitat on Lake Chelan by controlling infestations of reed canarygrass.

Wildlife Enhancement after Removal of Reed Canarygrass at the Head of Lake Chelan

THE PLAN

Goals: The goal of this plan is to enhance wildlife habitat through the creation of a diverse multistoried riparian corridor. The goal will be achieved through the removal of reed canarygrass, a non-native invasive species, and the planting of native species. Expected results include a quantitative goal of 80% cover of native species and less than 20% cover of non-native species in 10 years. Additionally the structure of the vegetation will be increased by 50%.

Site Description: The project area is located at the head of Lake Chelan. It is a 7-acre parcel of NPS property. The site is dry during a two-month period in the spring during drawdown. Baseline vegetation surveys documented a mosaic of native and non-native vegetation with reed canarygrass being the primary weed species. The site is level with no aspect. Elevation is 1,100 feet. The site is surrounded by a road to the north and east, private homes and Lake Chelan to the southwest and south. No fill will be needed for this project. The site has been divided into treatment activities and planting requirements including seeding rates and planting densities by species.

Actions and Materials: Three distinct units are found with the project area. The vegetation manipulation and planting will vary between units. Those with extensive reed canarygrass cover may undergo herbicide treatments. In these units, native plants would be collected (salvaged) and held for future plantings after the reed canarygrass is removed. Other wetland units may require additional planting of shrubs and/or trees, while other units that are primarily dominated by native species will receive no treatment or re-vegetation. In some or parts of each unit mechanical manipulation of the site may be required using hand tools or heavy equipment. No fill will be needed.

The project area will need approximately 8,500 shrubs and 3,000 trees to achieve prescribed goals. Trees that will be planted in some of the units include Grand fir (*Abies grandis*), Western red cedar (*Thuja plicata),* big leaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*), and cottonwood (*Populus balsamifera* ssp. *trichocarpa*). Shrub species that will be planted include thimbleberry (*Rubus parviflorus*), serviceberry (*Amelanchier alnifolia*), vine maple (*Acer circinatum*), salmonberry, spirea (*Spirea* spp.), and streamside dogwood. Herbaceous plants would include a variety of forbs, sedges, and rushes that occur on site

DOCUMENTATION AND MONITORING

The success of the project will be determined by vegetation monitoring, which would occur yearly for the first 5 years, and then every two years until year 10, and by wildlife surveys, which will occur prior to the restoration effort, and at 5 years and again at 10 years

Vegetation transects will be established to assess effectiveness of the enhancement effort. Attributes to be monitored include the cover, density, and frequency of natives and non-natives (trees, shrubs and herbs), the height of trees and shrubs, the density and distribution of trees and shrubs, and the distribution of non-natives. When trees are greater than 7 meters, a range finder will be used to accurately measure tree height.

Transects will be used for both quadrat and line-intercept sampling. The quadrat sampling technique is more accurate for herbaceous species, especially grasses, sedges, and rushes. The line-intercept method is used to characterize species distribution, cover of trees and shrubs, and height of trees and shrubs. Data will be analyzed for changes in vegetation cover. Each year the vegetation data will determine if additional plants are required on site. If deemed necessary, planting will occur in the fall following the sampling event.

Photo documentation will provide a visual record of the changes over time. Permanent photo point locations will be established in multiple sites to capture changes within the restoration area. Each photo point site will be described and permanently marked and the location will be recorded using a GPS unit. Photos of the previous year will be used in the field to assist in orienting the camera. Photos will be taken as close as practicable to the same date and time of day as previous year's photos.

Appendix G. Agreement Example

The NPS will consider establishing cooperative agreements with other landholders and land management agencies (private, county, state, and federal lands) under the Consolidated Natural Resource Act of 2008 to conduct invasive plant management activities on lands within or adjacent to the Park Complex. Below is an example of an agreement that could be used.

MEMORANDUM OF UNDERSTANDING (MOU)
between
The U.S. Department of the Interior, National Park Service
North Cascades National Park Service Complex (NOCA)
And
Landowner

Subject Document Number: ***MOU – #***

Title: Natural Resource Protection in Lake Chelan National Recreation Area
This Memorandum of Understanding (MOU) is entered into by and between the United States Department of the Interior (USDI), the National Park Service (NPS), acting through the Superintendent of North Cascades National Park Service Complex (NOCA), and between *Landowner,* owner of property on *(Company Creek / Stehekin Valley Rd…)*, Stehekin, Washington.

ARTICLE I – BACKGROUND AND OBJECTIVES:
NOCA and *Landowner* each own certain property in the vicinity of *location in valley*, Chelan County, in the State of Washington. A resource issue of concern in that area is the control of the invasive plant species *invasive species common name, (scientific name)*.

Both parties recognize and agree that the presence of this invasive species require active management to prevent its spread to surrounding lands. *Invasive species* has been classified by the State of Washington as a *Class #* noxious weed.: Because of its very limited distribution in this region, landowners are required to control and prevent spread of this species. (Class B weeds)

This agreement specifies the means by which NOCA and *Landowner* will work together to facilitate control of *invasive species*.

ARTICLE II – AUTHORITY
A. Federal:
1. *16 U.S.C. §§ 1-3* declares that the National Park Service shall promote and regulate the use of the various Federal areas known as the national park system by such means and measures as conform to the fundamental purpose of the national park system, which purpose is to conserve the scenery and natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

ARTICLE III - STATEMENT OF WORK
A. NPS/NOCA agree to

1. Provide personnel and equipment to chemically control *invasive species* on public and private (*Landowner*) property in the vicinity of *location*. This work is expected to occur each *season(s)*.

2. Provide courtesy notification to the landowner approximately one week prior to commencing actual work.

3. Provide funding needed to accomplish the work described above.

B. *Landowner* agrees to

1. Grant NOCA the authority and access to chemically control and to monitor the population of *invasive species* on *Landowner* designated lands;

ARTICLE IV –TERM OF AGREEMENT

This Agreement will be effective from the day following the signature of all parties, and remain in effect until all work has been completed and *invasive plant species* has been eradicated from the landowner's property, unless it is terminated earlier by one of the parties pursuant to Article IX. In no event shall this agreement extend beyond five years from the date of the final signature.

ARTICLE V – KEY OFFICIALS

A. *Landowner* has the sole authority for his property regarding matters pursuant to this agreement.

Both Parties agree to consult and communicate to discuss the conditions covered by this Agreement and take necessary actions to further implement and further the stated goals and desired results.

Key officials are essential to ensure maximum coordination and communication between the parties and the work being performed. They are:

1. **Landowner:** Landowner
   Mailing Address
   Telephone #

2. **NPS/NOCA:**
   Signatory/Administrative
   Chip Jenkins, Superintendent
   North Cascades National Park Service Complex
   810 State Route 20
   Sedro Woolley, WA 98284-1239
   360-856-7205
   Fax: (360)856-1934
   E-mail: Chip_Jenkins@nps.gov

   Local/Coordinating
   Name, Stehekin District Natural Resource Mgr
   North Cascades National Park
   Stehekin District
   P.O. Box 7

Stehekin, WA 98852
(360) 854-7365 ext #
Fax: 360-856-6055 ext 25
E-mail: *email address*

B. **Communications –** *Landowner* will address any communication regarding this agreement to a Local/Coordinating Representative at NOCA (shown above). NOCA will address any communication regarding this Agreement to *Landowner*. Communications may be in oral, written, or electronic format. Issues of concern by either party shall be followed up in writing.

C. **Change in Key Officials -** NOCA or *Landowner* may not make any permanent change in a key official without written notice to the other party reasonably in advance of the proposed change. The notice will include a justification with sufficient detail to permit evaluation of the impact of such a change on the scope of work specified within this agreement. Any permanent change in key officials will be made only by modification to this agreement.

ARTICLE VI – FUNDING
Funds will not be exchanged under this agreement.

ARTICLE VII – PRIOR APPROVAL
NOCA shall execute the *invasive species* control activities through approval of an NPS Plant Ecologist.

ARTICLE VIII – REPORTS AND/OR OTHER DELIVERABLES
No reports or other deliverables are anticipated; however, upon request and to the full extent permitted by applicable law, the parties will share final reports of actions involving both parties.

ARTICLE IX – MODIFICATION AND TERMINATION
A. This agreement may be modified only by a written instrument executed by the parties.

B. Either party may terminate this Agreement by providing the other party with 30 days advance written notice. In the event that one party provides the other party with notice of its intention to terminate, the parties will meet promptly to discuss the reasons for the notice and to try to resolve their differences.

ARTICLE VII – STANDARD CLAUSES
A. **Civil Rights -** During the performance of this agreement, the participants will not discriminate against any person because of race, color religion, sex, or national origin. The participants will take affirmative action to ensure that applicants are employed without regard to their race, color, sexual orientation, national origin, disabilities, religion, age, or sex.

B. **Promotions –** *Landowner* will not publicize, or otherwise circulate promotional material (such as advertisements, sales brochures, press releases, speeches, still and motion pictures, articles, manuscripts or other publications) which states or implies Governmental, Departmental, bureau or Government employee endorsement of a product, service, or position which *Landowner* represents. No release of information relating to this agreement may state or imply that the Government approves of *Landowner* services, or considers *landowner* services to be superior to other services.

C. Public Information Release and Publications of Results of Studies -No party will unilaterally publish a joint publication without consulting the other party. This restriction does not apply to popular publication of previously published technical matter. Publications pursuant to this Agreement may be produced independently or in collaboration with others; however, in all cases proper credit will be given to the efforts of those parties contributing to the publication. In the event no agreement is reached concerning the manner of publication or interpretation of results, either party may publish data after due notice and submission of the proposed manuscripts to the other. In such instances, the party publishing the data will give due credit to the cooperation but assume full responsibility for any statements on which there is a difference of opinion.

ARTICLE IX - SIGNATURES

IN WITNESS HEREOF, the parties hereto have executed this Agreement on the date(s) set forth below.

FOR *Landowner* and NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

_____________________________________ ______________

Name, Landowner Date

FOR THE NATIONAL PARK SERVICE

______________________________________ _______________

Palmer L. Jenkins, Superintendent Date
North Cascades National Park Service Complex

Appendix H. Project Maps

Appendix H contains maps that depict project locations proposed in this EA. Due to scaling issues and the need to effectively portray project locations throughout the Park Complex, several maps are provided. There is one map depicting projects in the Stehekin Valley (Figure H-1), while there are three maps that depict project locations for west side (Skagit) projects (Figures H-2 to H-4). Refer to the table below as a key to the project numbers that appear on each map.

Table H-1. Map Key (Project numbers correspond to numbers on each map)

Project Names and Map Point Numbers		Treatment by Alternative		
#	**East Side – Stehekin Projects**	**Alternative 1**	**Alternative 2**	**Alternative 3**
1	Airstrip, fairways, and other cleared areas	treated	treated	treated
2	Airstrip wetland and beaver ponds	not treated	treated	not treated
3	Buckner Homestead Historic District	treated	treated	treated
4	Company Creek gravel pit	not treated	treated	treated
5	Stehekin Landing	not treated	treated	treated
6	Lake Chelan reed canarygrass	treated	treated	treated
7	Mill Pond and maintenance yard	not treated	treated	treated
8	Riparian weeds (excluding knotweed)	not treated	treated	treated
9	Stehekin River & tributaries knotweed	inventory only	treated	inventory only
10	Stehekin Valley cheatgrass	inventory only	treated	inventory only
11	Stehekin Valley road improvements	not treated	treated	treated
12	Stehekin Valley Scotch broom	treated	treated	treated
#	**West Side – Skagit Projects**	**Alternative 1**	**Alternative 2**	**Alternative 3**
1	Big Beaver Creek reed canarygrass	inventory only	treated	inventory only
2	Gravel pits	treated	treated	not treated
3	Hozomeen developed area	treated	treated	treated
4	Marblemount Compound	treated	treated	treated
5	Park-wide trails	treated	treated	treated
6	Ridley Lake reed canarygrass	not treated	treated	treated
7	Roads-Cascade River Road	not treated	treated	not treated
8	Roads-SR 20 Corridor	treated	treated	treated
9	Roads-Other Roads	treated	treated	treated
10	Ross Lake reed canarygrass	treated	treated	not treated
11	Ruby pasture	not treated	treated	not treated
12	Skagit River knotweed	treated	treated	not treated
13	Skagit River other weeds	not treated	treated	treated

Figure H-1. Stehekin Project Map

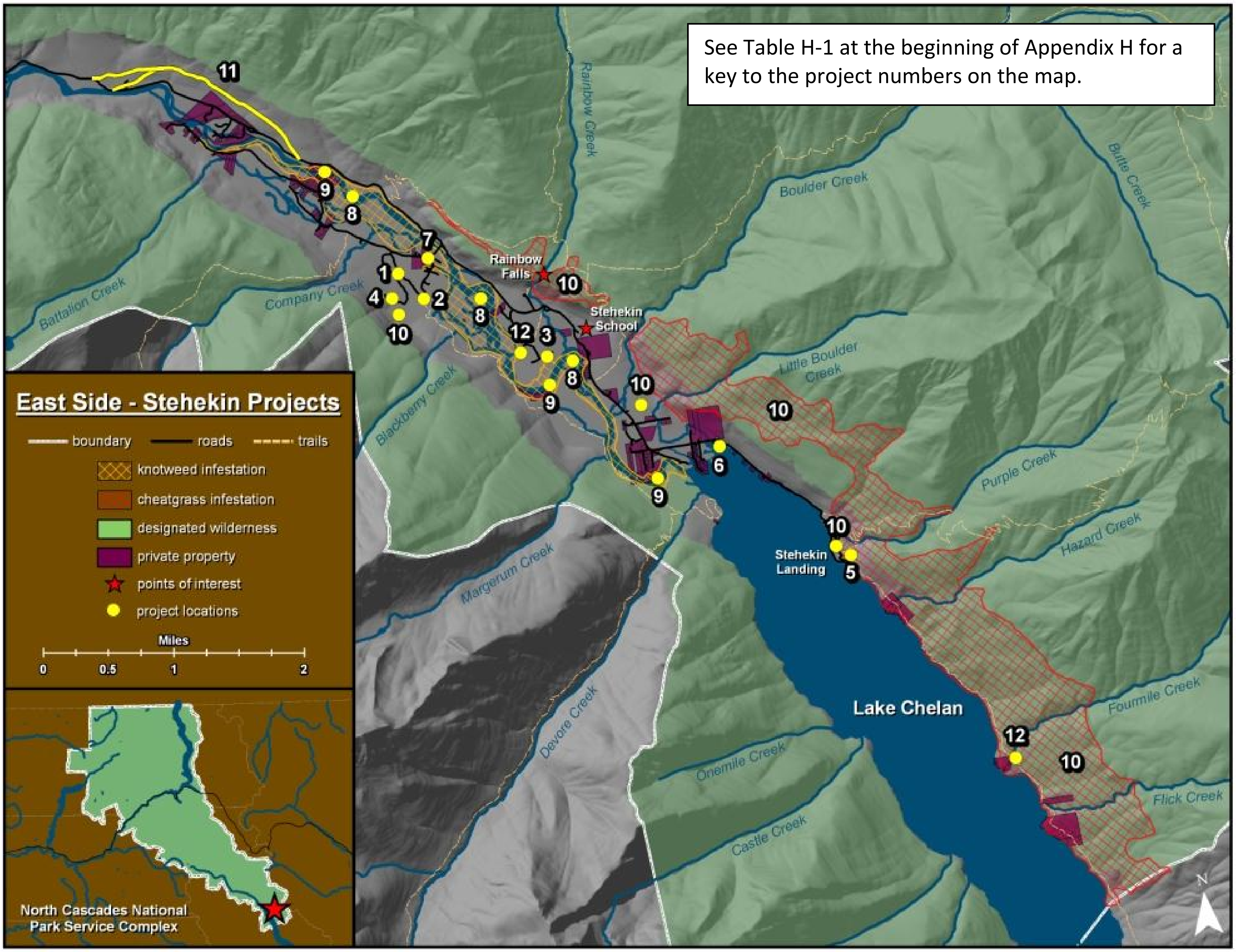


Figure H-2. Skagit Project Map (Marblemount-Cascade River Road)

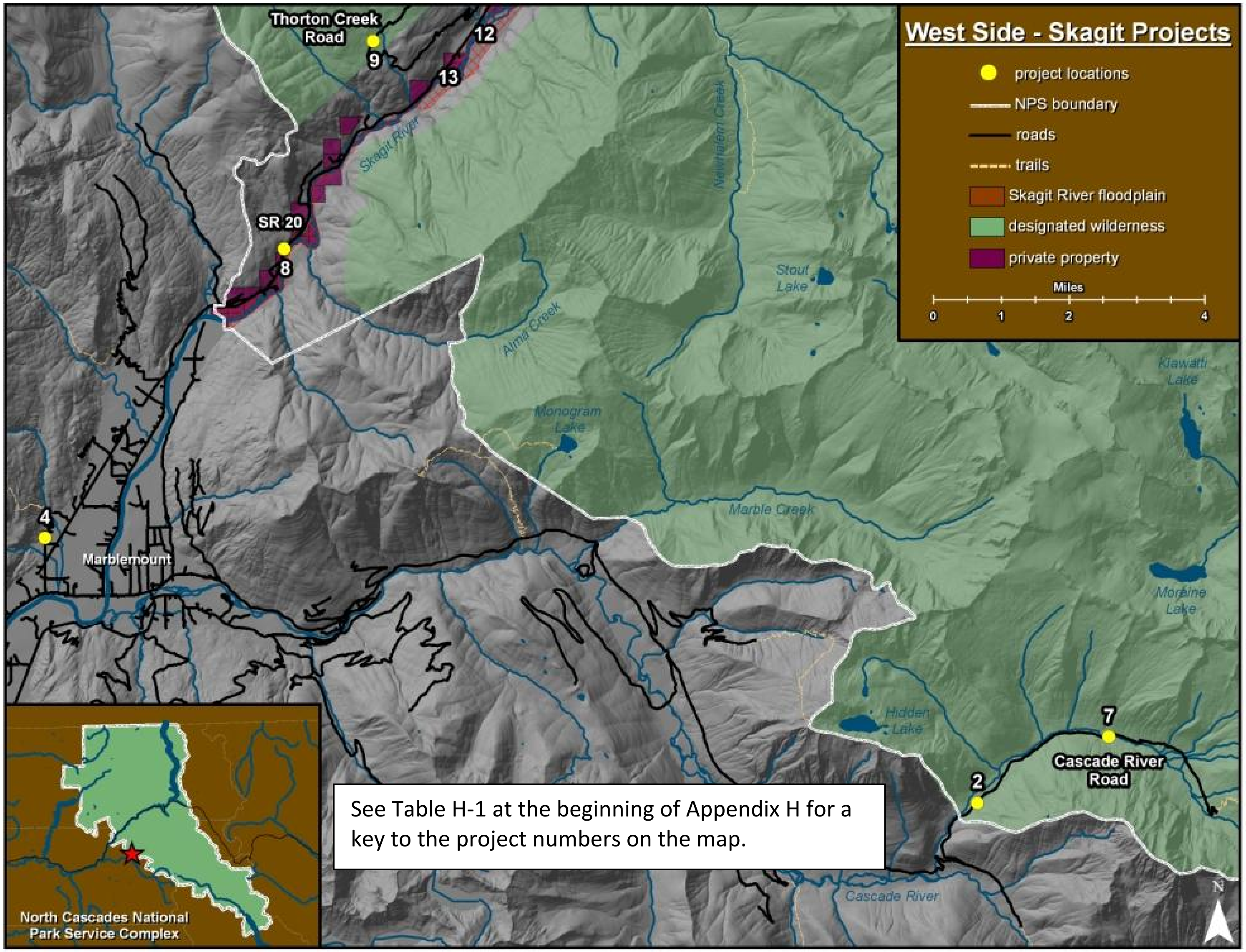
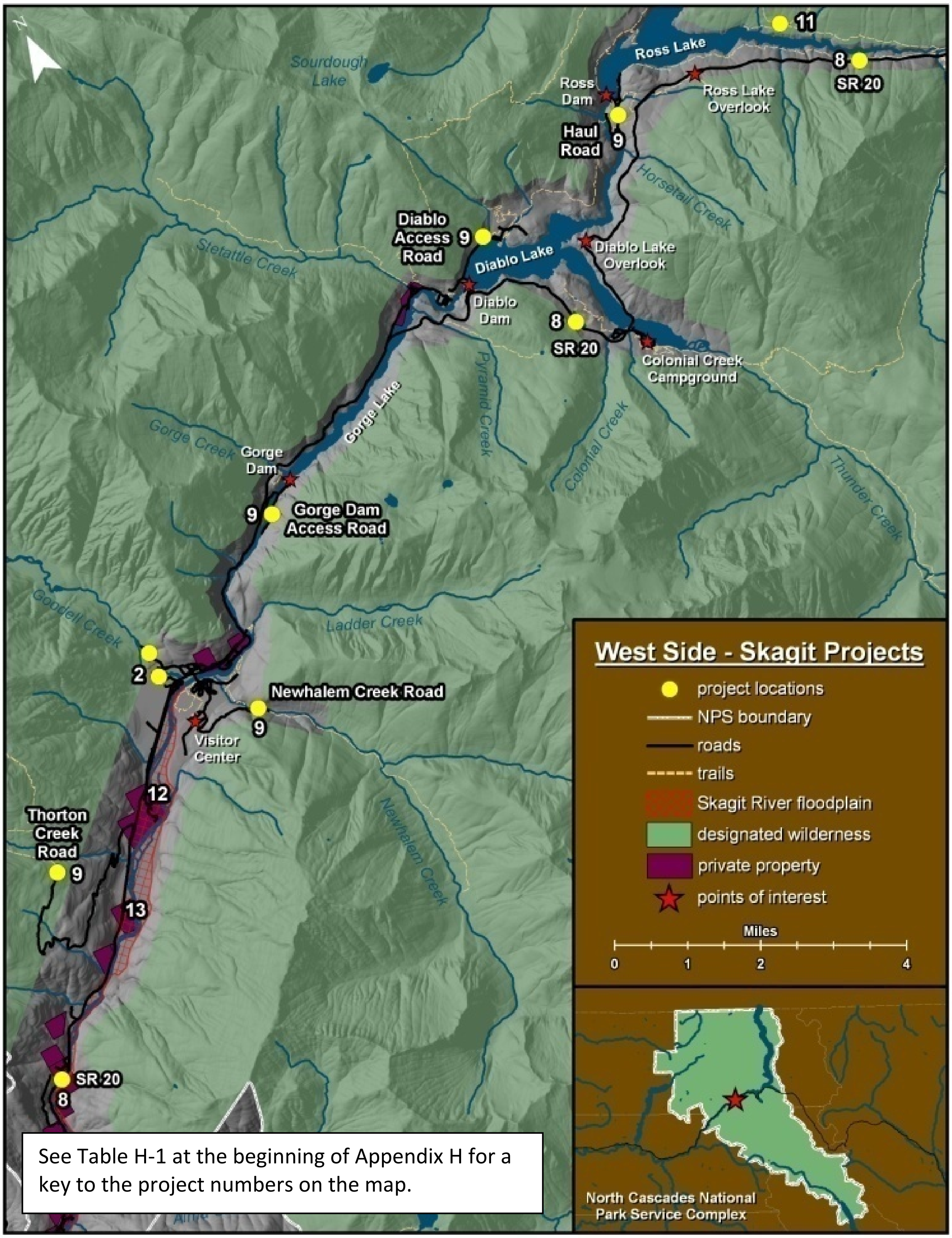


Figure H-3. Skagit Project Map (SR 20)



See Table H-1 at the beginning of Appendix H for a key to the project numbers on the map.

Figure H-4. Skagit Project Map (Ross Lake)

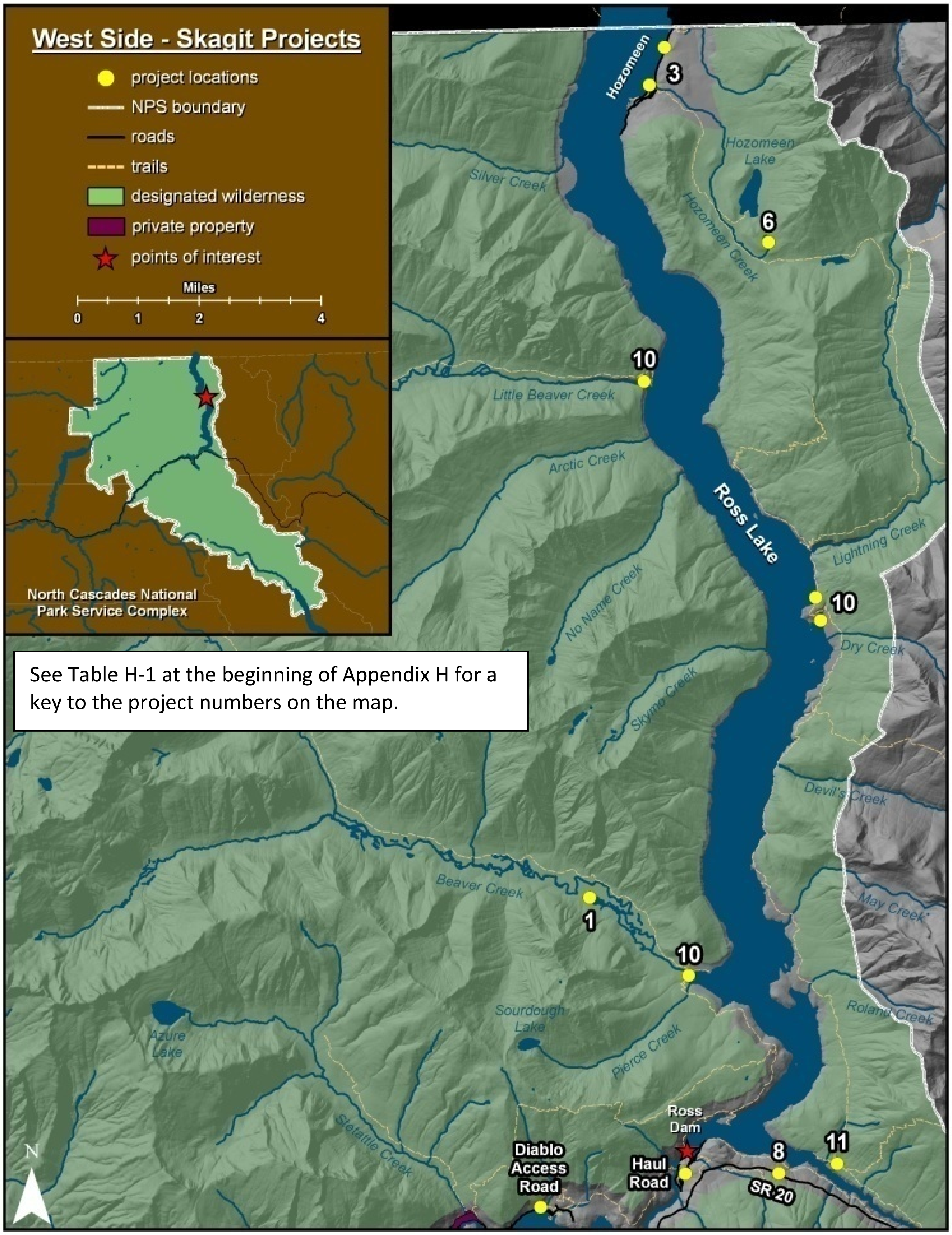
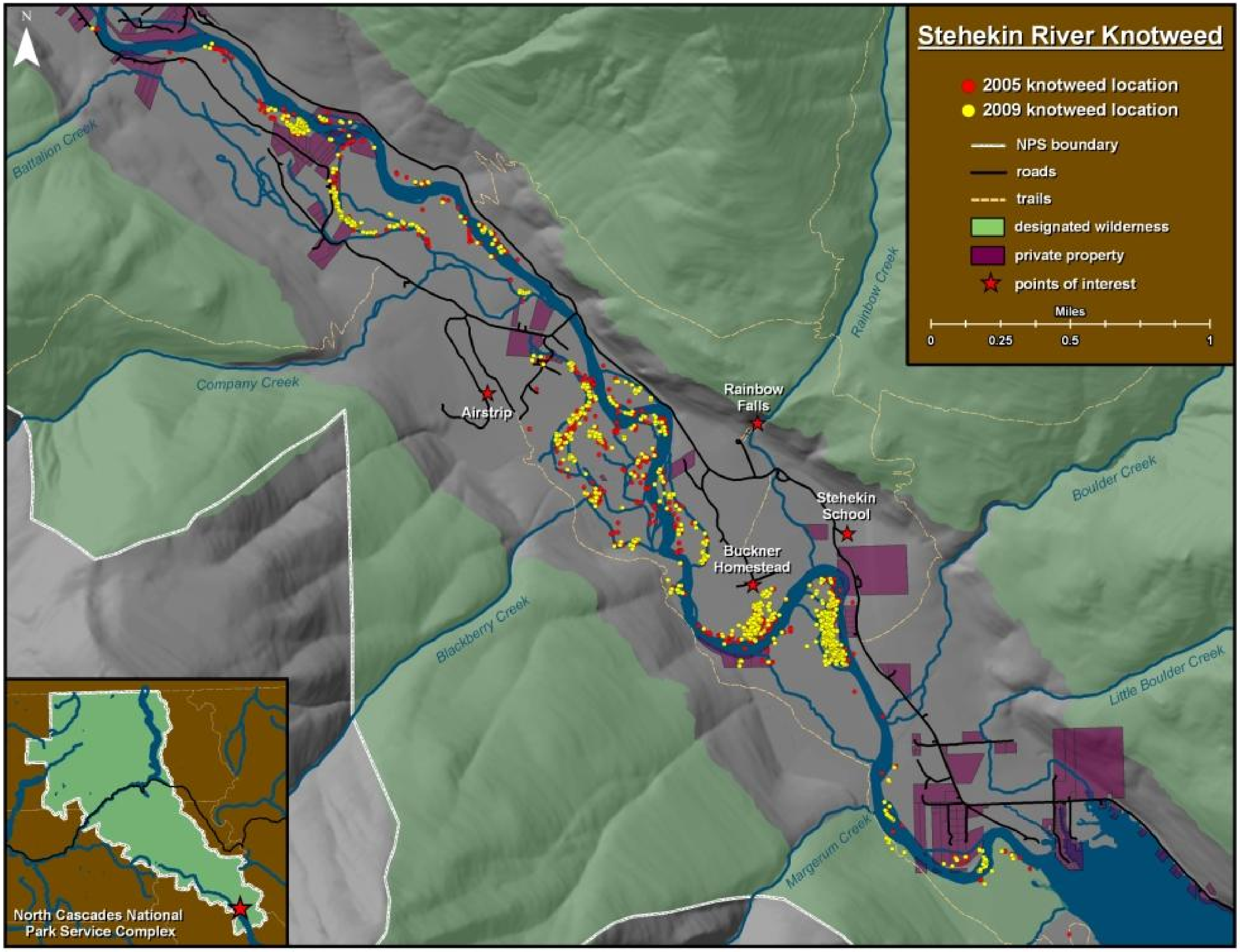


Figure H-5. Stehekin River Knotweed Extent (2005 and 2009)



Appendix I. Sensitive, Threatened or Endangered Plant Species in the State of Washington

The Washington State Natural Heritage Program (WNHP), a division of the Washington State Department of Natural Resources (DNR) is responsible for tracking species and ecosystems within the state that are considered rare or to have limited distribution. Information on priority species and ecosystems comes from a wide variety of sources, including WNHP and other state/federal agency botanists, Washington Native Plant Society members, private botanical consultants, University of Washington Rare Care program, and published literature. If a plant is listed by the WNHP it is given a status and ranking. This system is comparable to those of other states throughout the U.S. The state assigns each species a status which includes endangered, threatened, sensitive, review and watch. This list includes species that are known to occur or are likely to occur within the Park Complex. No plant species within the Park Complex are federally listed.

Endangered species are those that are endangered of becoming extinct or extirpated within the state of Washington, are at critically low population numbers and factors such as habitat degradation are continuing to contribute to the decline of the species.

Threatened species are those species that will be considered Endangered in the foreseeable future if habitat degradation continues.

Sensitive species are those that are vulnerable or declining and could become Endangered or Threatened in the state without active management or removal of threats.

Review species are those that have potential concern but have not been assigned a status

Watch species are those species that were previously listed with a higher status but were found to be more abundant or less threatened than previously thought.

Table I-1. Washington State Rare Plants Known or Likely to Occur within the Park Complex

Scientific name	Elevation	Habitat	Blooming time	Status
Botrychium lanceolatum lance-leafed moonwort	760'-6000'	Moist sites, alpine meadows	June-September	Watch
Botrychium lunaria common moonwort	3000'-6400'	Moist open areas in meadows and forests	June-September	Watch
Botrychium minganense moonwort	2000'-5700'	Moist sites in deciduous and coniferous forest, subalpine sites	June-September	Watch
Botrychium pedunculosum stalked moonwort	1600'-3000'	Moist wooded sites	June-September	Sensitive
Carex atrosquama blackened sedge		Open wet meadows and dry slopes at moderate to high elevations	July-August	Review group 2
Carex buxbaumii Buxbaum's sedge	700'-6200'	Bogs, marshes, wet meadows	June-August	Watch
Carex capillaries hair-like sedge	2800'-6500'	Stream banks, wet meadows, wet ledges, and marshy lake shores	June-August	Threatened
Carex comosa bristly sedge	50'-2000'	Marshes, lake edges, wet meadows	July-August	Sensitive

Scientific name	Elevation	Habitat	Blooming time	Status
Carex flava yellow sedge	2000'-4000'	Wet meadows, forested wet-lands, bogs shores of streams and lakes	July-August	Sensitive
Carex heteroneura different nerved sedge	Moderate to high eleva-tion	Wet meadows to dry slopes	June-August	Review group 2
Carex machrochaeta large awned sedge	600'-3200'	Open wet meadows, seeps, waterfalls	July-August	Threatened
Carex magellanica ssp. Irrigua poor sedge	2000'	Bogs, sedge meadows, fens, spruce/sedge association	August	Sensitive
Carex pluriflora several flowered sedge	100'-3100'	Marshes, stream banks, lake margins	July-August	Sensitive
Carex saxatilis var. major russet sedge	2500'-5500'	Wet meadows, edges of streams and ponds, bogs	July-August	Watch
Carex scopulorum var. priono-phylla mountain sedge	4600'	Moist-wet meadows, lake-shores, stream banks	July-August	Watch
Cicuta bulbifera bulb-bearing hemlock	240'-3700'	Edges of marshes, lakes, bogs, meadows shallow standing or slow moving water	August-September	Sensitive
Epipactis gigantean giant hellebore	0'-4000'	Stream banks, lake shores, seeps, springs	April-July	Watch
Erigeron salsihii Salish fleabane	6000'-8000'	Dry alpine ridges	July-August	Sensitive
Eriophorum viridicarinatum green keeled cottongrass	2000'-6600'	Cold swamps and bogs	June-July	Sensitive
Fritallaria camschatcensis black lily	0'-3000'	Moist to wet meadow, open, riparian areas, tide flats	May-June	Sensitive
Galium kamtschaticum boreal bedstraw	1500'-2100'	Moist coniferous forest, seeps and areas of standing water	July-August	Watch
Githopsis specularioides common blue-cup	200'-2300'	Dry, open places in foothill, areas of thin soils, talus slopes	April-June	Sensitive
Hypericum majus Canadian St. Johnswort	100'-2300'	Along ponds and lakeshores, riparian areas	July-September	Sensitive
Iliamna longisepala longsepal globemallow	500'-4500'	Sagebrush steppe, open hill-sides, dry streams, open Ponderosa and Douglas fir forest	June to Au-gust	Sensitive
Impatiens Aurelia orange balsam	Low eleva-tion	Moist shaded areas	June-August	Review group 2
Limosella acaulis mudwort	< 4000'	Ponds edges, lakeshores, river edges in areas of slow moving water	May-November	Watch
Lycopodiella inundata bog clubmoss	1500'-6400'	Bogs, marshes pond margins	July	Sensitive
Lycopodium dendroideum treelike clubmoss	800'-3600'	Rock outcrops, talus fields, moss and significant debris layer	June-July	Sensitive

Scientific name	Elevation	Habitat	Blooming time	Status
Pellea brachyptera Sierra cliff brake	770’-2200’	Dry Rocky slopes, talus, out-crops in Douglas fir and Ponderosa Pine forest	August-September	Sensitive
Penstemon eriantherus var. whi-tedii fuzzy-tongued penstemon	3500’	Open sagebrush shrub, open areas in valleys and foothills	May-July	Sensitive
Pinguicula vulgaris common butterwort	1500’-7000’	Moist seeps, meadows and ta-lus slopes	July-August	Watch
Planthera obtusata small northern bog orchid	800’-5000’	Moist places in forests, bogs, stream banks, marshes, mea-dows,	June-July	Sensitive
Pleuricospora fimbriolata Sierra sap	1000’-4000’	Dry coniferous forest with lit-tle understory	July-August	Watch
Potemogeton obtusifolius blunt leaved pondweed	50’-2000’	Waters of lakes and slow mov-ing streams	August-September	Sensitive
Saxifragopsis fragarioides strawberry saxifrage	1400’-4500’	Crack and crevices on cliffs and rock outcrops in Ponderosa pine and Douglas fir forest.	June-July	Threatened
Silene seelyi Seely’s silene	1500’-6300’	Cliffs and talus slopes	May-August	Sensitive
Spiranthes porrifolia Western ladies tresses	60’-6800’	Meadows, seeps streams	May-August	Sensitive
Swertia perennis Swertia	4000’	Montane to subalpine mea-dows, stream banks	July-August	Review group 1
Utricularia minor sesser bladderwort	300’-2000’	Shallow standing/slow moving water	June-September	Review group 1

Appendix J. Fact Sheet on Herbicides and Adjuvants

Each of the herbicides selected for use in this EA has been thoroughly examined through a Human Health and Ecological Risk Assessment, previously prepared for the US Forest Service by an independent contractor. These risk assessments represent a synthesis of the best available research and information regarding the potential effects of these chemicals on human and wildlife health, and their environmental fate under different application and spill scenarios. The fact sheets presented in this appendix should only be considered a summary of the pertinent information provided in the risk assessments. For additional or more in depth information, the original documents should be consulted. The risk assessments are available in their entirety at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

Each herbicide product varies in terms of its chemical and biological behavior in the environment. Factors that may influence the environmental fate of herbicides in the environment are summarized below (from Miller and Westra 1998), and can be used to assist in interpreting the information presented in the fact sheets presented in this appendix.

Acid or base strength - refers to whether an herbicide has basic, acidic, or non-ionizable properties. This factor determines the ability of an herbicide to exist in soil water or be retained onto soil solids. In general, herbicides whose pH is close to the pH of soil are strongly retained and are not subject to runoff, erosion, and/or leaching. In contrast, herbicides whose pH is not close to that of the soil are less strongly retained and are subject to runoff, erosion, and/or leaching. These herbicides are also more available for plant uptake than those herbicides that are strongly retained onto soil solids.

Water solubility - refers to how readily an herbicide dissolves in water and determines the extent to which an herbicide is in the solution (water) phase or the solid phase. An herbicide that is water soluble generally is not retained by soil.

Volatility - refers to the tendency of an herbicide molecule to become a vapor. Herbicides with high vapor pressures are likely to escape from the soil and volatilize in the atmosphere.

Soil retention - is an index of the binding capacity of the herbicide molecule to soil organic matter and clay. In general, herbicides with high soil retention are strongly bound to soil and are not subject to leaching. Those not exhibiting high soil retention are not strongly bound and are subject to leaching.

Soil persistence - refers to the longevity of an herbicide molecule, typically expressed in terms of a half-life, as determined under normal conditions in the region where the herbicide would be used.

Table H-1 contains a summary of the environmental fate and toxicology of the 12 herbicides proposed for use in this plan. Fact sheets containing more detailed information for each chemical are found below the table. Additionally, information summaries provided for adjuvants are found after the herbicide fact sheets. These summaries are taken from product Material Safety Data Sheets and labels which are available at: http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=.

Table J-1. Herbicide Environmental Fate and Toxicology

	Fish & Wildlife	Water	Soils
Aminopyralid	Practically non-toxic to aquatic organisms, fish, birds, and mammals. Does not bioaccumulate.	Rapid degradation by photolysis in surface water.	Weakly adsorbed. Average half life of 35 days. Low potential for leaching, field experiments show limited movement in the soil profile.
2, 4-D	2, 4-D amine salt formulations are practically non-toxic to fish and aquatic invertebrates. 2, 4-D ester and dimethyl amine formulations may be highly toxic to fish and aquatic invertebrates. Formulations may range from practically non-toxic to moderately toxic to birds. Mammals are moderately sensitive.	Limited potential to contaminate groundwater due to rapid degradation in most soils and uptake by plants. 2, 4-D residues dissipate rapidly, especially in moving water.	May remain active in the soil; however, it is not persistent and binds strongly to soils that are high in organic matter. 2, 4-D is rapidly degraded in soil by microorganisms and persists for no more than 30 days, with an expected half life of < 10 days.
Chlorsulfuron	Relatively non-toxic to aquatic organisms due to low water solubility. Low toxicity to birds and mammals, and mildly toxic to terrestrial microorganisms.	Half-life in water of up to one month. High potential for movement to non-target vegetation as surface run-off.	Moderately mobile at soil pH > 6 adsorbed by soil organic matter. Average half life of 40 days, shorter at lower pH. Primary degradation by hydrolysis, with slower microbial breakdown.
Clopyralid	Low toxicity to aquatic organisms, fish and invertebrates; low toxicity to birds and mammals; non-toxic to bees. Does not bioaccumulate.	Highly soluble in water. May leach into groundwater if applied to areas where soils are very permeable and the water table is shallow.	May be persistent in soils under anaerobic conditions; otherwise it is broken down by soil microorganisms. Soil half-life can range from 15 to 287 days, with an average of 40 days.
Fluroxpyr	Practically non-toxic to terrestrial and aquatic organisms due to rapid degradation.	Unlikely to contaminate groundwater due to short half-life. 4-14 day half life in water, practically non-toxic to aquatic organisms.	Little or no movement in soil due to short half life (11-38 days for the acid formulation, 7-12 days for the ester formulation). Breakdown in soil is primarily by soil microorganisms.
Glyphosate	Slightly toxic to freshwater fish; practically non-toxic to aquatic invertebrates (Roundup formulation). Aquatic formulations (Rodeo) practically non-toxic to freshwater fish and aquatic invertebrates. Does not bioaccumulate.	Potential for leaching low. Glyphosate and the surfactant in Roundup are strongly adsorbed to soil particles, including those suspended in the water column. Half-life for glyphosate in pond water ranges from 12 to 63 days, and significantly less in flowing water systems.	Not generally active in the soil. It is not usually absorbed from the soil by plants. Half-life in soils can range from 3 to 130 days, with an average half life of 47 days. Soil microorganisms break down glyphosate. In tests, the surfactant in Roundup has a soil half-life of less than 1 week. Soil microorganisms break down the surfactant.
Imazapyr	Practically non-toxic to wildlife and aquatic organisms.	Half-life in water is 1-2 days. Photolysis is the primary mode of breakdown in water.	Weakly adsorbed to soil, increasing with organic matter and clay content. Not subject to surface run-off, and negligible soil mobility. Half life of 24-142 days depending on soil type. Primarily degraded by soil microbial community, with some breakdown by photolysis.
Imazapic	Practically non-toxic to wildlife and aquatic organisms.	No information available.	Weakly adsorbed to soil, increasing with organic matter and clay content. Not subject to surface run-off, and negligible soil mobility. Average half-life 120 days. Primarily degraded by soil microbial community.

	Fish & Wildlife	Water	Soils
Metsulfuron-methyl	Practically non-toxic to wildlife and aquatic organisms.	Moderately persistent and highly mobile, however, very low application rates and microbial breakdown suggest little opportunity to enter ground water.	Half life varies from a week to a month, depending on soil pH and moisture, with an average field half-life of 30 days. Degradation primarily to hydrolysis, increasing at lower soil pH, and increasing with temperature and moisture.
Rimsulfuron	Practically non-toxic to wildlife and aquatic organisms.	Degrades rapidly in water	Degrades rapidly in soil through hydrolysis, with a half life of 1-5 days. Low risk for leaching into soil.
Sethoxydim	Practically non-toxic to wildlife and aquatic organisms. May cause temporary eye irritation.	Degrades in < 1hr in water.	Not soil mobile, microbially degraded in <24 hrs, with field half lives averaging <5 days.
Triclopyr	Amine salt formulation is slightly toxic to freshwater fish; slightly to practically non-toxic to aquatic invertebrates; slightly toxic to mammals and very slightly toxic to birds; non-toxic to bees. Does not bioaccumulate. Ester formulation is considered toxic to aquatic organisms and is not for use in or near water.	Leaching potential is low in soils as Triclopyr binds strongly to clay and organic matter. May leach from fine soils following heavy rainfall. Triclopyr is broken down rapidly by sunlight; the half-life in water is less than 24 hours.	Rapidly degraded by soil microorganisms. Average half-life in soil is 46 days. Binds strongly to clay particles and organic matter in the soil, but may be soil-active and absorbed by plant roots.

AMINOPYRALID HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of aminopyralid (4-amino-3,6 dichloropyridine-2-carboxylic acid or 2-pyridinecarboxylic acid, 4-amino-3,6-dichloro-). Information is summarized from:

Durkin, P. R. 2007. *Aminopyralid - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 231 pp.

Overview

Aminopyralid is of the chemical class pyridine carboxylic acid. This class of chemicals also includes the herbicides clopyralid, picloram, and triclopyr. The formulation of aminopyralid known as Milestone® contains the triisopropanolammonium salt of aminopyralid. Neither Milestone®, nor Milestone VM®, contains inert ingredients other than water and triisopropanolamine.

Aminopyralid is a relatively new herbicide, specifically designed for non-crop and wildland areas for noxious and invasive weed control. Like all new herbicides, little published research exists on aminopyralid when compared to other herbicides that have been used for many years. Dow AgroSciences has produced toxicity studies to support registration by the US Environmental Protection Agency (EPA).

Mode of Action

Milestone® is a foliar-applied, broadleaf selective herbicide. Members of the sunflower/composite (Asteraceae), Pea/Legume (Fabaceae), and Nightshade (Solonaceae) families may be more strongly affected by the chemical than other broadleaved plants. Grass (Poaceae) species are generally unaffected by aminopyralid, however some grass species may be affected depending on the application rate and timing. Aminopyralid is expected to be effective at lower application rates than clopyralid, picloram, and triclopyr. The strongest concentration recommended for wildland application with hand sprayers is

0.0025 percent Milestone® to 99.9975 percent water, although the solution can be diluted as much as 0.00012 percent Milestone® to 99.99988 percent water.

Aminopyralid is an auxin-like growth regulator. Auxins are plant hormones that control plant stem and root growth by binding to receptor sites on individual cells and triggering responses from those cells. Auxin mimics bind to those receptor sites, preventing auxins from binding. This disrupts or alters plant growth in ways that lead to mortality or decreased vigor.

Human Toxicity

Auxins are plant hormones and are not present in animals except as ingested food. Animal cells do not have auxin-binding sites. Auxin mimics have no impact on hormonal processes in animals, including humans. Orally ingested aminopyralid passes through the digestive tract largely un-metabolized and unchanged. When orally ingested, 96 percent of aminopyralid is excreted unchanged through urine and feces. The mechanism for toxicity to mammals is not well established.

According to the US Forest Service Human Health and Environmental Risk Assessment (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." In animal testing, Milestone® is non-mutagenic, not likely to produce cancer in humans, has a low acute oral toxicity, and is not thought to bio-accumulate. In oral ingestion studies, less than 0.73 percent of ingested aminopyralid was recovered in animal tissues. The No Observed Adverse Effect Level was greater than 1,000 milligrams per kilogram (mg/kg) per day in mammals, with LD50 > 5,000 mg/kg per day . The Milestone® formulation is slightly irritating to the eye.

Environmental Fate and Toxicity

The physical and chemical properties of aminopyralid suggest the potential of for moderate soil mobility; however field experiments show limited movement in the soil profile. Studies suggest that aminopyralid is weakly adsorbed to soil, and is primarily degraded by photolysis.

After application, aminopyralid is likely to primarily degrade aerobically by metabolism in the soil. The EPA bases soil half-life used in the risk assessment (103.5 days) on the only soil in the study that has an admissible material balance that could be used for quantification. Half-life in this study ranges from 6 to 533.2 days. The longest half-life (533.2 days) assumes that all "non-extractable residues" were the parent chemical. On the surface, photo-degradation occurs with a half-life of 72 days. This degradation produces carbon dioxide, non-extractible residues, and small amounts of acidic volatiles.

The metabolic breakdown of aminopyralid is not understood. The amino and carboxyl groups should be easily removed, but the chlorinated ring structure could be resistant to degrading in natural systems. In laboratory experiments, aminopyralid has been found to degrade to small acids, acid amines, and carbon dioxide by aqueous photolysis.

Based on the adsorption equilibrium constant for dissociation (soil/water coefficient) average of 0.22 and median of 0.13, aminopyralid can be expected to be mobile in soil. The EPA suggest that aminopyralid weakly adsorbs to the soil and is fairly non-mobile, with only a small fraction of the material leaching farther than 15 to 30 centimeters below the surface.

In a lab experiment, aminopyralid in clear water degrades by photolysis with a half-life of 0.6 day. Aminopyralid is considered stable in an anaerobic environment and stable to hydrolysis. In aerobic sediment-water systems, half-life ranges from 462 to 990 days.

Aminopyralid appears to have low acute and chronic oral toxicity to mammals, birds, terrestrial invertebrates, and aquatic animals including amphibians. According to the US Forest Service Human and Environmental Risk Assessment (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). Unlike the case with mammals, however, the upper bound of the acute hazard quotients approaches a level of concern at the highest application rate – i.e., a hazard quotient of 0.6 for a large bird consuming contaminated grasses and a hazard quotient of 0.9 for a small bird consuming contaminated insects." 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 of fish tested (both fresh water and marine), amphibians, marine invertebrates, and marine algae.

The low application rates needed to target plant species, combined with the low toxicity indicated by the initial studies, suggest that aminopyralid will not adversely affect other organisms. The deficit of research is a product of the newness of the herbicide, and will likely become more thorough over time. Further research will help to verify the preliminary research and widen the scope of knowledge of aminopyralid.

2,4-D HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of 2, 4-D (2, 4-dichlorophenoxy)acetic acid). Information is summarized from:

U.S. Forest Service. 2006. *2, 4-D - Human Health and Ecological Risk Assessment - Final Report*. U.S. Forest Service, Arlington, Virginia. 245 pp.

Overview
2, 4-D is a systemic growth regulator type herbicide in the phenoxy-carboxylic acid family that is used post-emergence for the selective control of broadleaf weeds. 2, 4-D is registered for a variety of uses including turf, lawns, rights-of-way aquatic and forestry applications. 2, 4-D has been used as an herbicide since the 1940's, and currently, over 600 end-use products are registered with 2,4-D as the active ingredient. 2, 4-D is formulated primarily as an amine salt in an aqueous solution, or as an ester in an emulsifiable concentrate. 2, 4-D may be used to improve the efficacy of other broadleaf selective herbicides, or to target some annual broadleaf weeds while minimizing collateral damage to woody perennials.

Mode of Action
2, 4-D is a pesticide active ingredient classified as an herbicide, a plant growth regulator, and a fungicide. It is, however, mainly used as a broadleaf selective post emergence herbicide. The mode of action of 2, 4-D is not completely understood, but it is similar to other auxin-like growth regulators, in that it is thought to increase cell wall plasticity, biosynthesis of proteins and the production of ethylene. The abnormal increase in these processes is thought to result in uncontrolled cell division and growth which damages plant vascular tissues. 2, 4-D is a systemic herbicide, which is translocated throughout the plant after absorption by roots, shoots and leaves, accumulating in regions of high metabolic activity such as meristems. Typical non-cropland application rates range from 1.5 lbs active ingredient (ae)/acre (A) per year up to 4 lbs ae/A per year in some forestry and non-cropland uses.

Human Toxicity
2, 4-D has recently undergone a re-registration eligibility and risk assessment by the EPA. Based on numerous unpublished studies submitted by registrants as part of the registration process, U.S. EPA/OPP concludes that:

2, 4-D in its salt and ester formulations are of low acute toxicity on the basis of oral, dermal and inhalation routes of exposure, and are not skin sensitizers or primary skin irritants; 2, 4-D acid and salts are severe eye irritants; 2, 4-D is not classifiable with regard to human carcinogenicity, and is not mutagenic; however, some cytogenic effects were observed. Renal clearance is key in 2, 4-D toxicity; in laboratory animals, repeated oral exposure to amine salt and ester 2, 4-D at levels that saturate renal clearance is associated with toxic effects, primarily manifested in the eyes, blood, thyroid, liver, kidneys, adrenals, ovaries and testes. Based on recent studies published in open literature, 2, 4-D is toxic to the immune system and developing immune system, especially when used in combination with other herbicides. Developmental and reproductive effects are seen only in association with maternal toxicity above the threshold for renal clearance. Neurotoxicity is seen in laboratory animals following high dose exposure. Signs of neurological, cardiac, hepatic, and renal toxicity are evident in cases of 2, 4-D following suicide attempts. Signs and symptoms of toxicity in humans include irritation to mouth, throat, and gastrointestinal tract, vomiting, chest and abdominal pain, diarrhea, muscle twitches, tenderness, and stiffness. In humans, health concerns are greatest for applicators regularly exposed to 2, 4-D during mixing and loading, or through the consumption of food (fruit) treated with 2, 4-D.

Environmental Fate and Toxicity
The average half-life of 2, 4-D under field conditions is 10 days. While 2, 4-D has the potential for movement in the soil, its short half-life, combined with removal from the soil by plant uptake minimizes leaching. Studies of movement in the soil show that 95% of 2, 4-D moves <15 cm; however, in sandy soils 2, 4-D has been shown to move 30 - 46cm under irrigation.

Based on EPA classification of acute toxicity, 2, 4-D is slightly to moderately toxic to mammals; practically non-toxic to moderately toxic to birds; and practically non-toxic to honey bees. U.S. EPA classifies the toxicity of 2, 4-D to freshwater and marine fish as practically non-toxic for 2, 4-D acid/salts and highly toxic for esters, with a similar pattern observed for aquatic invertebrates and amphibians. 2, 4-D causes toxicity in non-target plants at concentrations likely to be used under field conditions if precautions are not taken to limit spray drift. A limited number of studies suggest that effects of 2, 4-D on soil microorganisms and invertebrates are possible.

CHLORSULFURON HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of chlorsulfuron, 2-chloro-N-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl] benzenesulfonamide. Information is summarized from:

Klotzback, J. and P.R. Durkin. 2004. *Chlorsulfuron - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 180 pp.

Overview
Chlorsulfuron was the first commercial herbicide in the sulfonylurea group. Chlorsulfuron is formulated as a water dispersible granule to be mixed in water and applied as a spray at non-crop sites for the control of susceptible annual and perennial broadleaf weeds. Chlorsulfuron is the active ingredient in Telar®, Glean®, and Corsair®. Chlorsulfuron may be applied to seasonally dry floodplains or flood deltas, and other transitional areas between upland and lowland sites when no water is present, It is not intended for applications to surface water. Climatic conditions influence efficacy of Chlorsulfuron: warm, moist conditions following application accelerate herbicidal activity while cold, dry conditions delay herbicidal activity. Weeds hardened off by drought or other stresses are less susceptible to Chlorsulfuron.

Mode of Action
Foliar applied chlorsulfuron is absorbed and then translocated in the phloem. Small amounts move out of the leaves to other shoots and less to the roots. Absorption by roots from the soil solution is not as ef-

ficient but is compensated for by better movement up to the leaves. Within the plant, chlorsulfuron inhibits acetolactate synthase (ALS), a key enzyme in plants needed in the biosynthesis of the branched amino acids isoleucine, leucine and valine. Secondary effects on photosynthesis, respiration and ethylene production produce the symptoms of yellowing and reddening of grasses and leaf drop in broadleaved weeds. Chlorsulfuron has little effect on germination and weeds may emerge and grow for a week or two before dying. Chlorsulfuron does not affect the soil microbial community associated with nitrogen fixation in legumes.

Human Toxicity

Because animals do not possess the ALS enzyme to synthesize proteins, chlorsulfuron has been determined to be practically non-toxic to birds, mammals and freshwater fish on an acute exposure basis. On an acute contact basis, chlorsulfuron is practically nontoxic to honeybees.

Orally ingested chlorsulfuron passes through the digestive tract largely un-metabolized and unchanged. Studies with rats show approximately 85% of undegraded chlorsulfuron was excreted in urine. Laying hens eliminated approximately 90% of the administered chlorsulfuron in excreta.

Chlorsulfuron is a mild eye and skin irritant but not a skin sensitizer. The EPA classifies chlorsulfuron as having no evidence of carcinogenicity (causing cancer) based on a lack of evidence in rat and mice studies. Studies evaluating human exposure scenarios, including adults and children eating drift-contaminated garden vegetables or children directly touching drift-contaminated berries or vegetation suggest chlorsulfuron poses negligible risks. Multiple studies show that chlorsulfuron is not a mutagen. According to the US Forest Service Human Health and Environmental Risk Assessment, "there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.056 lb a.e./acre or the maximum application rate of 0.25 lb a.e./acre."

Environmental Fate and Toxicity

Chlorsulfuron is likely to be persistent and mobile in the environment. Chlorsulfuron may be transported to non-target areas by runoff and/or spray drift. Degradation by hydrolysis appears to be the most significant mechanism for breakdown of chlorsulfuron, but is only significant in acidic environments (23 day half-life at pH = 5); it is stable to hydrolysis at neutral to high pH.

Chlorsulfuron has moderate affinity for soil organic matter, but adsorption to clay is low. Degradation half-lives in soil environments range from 14 to 320 days. Soil microbes break down chlorsulfuron through hydrolysis which can be accelerated by moist soils, higher temperatures, and lower pH. Field studies at three sites with soils of pH > 7.5 showed an average half-life of 53 days, demonstrating that field soil dissipation can be faster than that exhibited under laboratory conditions. Photodegradation is believed to play a minor role in the overall degradation of chlorsulfuron under field conditions. Based upon laboratory adsorption-desorption studies chlorsulfuron is considered to be moderately mobile in soils of high pH, with less potential for leaching at pH < 6. However, field studies conducted in high pH soils over a year and a half have shown that most of the chlorsulfuron applied to soil remains in the upper 30 cm. Potential soil mobility is generally greater at higher pH and lower organic matter content.

Chlorsulfuron is considered moderately mobile in the soil, but due to its relatively rapid degradation, low use rates and low toxicity it is not likely to cause groundwater contamination. However, the low application rates needed to target plant species, combined with the low toxicity indicated by the initial studies, suggest that chlorsulfuron will not adversely affect other organisms. According to the US Forest Service Human and Environmental Risk Assessment "adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.056 lb a.e./acre or the maximum application rate of 0.25 lb a.e./acre."

CLOPYRALID HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of clopyralid, (3, 6-dichloro-2-pyridinecarboxylic acid). Information is summarized from:

Durkin, P.R. and M. Follansbee. 2004. *Clopyralid - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 154 pp.

Overview

Clopyralid is a foliar applied, post-emergent selective herbicide used primarily in the control of certain broadleaf weeds, and is particularly effective for the control of asters, nightshades, buckwheats and legumes. In non-crop situations, clopyralid is used almost exclusively for noxious weed control under the trade name Transline®. Because of its high degree of selectivity, Transline® is an excellent tool for managing broadleaf weeds such as knapweed, starthistles, Canada thistle and hawkweeds while minimizing damage to native broadleaved species and grasses. Transline® is a liquid formulation which contains 40.9% clopyralid and 59.1% inert ingredients, which are considered proprietary with the exception of isopropyl alcohol and polyglycol. Clopyralid is contaminated as part of the manufacturing process with hexachlorobenzene and pentachlorobenzene, with nominal average concentrations of < 2.5 ppm for hexachlorobenzene and < 0.3 ppm for pentachlorobenzene.

Mode of Action

Clopyralid is in the pyridine herbicide family, and is a growth-regulator type herbicide which has properties similar to that of other auxin-mimic type herbicides. Clopyralid is readily absorbed by roots and foliage, and then translocated quickly by xylem and phloem from treated foliage to meristematic growth points. Symptoms are typical of other auxin-type herbicides, with twisting of stems, leaves and petioles, and leaf cupping and curling, followed by chlorosis at the growth points, followed by necrosis.

Human Toxicity

Based on the estimated levels of exposure, and the criteria for acute and chronic exposures developed by U.S. EPA, there is no evidence that typical or accidental exposure will lead to exposure levels that exceed the level of concern for workers or the general public. Skin and eye irritation and damage can result from exposure to concentrated clopyralid during handling. The contamination of clopyralid with hexachlorobenze and pentachlorobenze does not appear to present any substantial cancer risk. The highest risk level is estimated at about 3 in 100 million under an exposure scenario where contaminated fish are consumed by subsistence populations (groups that consume relatively large amounts of contaminated fish.)

Environmental Fate and Toxicity

Clopyralid does not bind tightly to soil, and would seem to have a high potential for leaching. While clopyralid will show leaching under conditions that favor it (sandy soils, sparse microbial population and high rainfall); however, the potential for leaching and runoff is greatly reduced by the relatively rapid degradation of clopyralid in the soil. The average field half-life of clopyralid is 40 days, but residues from degradation may still injure sensitive plants up to one year after application. Clopyralid is degraded by the soil microbial population, with negligible loses to sunlight.

No adverse effects are anticipated in terrestrial or aquatic animals from the use of clopyralid at typical rates used for invasive plant management. The highest risk is to sensitive non-target plant species, which may be impacted by off-site drift or direct application. Because of the tendency for clopyralid to move into soil rather than to be transported by runoff and because of the greater toxicity of clopyralid by foliar uptake compared to uptake from the soil, off-site movement by soil runoff does not appear to be a substantial risk to non-target plants.

FLUROXPYR HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of fluroxpyr, [(4-amino-3, 5-dichloro-6-fluoro-pyridinyl)oxy]acetic acid. Information is summarized from:

Durkin, P.R. 2009. *Fluroxypyr - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 218 pp.

Overview

Fluroxypyr is a foliar applied, post-emergent, systemic, broadleaf selective herbicide, used for the control of susceptible annual and perennial broadleaf weeds and wood brush. Fluroxypyr is the active ingredient in Vista® and Starane®.

Mode of Action

Fluroxypyr is in the pyridine carboxylic acid family of herbicides like clopyralid, and induces an auxin-type response in susceptible weeds. Fluroxypyr is rapidly absorbed through foliage and roots, although it has little soil activity. Once absorbed, it is rapidly translocated to throughout the plant and accumulates at growth points. Plant growth is disrupted by the deregulation of cellular growth processes by interfering with binding at plant cell auxin receptor sites. Fluroxypyr also interferes with a plant's ability to metabolize nitrogen and produce enzymes, resulting in an overall disruption of growth regulation and plant death.

Human Toxicity

From laboratory studies of mammals on the absorption, distribution and excretion of Fluroxypyr, it can be concluded that Fluroxypyr is both rapidly absorbed and then excreted primarily unchanged in urine, with a half life in the body of less than six hours. Under normal uses for the control of invasive, non-native plants, Fluroxypyr is not expected to cause adverse human health effects, with an LD50 for the ester formulation >5,000 mg / kg of body weight. However, the ester formulation does pose a greater risk for eye damage than more dilute formulations, and appropriate personal protective equipment must be worn to mitigate this risk. Based on current studies submitted to EPA where no developmental or reproductive toxicity has been observed, Fluroxypyr is classified as "not likely to be carcinogenic."

Environmental Fate and Toxicity

After application, the ester formulation of fluroxypyr is rapidly converted into the acid form, and degraded primarily by soil microbial communities. With a relatively short soil half life of 7-12 days for the ester formulations, fluroxypyr is considered unlikely to contaminate groundwater. According to the US Forest Service Human Health and Ecological Risk Assessment for Fluroxypyr, applications of fluroxypyr to any susceptible broadleaf plant species (target or non-target) at expected use rates are likely to result in plant mortality, however, fluroxypyr is unlikely to cause adverse effects in terrestrial animals, or fish, aquatic invertebrates, algae, or aquatic macrophytes, with the possible exception of interfering with shell formation of certain susceptible species of mollusk.

GLYPHOSATE HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of glyphosate. Information is summarized from:

Durkin, P.R. 2003. *Glyphosate - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 281 pp.

Overview

Glyphosate is a foliar applied, post-emergent, broad-spectrum, nonselective systemic herbicide used for control of annual and perennial plants including grasses, sedges, broad-leaved weeds, and woody plants. It is an isopropylamine salt of N-(phosphonomethyl) glycine, is the active ingredient of Rodeo®/Aquamaster® and Roundup®. Glyphosate was the seventh most commonly used conventional pesticide in U.S. agricultural crop production, and the second most commonly used homeowners applications in 1995.

Mode of Action
Glyphosate inhibits the shikimic acid pathway, which is involved in the synthesis of aromatic amino acids in plants and EPSP synthase. Blocking this step in the protein synthesis leads to the depletion of the aromatic amino acids tryptophan, tyrosine, and phenylalanine, all needed for protein synthesis or biosynthetic pathways leading to plant growth.

Glyphosate is translocated throughout the plant, and blocking the shikimic acid pathway, and essentially interrupts photosynthesis. Although some soil microorganisms have the shikimic acid pathway, research suggests glyphosate has no effect or slight enhancement to microorganisms in soil. The shikimic acid pathway does not occur in humans and other animals.

Human Toxicity
Multiple peer-reviewed scientific studies are available to estimate glyphosate exposure routes and toxicity. The LD50 for glyphosate in mammals ranges from about 2,000 to 6,000 mg/kg of body weight. The estimated LD50 in humans is >5,000 mg / kg of body weight. Glyphosate has not shown signs of causing neurotoxicity, and has the lowest risk of carcinogenicity. Chronic or subchronic exposure to glyphosate tends to cause loss of body weight, but it has been shown to not bioaccumulate. According to the US Forest Service Glyphosate Human Health and Ecological Risk Assessment Final Report “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 a.e./acre. Even at the upper range of plausible exposures in workers, most hazard quotients are below the level of concern.”

Environmental Fate and Toxicity
Glyphosate is not mobile in soil because it is tightly adsorbed soil. Soil bacteria and microorganisms metabolize and break it down. Once the glyphosate adsorbs to the soil, it is no longer available to plants. This strong adsorption to the soil limits the environmental transport of residual glyphosate from the application site. It is unlikely that glyphosate will reach ground or surface water from upland uses because of its strong affinity to bind with the soil. Glyphosate is strongly attracted to particles suspended in natural waters. The glyphosate preferentially bonds to organics in the solution, reducing the glyphosate in solution. This is likely the largest sink of glyphosate in water. The half-life for glyphosate in water is a few days to two weeks.

Glyphosate is biodegraded in both water and soil. Glyphosate in soil is primarily biodegraded by microorganisms. The half-life for glyphosate in soil ranges from 1 to 197 days. Both bound and unbound molecules are biodegraded. Glyphosate is biodegraded rapidly, even while strongly bound to the soil. Some microorganisms possibly increase with application, although the effect is not apparent until large quantities of glyphosate are applied. Field application rates appear to have little effect on microbial communities. Application of 100 times the field application rate does increase microbial communities.

The primary breakdown product of glyphosate is aminomethylphosphonic acid; this product primarily breaks down into carbon dioxide, ammonium, and phosphate. Like glyphosate, aminomethylphosphonic acid binds well with soil and sediments and has low toxicity. There is limited literature on the effects of aminomethylphosphonic acid, but it is currently considered of less toxicological concern.

According to the US Forest Service Glyphosate Human Health and Ecological Risk Assessment, "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 HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of imazapic, 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid. Information is summarized from:

Durkin, P.R. and M. Follansbee. 2004. *Imazapic - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 110 pp.

Overview
Imazapic is a broad-spectrum herbicide which can be applied either pre or post-emergent for the control of grasses, broadleaved plants and vines, and would primarily be used for the selective control of non-native grass species such as downy brome (cheatgrass). Imazapic is the active ingredient in the herbicide Plateau®. Imazapic is part of the imidazolinone herbicide family which also includes imazapyr, and is formulated as both a liquid and a dispersible granule (DG).

Mode of Action
Imazapic inhibits branched chain amino acid production in susceptible plants by inhibition of the enzyme acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS). This enzyme is not present in animals, and thus is not relevant to the assessment of potential effects in mammals. Imazapic is absorbed by both roots and foliage, and translocated throughout the plant in both xylem and phloem. Growth of susceptible plants is inhibited within a few hours of application; however, symptomology may not be apparent for several weeks. Treated plants first become chlorotic at the meristematic growth points, followed by foliar chlorosis and necrosis. Symptomology is similar to glyphosate.

Human Toxicity
Adverse effects in humans or other species due to exposure to imazapic do not appear to be plausible with no exposure scenario suggesting that workers or members of the general public will at any substantial risk from exposure to imazapic. In experimental mammals, the acute oral LD50 for imazapic is >5,000 mg / kg indicating a low order of toxicity. Imazapic appears to be essentially non-irritating and non-sensitizing to the skin, and minimally irritating to the eyes.

Environmental Fate and Toxicity
Imazapic is weakly adsorbed in high pH soils, with adsorption increasing as pH decreases, and clay and organic matter content increase. Soil persistence varies, with an average half-life of 120 days. Field studies do not indicate any potential for imazapic to move with surface water, or contaminate groundwater, as imazapic remains in the top 30-45 cm of soil until degraded. There is little indication that use of imazapic for the purposes presented in this management plan will lead to substantial unintended effects. Because imazapic is a highly effective herbicide, it is likely that non-target plant species directly sprayed with imazapic at normal application rates may be damaged. Damage to plants from runoff is possible but unlikely. Adverse effects in terrestrial and aquatic animals do not appear to be likely. Available research suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using worst case exposure assumptions at the typical application rates analyzed in the US Forest Service Human Health and Ecological Risk Assessment for Imazapic.

IMAZAPYR HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of imazapyr ((+)-2-[4,5 dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid). Information is summarized from:

Durkin, P.R. and M. Follansbee. 2004. *Imazapyr - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 149 pp.

Overview

Imazapyr is a broad-spectrum herbicide that controls annual and perennial grasses, broadleaved herbs, woody species, riparian, and emergent aquatic species vegetation. It can be used where total vegetation control is desired or in spot applications. Legumes and some vines in the Rose family (including Himalayan blackberry) are not strongly affected by it.

Imazapyr is part of the imidazolinone chemical class. This class of chemicals also includes the herbicides imazapic and imazethapyr. Imazapyr is formulated as a liquid, a wettable powder (in water soluble bags only), and a granular. It is used for pre- and post-emergence control of a broad range of weeds. Because it is non-selective, non-target plants that are inadvertently sprayed are likely to be severely damaged. Long-term, adverse effects to non-target vegetation are not expected due to imazapyr's rapid degradation and dissipation.

Mode of Action

Imazapyr is a non-selective herbicide that controls plant growth by preventing the synthesis of branched-chain amino acids. Imazapyr is absorbed quickly through plant tissue and can be taken up by roots. It is translocated in the xylem and phloem to the meristematic tissues, where it inhibits the enzyme acetolactate synthase (ALS). The rate of plant death usually is slow (weeks to months) and is likely related to the amount of stored amino acids available to the plant. Plants cease to grow initially in the roots and later in the aboveground portions. Only plants have ALS and produce these three amino acids, and therefore, imazapyr is of low toxicity to animals (including fish and insects).

Human Toxicity

According to the US Forest Service Imazapyr Human Health and Ecological Risk Assessment, "typical exposures to imazapyr do not lead to estimated doses that exceed a level of concern for either workers or members of the general public at either the typical or highest application rate. Although there are several uncertainties in the exposure assessments for workers and the general public, the upper limits for hazard quotients associated with the longer-term exposures are sufficiently below a level of concern that the risk characterization is relatively unambiguous. Based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that the workers or members of the general public will be at any substantial risk from longer-term exposure to imazapyr even at the upper range of the application rate considered in this risk assessment."

Environmental Fate and Toxicity

Upon direct application to, or indirect release into surface water, imazapyr degrades through photolysis, with a half-life of approximately 3 to 5 days. In forestry dissipation studies, reported values for the half-life of imazapyr range from 14 to 44 days in forest litter, 19-34 days in forest soils and 12 to 40 days on plants.

There is little to no photodegradation of imazapyr in soil, and it is not readily degraded by other chemical processes. Imazapyr does not bind strongly with soil particles, and depending on soil pH, can be neutral or negatively charged. When negatively charged, imazapyr remains available in the environment. In forest dissipation studies, it did not run off into streams, and no evidence of lateral movement was observed.

According to the US Forest Service Imazapyr Human Health and Ecological Risk Assessment, "adverse effects in terrestrial or aquatic animals do not appear to be likely. The weight of evidence suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.45 lb/acre or the maximum application rate of 1.25 lb/acre. As in any ecological risk assessment, the risk characterization must be qualified. Imazapyr has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target organisms. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available."

METSULFURON METHYL HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of metsulfuron methyl, methyl 2-(4-methoxy-6-methyl-1,3,5-trian-2-ylcarbamoylsulfamoyl)benzoic acid. Information is summarized from:

Klotzback, J. and P.R. Durkin. 2004. *Metsulfuron Methyl - Human Health and Ecological Risk Assessment - Final Report.* Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 152 pp.

Overview
Metsulfuron methyl is a selective, pre or post-emergence applied sulfonylurea herbicide used to control many annual and perennial weeds and woody plants. Metsulfuron methyl is the active ingredient in the herbicide formulation Escort XP®.

Mode of Action
Metsulfuron methyl inhibits branched chain amino acid production in susceptible plants by inhibition of the enzyme acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS). This enzyme is not present in animals, and thus is not relevant to the assessment of potential effects in mammals. Metsulfuron methyl is rapidly absorbed through foliage and roots, and translocated extensively primarily though xylem and a lesser degree through the phloem, accumulating in meristematic tissues. Meristematic areas gradually become chlorotic and necrotic, followed by general foliar chlorosis and necrosis.

Human Toxicity
In experimental mammals, the acute oral LD50 for metsulfuron methyl is > 5,000 mg / kg of body weight. Metsulfuron methyl is eliminated from the body by a combination of excretion of the unchanged compounds and metabolites. In all species, metsulfuron methyl is eliminated rapidly with a half-life of less than a day, with most material being excreted as the unchanged compound. Skin absorption is the primary route of exposure for workers. Information regarding the inhalation of metsulfuron methyl is not well documented, but available literature indicate that it induces irritant effects at very high exposure levels. Regardless, inhalation is not considered of substantial concern because of the implausibility of inhaling high concentrations of this compound at expected field use rates, but exposure to concentrated formulations may cause mild skin and eye irritation. Metsulfuron methyl is not considered a mutagen or carcinogen.

Environmental Fate and Toxicity
Field half-life of metsulfuron methyl ranges from one week to one month, with a typical half-life of 30 days. Field degradation increases with increased temperatures and soil moisture. Degradation is due to both microbial action and hydrolysis, which cleaves the sulfonylurea bridge. Metsulfuron methyl is adsorbed weakly to clay, and strongly to organic matter. Metsulfuron-methyl is considered moderately

persistent and highly soluble, with the potential to enter surface waters from runoff, however, the very low application rates, and pathways of microbial degradation suggest that it has little potential to enter ground water. Exposure related mortality is not expected to be observed in fish exposed to concentrations of < 1,000 mg/L. No studies are available on the toxicity of metsulfuron methyl to amphibians, and metsulfuron methyl appears to be relatively non-toxic to aquatic invertebrates based on laboratory studies.

RIMSULFURON HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of rimsulfuron, 1-(4,6-dimethoxypyrimidin-2-yl)-3-(3-ethylsulfonyl-2-pyridylsulfonyl) urea. Available information and reports on rimsulfuron is limited compared to other chemical profiles detailed in this document. Information is summarized from:

DuPont. 2007. Technical Bulletin: Identity of Active Substance of Matrix (Rimsulfuron). Effective date September 2007.

Martins, J.,Chevre, N.,Spack, L., Tarrradellas, J., and Mermoud, A. 2001. Degradation in soil and water and ecotoxicity of rimsulfuron and its metabolites. *Chemosphere* 45: 515-522.

New York State Department of Environmental Conservation 2009. Registration of a Major Change in Labeling for DuPont Matrix FNV Herbicide (EPA Reg. No. 352-671) Containing the Active Ingredient Rimsulfuron (Active Ingredient Code 129009). Available online: http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/rimsulfuron/matrix_mcl_0509.

Schneiders, G., Koeppe, M., Naidu, M., Horne, P., Brown, A., and Mucha, C. 1993. Fate of Rimsulfuron in the Environment. *Journal of Agriculture and Food Chemistry* 41: 2404-2410.

Vischetti, C., Perucci, P., Scarponi, L. 1997. Rimsulfuron in soil: Effect of persistence on growth and activity of microbial biomass at varying environmental conditions. *Biogeochemistry* 39:165-176.

Overview

Rimsulfuron is of the chemical class sulfonylurea. This class of chemicals also includes the herbicides chlorsulfuron. bensulfuron-methyl, and nicosulfuron. Due to its toxicological profile and recommended low use rate the rimsulfuron label has reduced Worker Protection standards. The low use rates also place less of a chemical load on the environment (DuPont 2007). Rimsulfuron would be used to control nonnative invasive, annual and perennial broadleaf weeds and grasses, such as cheat grass, members of the mint, aster, carrot and other families when conditions are appropriate (DuPont 2007). Rimsulfuron works mainly by foliar action and would be applied via foliar spray using backpack sprayers.

Mode of Action

Rimsulfuron inhibits acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS), a key enzyme in the biosynthesis of the branch-chain amino acids isoleucine, leucine and valine in plants. Movement within the plant is via both the xylem and phloem. Inhibition of ALS results in rapid cessation of growth at the tips of both roots and shoots of sensitive plants, causing eventual plant death. The absence of this enzyme in humans and other animals helps to explain the low toxicity of rimsulfuron. Translocation is affected by temperature. Hot, dry, sunny conditions increase the plant's waxy protective layers and reduce herbicide uptake. High moisture conditions increase the soil activity of rimsulfuron.

Human Toxicity

The metabolism of rimsulfuron in animals (rat, goat and hen) is adequately understood and is similar among the species evaluated. Rimsulfuron was rapidly eliminated via urinary and fecal excretion in rats. Approximately 60 to 70 percent of the administered dose to rats was excreted within 24 hours. Rimsulfuron is nonhazardous to animals, fish, honey bees and other wildlife, based on low toxicity demonstrated in several studies. Because isoleucine and valine are plant-based amino acids, and are not present in animals except as ingested food, Sulfonylureas, in general, have little or no toxicological effects on mammals with oral LD50 usually >5000 mg/kg in rats.

Rimsulfuron is metabolized to several breakdown products. Toxicology studies indicate that the primary metabolite in plants is nontoxic to rats and is nonmutagenetic. The EPA has determined rimsulfuron is not likely to be a human carcinogen.

In animal testing, the formulated product is non-mutagenic, not likely to produce cancer in humans, has a low acute oral toxicity, and is not thought to bio-accumulate. Acute LD50 concentrations are >5,000 mg/kg for rats and >2,000 mg/kg for rabbits. Testing with rabbits found the formulation is not a skin irritant and moderately irritating to the eye, returning to normal by 72 hours.

Environmental Fate and Toxicity

Rimsulfuron is highly unstable in aqueous medium and degrades rapidly, while its persistence in soil, measured under laboratory conditions, has been found to vary according to soil characteristics and temperature. Degradation occurs predominantly via chemical pathways with microbial degradation playing a minor role. Rates of rimsulfuron degradation are influenced by pH. The compound is most stable in neutral soil pH and degrades more rapidly in alkaline and acidic soils.

Studies have indicated that rimsulfuron degrades rapidly in aquatic systems via contraction of the sulfonylurea bridge. In aqueous solutions, pure rimsulfuron was rapidly hydrolyzed into metabolites with half-lives of 2 and 2.5 days, respectively. Hydrolysis was instantaneous under alkaline conditions (pH= 10). Half-lives in water at 25°C ranged from 4.6 days to 0.2 days between pH 5.0 and 9.0, respectively.

The half-life of rimsulfuron in soil is 21 and 18 days at 25°C under aerobic and anaerobic conditions, respectively. Adsorption of rimsulfuron differs among various soil types. The adsorption increases with the increasing amount of organic matter or clay content. Photolysis and volatilization are relatively minor processes. Leaching of rimsulfuron and its degradation products in soil are considered negligible. In radio labeled field soil dissipation studies of rimsulfuron applied at 70 grams active ingredient per hectare, no detectable residues were observed below 7.5 centimeters. Field studies indicate that rimsulfuron poses very low risk of leaching into groundwater. One study indicated rimsulfuron can interfere with the growth and activity of soil microbial biomass, the extent of which depends on the difference in herbicide persistence.

The low application rates needed to target plant species, combined with the low toxicity indicated by the initial studies, suggest that rimsulfuron will not adversely affect other organisms. According to the New York State Department of Environmental Conservation (2009), “Rimsulfuron clearly poses no risks to birds, mammals, fish, or aquatic invertebrates. The mode of toxicity is applicable only to plant physiology, the residue values are all well below toxicity thresholds, and rimsulfuron is generally applied to bare ground to prevent weeds (pre-emergence), and not to foliage that birds, mammals, and other varieties of organisms would feed upon.”

SETHOXYDIM HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of sethoxydim, 2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one. Information is summarized from:

Durkin, P.R. 2001. *Sethoxydim [Poast] - Human Health and Ecological Risk Assessment - Final Report*. Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 182 pp.

Overview
Sethoxydim is in the cyclohexanedione herbicide family, and is the active ingredient in the formulation Poast®. Sethoxydim is used for the selective post emergence control of annual and perennial grass weeds (monocots), and does not affect broadleaved weeds (dicots). Poast would be used under this plan for the selective control of non-native grasses in areas where the restoration of native grasses is desired.

Mode of Action
Sethoxydim inhibits the production of the enzyme acetyl-CoA carboxylase (ACCase), the enzyme which catalyzes fatty-acid synthesis in susceptible plants. Broadleaf species are naturally resistant to sethoxydim because of an insensitive ACCase enzyme, with a similar tolerance demonstrated in some grasses. Sethoxydim is rapidly absorbed into roots and leaves, and generally is rainfast within one hour of application. Once absorbed, sethoxydim is translocated throughout the xylem and phloem, accumulating in meristematic areas of treated roots and shoots. Translocation does generally not occur outside of treated vegetation, and is somewhat limited.

Human Toxicity
Sethoxydim has been tested for and does not appear to cause carcinogenicity, birth defects, or other reproductive effects. The acute oral LD50 for sethoxydim is >5,000 mg / kg of body weight. Poast may cause skin and eye irritation, and the formulation Poast® contains a substantial amount of petroleum solvent (74%) which includes naphthalene (7% of the solvent). However, at the exposures to workers and the public anticipated in the US Forest Service Human Health and Ecological Risk Assessment for Sethoxydim, even including accidental exposures, sethoxydim does not seem likely to pose any substantial risk to human health.

Environmental Fate and Toxicity
While sethoxydim is highly water soluble, and resultantly mobile, it is unlikely to contaminate ground or surface waters because it is not persistent under most conditions. Under aerobic conditions, half-lives were < 24 hours. Sethoxydim is broken down in the environment by photodegradation, aerobic metabolism in water and soil, and hydrolysis in water. The average field half life for sethoxydim is <5 days. While EPA has classified sethoxydim as practically non-toxic to insects and birds, there is some concern over the toxicity of the formulation Poast® to aquatic organisms due to the high percentage of petroleum solvent. While speculative, it appears the toxicity of Poast® to aquatic species may be exclusively due to the solvent rather than sethoxydim. However, based on acute toxicity studies, both sethoxydim and Poast® appear to be approximately equally toxic in humans and other mammals (wildlife).

TRICLOPYR HERBICIDE INFORMATION SHEET

This information sheet summarizes existing scientific knowledge pertaining to the use of triclopyr (3, 5, 6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt). Triclopyr is a selective herbicide sold in three common formulations: triethylamine salt (TEA) (triclopyr amine or salt), a butoxyethyl ester TBEE (triclopyr ester), and a ready-to-use dilute ester formulation. The formulations are most often marketed as Garlon 3A®, Garlon 4®, Pathfinder ll®, and under as a wide variety of generic formulations. Information is summarized from:

Durkin, P.R. 2003. *Triclopyr – Revised Human Health and Ecological Risk Assessments - Final Report*. Syracuse Environmental Research Associates, Inc. Fayetteville, New York. 264 pp.

Overview

Triclopyr is of the chemical class pyridine carboxylic acid. This class of chemicals also includes the herbicides clopyralid, picloram, and aminopyralid. Triclopyr was first registered in 1979 and is predominantly sold as soluble or emulsifiable concentrates, such as ready-to-use liquids, wettable powders and pellets. Dow AgroSciences has produced toxicity studies to support registration by the US EPA.

Garlon 4® is the ester formulation of triclopyr, usually applied as an oil-based mixture diluted with specialty vegetable or mineral oils. These mixtures may includes petroleum products causing a strong odor; some dilutants contain limonene, which adds additional odor. Garlon 4® has been in use since the late 1980s. Triclopyr ester is heavily used for wildland weed control in the United States; it is very effective for treating woody dicots. Garlon 4® should not be applied in any situation where the herbicide can contact water or in areas where amphibians are present.

Garlon 3A® is the amine salt formulation of triclopyr. It is applied as a water-based mixture, usually with added adjuvants. Garlon 3A® can be used on the same species as Garlon 4®, but is approved for use in wetlands, or in situations where accidental overspray may result in the herbicide coming into contact with water.

Mode of Action

Triclopyr is a selective herbicide that mimics the effects of the plant hormone auxin. Auxins are plant hormones that control plant stem and root growth by binding to receptor sites on individual cells and triggering responses from those cells. Auxin mimics, such as triclopyr, bind to those receptor sites, preventing the auxins from binding. It is designed for use in forests and industrial non-crop areas, disturbed areas and for controlling target vegetation in and around standing water sites, such as wetlands and the banks of lakes. Triclopyr is absorbed by leaves and roots and is translocated throughout the plant causing phytotoxicity.

No one plant family is specifically affected by Triclopyr. Woody, annual and perennial broadleaf plants and vines are more strongly affected by the chemical than most other types of plants. Triclopyr has low phytotoxicity to grasses and is rapidly degraded by soil microorganisms. Therefore, there is not enough residue left in the soil to injure plants the next growing season.

Human Toxicity

Auxins are plant hormones that are not present in animals except as ingested food. Animal cells do not have auxin-binding sites. Therefore, auxin mimics have no impact on hormonal processes in animals, including humans. Orally ingested triclopyr passes through the digestive tract largely un-metabolized and unchanged. When orally ingested, 80 percent of triclopyr is excreted unchanged through urine. According to the US Forest Service Triclopyr Human Health and Ecological Risk Assessment, “There is no indication that workers will be subject to hazardous levels of triclopyr at the typical application rate of 1 lb/acre and under typical exposure conditions…For workers who may apply triclopyr repeatedly over a period of several weeks or longer, it is important to ensure that work practices involve reasonably protective procedures to avoid the upper extremes of potential exposure.”

TEA and TBEE both convert to triclopyr quickly, ranging from seconds in water to less than a day in soil. Triclopyr is slightly toxic to fish, mammals and birds, and from slightly toxic to practically non-toxic to daphnia. Triclopyr is practically non-toxic to bees. Acute toxicity levels (LD50) of triclopyr for mammals and duck was 310-713 mg/kg and 1698 mg/kg, respectively. Triclopyr and its formulations have not been tested for chronic effects in wildlife mammals. Triclopyr was negative in several laboratory tests for mutagenicity and was weakly positive in one test in rats. It is not likely to produce cancer in humans and is not thought to bio-accumulate.

The probability of worker exposure to a toxic concentration for either general health or reproductive effects was rated “Low” or “Negligible” for all application methods except for backpack sprayers, for which risk was rated “Moderate.” There are no reported cases of long term health effects in humans due to triclopyr or its formulations. Cases of eye and skin irritation have been reported in workers exposed to triclopyr formulations.

The studies on reproduction and development in rats and rabbits suggest that triclopyr is not an endocrine disruptor, but it has not been studied for its potential to interact or interfere with estrogen, androgen, thyroid or other endocrine organ hormone systems. A European Union survey of the scientific literature on endocrine effects of pesticides does not list triclopyr as a chemical of concern, nor do other sources of information on endocrine disrupting effects.

Environmental Fate and Toxicity

The outcome of studies on triclopyr movement in forested environments varies according to the amount and timing of precipitation, application method, herbicide formulation, treatment rate, non-uniform vegetation cover; and for surface water studies, proximity to a stream or river draining a watershed. Triclopyr amine salt formulations (TEA) are highly soluble in water and dissociate within one minute into the weak acid, triclopyr. Aquatic photolysis and microbial breakdown are significant degradation pathways for triclopyr. Dissipation half lives of triclopyr in water range from 0.5 days to 7.5 days. In field studies, triclopyr dissipation rates ranged from 2.8 to 5.8 days in the soil. Triclopyr is, however, persistent under anaerobic aquatic conditions. It is highly water soluble and is not expected to bind with organic materials.

Triclopyr has low vapor pressure so little volatilization occurs. With the exception of spray drift which can be avoided with proper application techniques, triclopyr is not expected to be found in air. Triclopyr has little tendency to hydrolyze and photolysis is the main degradation pathway in natural water. The half-life of triclopyr in water exposed to sunlight ranged from 3 hours to 4.3 days under field conditions. In river water, the half-life of triclopyr was 1.3 days.

The major route of dissipation of triclopyr in soil is microbial degradation and has a half-life of 3 hours. Soil photolysis is a minor route of dissipation. Triclopyr is listed as “fairly degradable” in soil with reported half-lives ranging from 12 to 27 days. Studies have classified triclopyr from “mobile” to “slightly mobile”, perhaps due to the fact that sorption to soil increases with time, thus decreasing its potential for leaching. The potential for triclopyr leaching increases as soil organic matter decreases, and as climatic conditions reduce soil microbial activity. Triclopyr has some characteristics conducive to leaching behavior. It is not strongly adsorbed to soil particles, and adsorbed molecules may later detach into water moving through the soil. Triclopyr exceeds the threshold for solubility used by EPA (30 ppm) when evaluating potential for leaching into groundwater. Long-term forest and pasture field studies found very little indication that triclopyr will leach substantially either horizontally or vertically in loamy soils. The breakdown products are also not mobile.

According to the US Forest Service Triclopyr Human Health and Ecological Risk Assessment, “For terrestrial mammals, the central estimates of hazard quotients do not exceed the level of concern for any exposure scenarios. At the upper range of exposures, the hazard quotients exceed the level of concern for large mammals and large birds consuming contaminated vegetation exclusively at the application site.” According to classification by the U.S. EPA, TBEE was found to be “highly toxic” to bluegill in a flow-through study by DowElanco. In a worst case scenario where TBEE is directly applied to surface water, TBEE may cause toxicity. However, since the TBEE half-life is less than a day in water and in soil, when properly applied it should not pose a problem. Triclopyr is much less toxic than TBEE. Triclopyr is listed as “slightly toxic” to crustaceans and “very slightly toxic” to fish.

A US Forest Service Report found that triclopyr is rapidly absorbed by animals and then excreted by the kidney. Since it is rapidly excreted, primarily in the unmetabolized form, it was estimated that only 10 percent of the ingested triclopyr is incorporated into the tissues of deer and rabbit. Studies calculated at an application of 3.0 lbs/acre, the concentration in deer tissue and rabbit tissue would be 2.2 and 1.7 ppm, respectively.

Studies conducted on forest streams found that when applied directly, TBEE and TEA degrade to triclopyr acid as it flows downstream. The only exception is some TBEE may be retained in organic matter such as leaf material and might pose a hazard for organisms that may feed on or inhabit organic matter. In general, once TEA and TBEE convert to triclopyr, there is little toxicological hazard to aquatic organisms and triclopyr does not accumulate to a great extent. In the environment, triclopyr would cause more damage to animal habitat due to eliminating vegetation, the intended purpose of the herbicide, than due to triclopyr toxicity to animals.

ADJUVANTS

An adjuvant is any substance in an herbicide formulation, or which is added to an herbicide mixture that modifies herbicidal activity or application characteristics. There are four types of adjuvants proposed for use under this plan, including surfactants, de-foamers, drift-reducers, and marker dyes. Surfactants increase the retention of spray droplets on plant foliage by reducing the surface tension of the herbicide formulation (resulting in a greater coverage of the spray solution and preventing run-off), increasing permeability of the leaf surface, thus increasing absorption of the spray solution. De-foamers prevent foaming during the mixing of some herbicides such as glyphosate. Foaming may occur when preparing certain tank mixes, and herbicide active ingredient may then be trapped in the foam, reducing the efficacy of the spray solution. Drift reducers (or thickeners) thicken the spray solution to increase droplet size, and reduce drift, especially in applications with high pressure equipment, such as ATV mounted boom-less sprayers, or high-pressure tank sprayers used for roadside and right of way applications. Marker dyes are used to improve the efficacy of herbicide applications by turning the spray solution a certain color (usually blue or red) which allows applicators to identify areas which have been previously treated.

The Washington State Department of Agriculture has registered specific adjuvants for use in aquatic herbicide applications, and requires that these adjuvants must meet the following criteria in order to be registered by the state:

- The adjuvant must fulfill all requirements for registration of a food / feed use spray adjuvant in Washington.
- The adjuvant must be either slightly toxic or practically non-toxic to freshwater fish. Rainbow trout (*Oncorhynchus mykiss*) is the preferred test species.
- The adjuvant must be moderately toxic, slightly toxic, or practically non-toxic to aquatic invertebrates. Either *Daphnia magna* or *Daphnia pulex* are acceptable test species.
- The adjuvant formulation must contain less than 10% alkylphenol ethoxylates (including alkylphenol ethoxylate phosphate esters).
- The adjuvant formulation must not contain any alkyl amine ethoxylates (including fallow amine ethoxylates).

Sources:
http://agr.wa.gov/PestFert/definitions/DefinitionCriteriaRegistrationSprayAdjuvantsAquatic.pdf
http://www.ecy.wa.gov/programs/wq/pesticides/Summary%20of%20aquatic%20acute%20toxicity%20data%20for%20spray%20adjuvants%20permitted%20for%20use%20on%20aquatic%20sites%20in%20Washington%2005-18-2009.pdf

Below are the adjuvants proposed for use in the invasive plant management plan.

Agri-dex ®. Agri-dex is a non-ionic blend of surfactants and highly refined oil designed for use with a broad range of pesticides where an oil concentrate adjuvant is recommended. Agri-dex is designed to improve pesticide applications by modifying the wetting, spreading, and deposition of spray mixes. Agri-dex is approved for aquatic applications and has been tested extensively for toxicity to fish. In studies, Agri-dex has an LC50 of 1,000 mg/L over a 96 hr exposure to both Rainbow trout and Bluegill sunfish, and over a 48 hr exposure to Daphnia. Repeat exposure may cause irritation of the skin, eyes, or respiratory tract. Adsorption to soil and sediment can be expected. Agri-dex is inherently biodegradable, and bioaccumulation is unlikely due to the low water solubility of the product. Agri-dex will primarily be used as a mix with glyphosate and imazapyr to improve efficacy to herbicides used to treat aquatic and wetland plants.

Blazon® Spray Pattern indicator. Blazon® Spray Pattern indicator is a non-staining blue liquid colorant designed to be used with pesticide, fertilizer, and/or plant growth regulator tank mixes. Blazon® helps the applicator determine the efficacy of the application by indicating where spray solutions have been deposited. Blazon® also aids in identifying equipment malfunctions such as leaks and clogged nozzles by making them readily obvious to the applicator. Blazon is a water soluble colorant, and is non-staining to skin, clothing and equipment; however it may stain porous surfaces. Overexposure may cause slight eye and skin irritation, however, Blazon® is considered essentially non-toxic and no further toxicological or ecological information is available.

Competitor ®. Competitor® is a modified vegetable oil containing a non-ionic emulsifier system. Competitor® can be used with products where a modified vegetable oil or crop oil concentrate is recommended, or as a surfactant in conjunction with aquatically labeled pesticides, as specified by the product label. Competitor® is mildly irritating to the skin and eyes, with a dermal LD50 of >5,000 mg/kg. Competitor® is not considered a carcinogen.

Forest Crop Oil®. Forest Crop Oil® is a highly refined emulsifiable petroleum oil used as a carrier (diluent) in place of water, or as an adjuvant and mixed with water soluble herbicides for woody plant control in forest and other non-crop sites where oil carriers or additives are recommended by the product label. This product is most often used as a carrier with oil soluble or miscible herbicides as the sole carrier to improve spreading and penetration into the bark of woody plants. Forest Crop Oil® may cause eye or skin irritation, and has an acute oral LD50 > 5,000 mg/kg of body weight, an acute dermal LD50 of >2,000 mg/kg, and is not considered a carcinogen. Forest Crop Oil® is not for aquatic use, and should not be applied where surface water is present.

Fighter-F®. Fighter-F® is an antifoaming / defoaming agent composed of dimethylpolysiloxane, polypropylene glycol, and methylated silicone designed to control foam in water, oil, fertilizer and pesticide spray mixtures. Foam can effect calibration and metering of spray mixtures, and result in the waste of active ingredient contained in foam. Fighter-F® helps to reduce waste of herbicide products, and ensure an accurate application, especially when using tank-mixed or agitated herbicide mixtures. Fighter-F® is not for use in aquatic applications. Fighter-F® causes moderate skin irritation, but is not an eye irritant.

The acute oral LD50 >5,000 mg/kg body weight, and the acute dermal LD50 > 2,000 mg/kg and is not considered a carcinogen.

Liberate ®. Liberate® is a non-ionic, low-foam penetrating adjuvant, deposition aid, and drift retardant consisting of lecithin, methyl esters of fatty acids, and Alcohol exthoxylate. Liberate® provides more uniform coverage of spray solutions, and retards drift by producing larger spray droplets and a more uniform spray pattern. Liberate® is not irritating to eyes, and a moderate irritant to skin (acute dermal LD50 >2,000 mg/kg). Liberate® has an LD50of 17.6 mg/L @ 96 HR to rainbow trout, and 9.3 mg/L @ 48 HR to Daphnia. Liberate® is not considered a carcinogen.

MSO (Methylated Seed Oil). MSO is sold under many trade names by different manufacturers. The product most commonly available for non-crop applications in the Northwest is Super Spread® MSO (Wilbur-Ellis Company). Super Spread® MSO is a 100% modified vegetable oil/surfactant that aids in penetration of the spray solution through the leaf cuticle, and also acts as a wetting and spreading agent. Super Spread® MSO may be used in place of non-ionic surfactants or crop oil concentrates in herbicide mixtures. Super Spread®MSO is not for use in aquatic environments. Super Spread® MSO may cause moderate skin and mild eye irritation, and has an acute oral and dermal LD50 > 5000 mg/kg of body weight, and is not considered a carcinogen.

The following references were used to compile the adjuvant information:

Helena Chemical

2009 Material Safety Data Sheet – Agri-dex Crop Oil Concentrate. Author. Collierville, Tennessee. 4 pp.

2010 Specimen Label – Agri-dex Crop Oil Concentrate. Author. Collierville, Tennessee. 2 pp.

Loveland Products Inc.

2007 Material Safety Data Sheet – Forest Crop Oil – Oil Carrier and Adjuvant. Author. Greely, Colorado. 3 pp.

2007 Specimen Label – Forest Crop Oil – Oil Carrier and Adjuvant. Author. Greely, Colorado. 1 pp.

2004 Material Safety Data Sheet – Fighter F-10, 10% Antifoamer Defoamer. Author. Greely, Colorado. 3 pp.

2004 Specimen Label – Fighter F-10, 10% Antifoaming/ Defoaming Agent. Author. Greely, Colorado. 1 pp.

2010 Material Safety Data Sheet – Liberate with Leci-tech. Author. Greely, Colorado. 3 pp.

2010 Specimen Label – Liberate Penetrant Deposition Aid Drift Control Agent. Author. Greely, Colorado. 1 pp.

Milliken Chemical

2008 Material Safety Data Sheet – Blazon Blue 2X2.5. Author. Spartanburg, South Carolina. 4 pp.

2007 Specimen Label – Blazon Spray Pattern Indicator. Author. Spartanburg, South Carolina. 2 pp.

Wilbur-Ellis
2005 Material Safety Data Sheet – Competitor Modified Vegetable Oil. Author. Fresno, California. 1 pp.

2005 Specimen Label – Competitor Modified Vegetable Oil. Author. Fresno, California. 2 pp.

2006 Material Safety Data Sheet – Super Spread MSO. Author. Fresno, California. 2 pp.

2010 Specimen Label – Super Spread MSO Modified Vegetable Oil. Author. Fresno, California. 2 pp.

Appendix K. Impairment Determination

A determination of impairment is made for each of the resource impact topics carried forward and analyzed in the environmental assessment for the preferred alternative. The description of park significance is found below and was used as a basis for determining if a resource is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
- identified in the park's general management plan or other relevant NPS planning documents as being of significance.

Impairment determinations are not necessary for visitor experience, human health and safety, socioeconomics, and park operations because impairment findings relate back to park resources and values. These impact areas are not generally considered to be park resources or values according to the Organic Act, and cannot be impaired the same way that an action can impair park resources and values.

Description of Park Purpose and Significance

North Cascades National Park Service Complex was established on October 2, 1968. The Park Complex is comprised of North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area. In 2006, park and regional planning staff generated foundation statements, including park purpose and significance, for each of the units of the Park Complex. These statements are a work in progress; through the General Management Planning process they will be reviewed and refined by the public, park stakeholders and outside resource experts. Purpose statements for each unit of the Park Complex include the following:

Purpose of North Cascades National Park

The purpose of North Cascades National Park is to preserve a dynamic wilderness landscape of dramatic alpine scenery including a vast expanse of glaciated peaks, countless cascading creeks and deep forested valleys for the benefit and inspiration of all.

Purpose of Ross Lake National Recreation Area

The purpose of Ross Lake National Recreation Area is to complement North Cascades National Park and conserve the scenic, natural, and cultural values of the Upper Skagit River Valley and surrounding wilderness, including the hydroelectric reservoirs and associated developments, for outdoor recreation and education.

Purpose of Lake Chelan National Recreation Area

The purpose of Lake Chelan National Recreation Area is to complement North Cascades National Park and conserve the scenic, natural and cultural values of the Lower Stehekin Valley, Lake Chelan and surrounding wilderness, while respecting the remote Stehekin community, for outdoor recreation and education.

Significance Statements

The Park Complex is significant for the following reasons:

- The North Cascades range reaches its finest expression in the North Cascades National Park, where a dense concentration of jagged glaciated peaks towers above alpine meadows and deep valleys and results in supremely majestic scenery.
- The North Cascades NPS Complex contains more glaciers than any other protected area outside Alaska, representing one quarter of all the glaciers in the lower forty- eight states, and supporting ecosystems, communities and industries in the Puget Sound and lower Columbia River basins.
- From deep forested valleys to alpine peaks, the North Cascades NPS Complex encompasses extreme gradients of climate and topography that contributes to an impressive diversity of habitats and species. This area is the core of a vast mountainous ecosystem of protected public lands spanning the border of the United States and Canada. The ecological integrity of the North Cascades National Park Service Complex and the greater North Cascades ecosystem depend on one another.
- Envisioned as a wilderness park from its inception, the North Cascades National Park Service Complex is the core of over 2 million acres of federally designated wilderness, one of the largest such areas in the lower 48 states.
- Preserved within North Cascades NPS Complex is abundant evidence of over 9,000 years of cultural and technological development. This long history reveals a range of human adaptations to changing climates and environments at all elevations of the North Cascades.
- North Cascades NPS Complex provides educational and scientific opportunities that support the understanding and preservation of park resources and values while contributing to public enjoyment and understanding.
- North Cascades NPS Complex provides the wilderness traveler great challenges of physical endurance, route-finding and navigation through on- and off- trail hiking. The park contains climbing routes of high quality and aesthetic appeal, guarded by remote, rugged access and weather volatility, resulting in mountaineering experiences of solitude, mental and physical challenge and fulfillment.
- The Skagit is the largest river draining into the Puget Sound. Abundant glaciers provide stable flows that help make it the only Puget Sound tributary to host all native species of anadromous fish and one of the highest concentrations of wintering Bald Eagles in the lower 48 states.
- Ross Lake National Recreation Area provides a variety of high quality outdoor recreation opportunities, accommodating people with a wide range of interests and abilities.
- Ross Lake provides diverse water- based opportunities where visitors can experience the scenic reservoir amidst a mountain wilderness where small or non-motorized watercrafts characterize recreation in this serene setting.
- Within Lake Chelan National Recreation Area, Stehekin is a private- land based community that provides visitors with an opportunity to see and experience life in a remote setting that is not accessible by roads and is surrounded by wilderness.
- Set in a glacier- carved trough nestled between steep valley walls, Lake Chelan is the nation’s third deepest lake. Fed by glacial melt and the Stehekin River, it is known for its exceptionally cold and clear water.

- Lake Chelan National Recreation Area provides a spectrum of recreational opportunities that transition from highly mechanized to primitive as one moves from the lake, up the Stehekin Valley, and into the wilderness.

Resource Topics

Soils

The majority of the invasive plant infestations that occur within the Park Complex are found in valley bottoms, including the Stehekin Valley and the Skagit Valley. Soils of the Skagit Valley bottom consist of very deep, somewhat poorly drained soils formed in alluvium from meandering rivers in the floodplain. Alongside the valley bottom are very deep, well drained soils formed in mixed volcanic ash and glacial drift over glacial drift on debris aprons, valley walls, and bedrock benches. Above the Newhalem area, where the Skagit Gorge is located, the soil characteristics change dramatically. Soils tend to consists of shallow, well drained soils formed in volcanic ash mixed with glacial drift and colluvium over gneiss, granite, or granodiorite bedrock. Along Ross Lake, the soils consist of mostly volcanic ash over glacial drift, with volcanic ash over alluvium mapped at the mouths of larger tributaries. Areas of high bedrock exposure contain soils that are cobbly ashy sandy loams to loamy sands with bedrock at 14 – 24 inches.

In the Stehekin Valley the floodplain and terrace soils tend to be very deep, somewhat poorly drained to moderately well-drained. On the debris apron and valley wall soils tend to be very deep and well drained, the parent material being volcanic ash and reworked glacial drift over glacial drift on valley walls, debris cones, fan terraces, and alluvial fans. There are also areas of shallow, well drained soils that are cobbly, ashy, sandy loams and contain a high component of rock outcrop.

The preferred alternative would not result in impairment because although there would be short-term, minor to moderate adverse impacts to soils as a result of herbicide treatments, long-term beneficial impacts would occur as areas recover and are better able to support natural soil functions. Restoration efforts could speed the recovery process for disturbed sites by returning organic matter, nutrients, and moisture back into the soil.

Hydrology and Water Quality

The Park Complex has two major watersheds, the Skagit River and the Stehekin River. Mainstem reaches of these rivers and lower reaches of major tributaries generally exhibit low to moderate gradients supporting a variety and abundance of fish habitat. Tributaries located further upstream in these drainages exhibit moderate to steep gradients with generally cobble and boulder beds. Waterfalls and cascades are common in these reaches and form barriers to fish migration. Hydrological patterns are primarily influenced by glaciers and snowmelt. There are 318 glaciers in the Park Complex that are primarily located on the west side of the Cascade Crest.

Because most of the Park Complex is located in protective wilderness, it appears that water quality is generally very good although some impacts have been documented and other impacts, related to various ecosystem stressors within and outside the park boundaries, are likely to be occurring. Currently only two water bodies are listed by the state (303d, Clean Water Act) as not meeting state water quality standards. These include Newhalem Creek for instream flows and Lake Chelan for three pesticides (DDT, Chlordane, Dieldrin) and two other persistent organic pollutants (PCBs and Dioxin). Lake Chelan is also listed for invasive aquatic species and total phosphorus. Since some residents in the Stehekin Valley use the river as their source of drinking or irrigation water, concerns about herbicide use near the river are warranted.

Aquatic weeds are of major concern to park managers. Parrot feather (*Myriophyllum aquaticum*) and Eurasian water milfoil (*Myriophyllum spicatum*) have been found in Lake Chelan (though not within the Lake Chelan NRA), and reed canarygrass is becoming established along the periphery of Ross, Diablo, and Gorge lakes and at the head of Lake Chelan. Japanese knotweed is present in both the Skagit and Stehekin river drainages, and has formed some thick monocultures along streambanks and on islands. Additionally, there is the possibility that cold-tolerant hydrilla (*Hydrilla verticillata*) could be introduced to the Park Complex by visiting watercraft. All of these species have the potential to form thick monocultures in slow moving or stationary water, and may result in the degradation of habitat for native flora and fauna and a reduction in recreational opportunities.

Water resources are necessary to fulfill the purposes for which the park units were established, and are key to the natural integrity and enjoyment of the park units. The preferred alternative would not result in impairment because although there would be short-term, minor adverse impacts to hydrology and water quality as a result of herbicide treatments, long-term beneficial impacts would occur as areas recover and are better able to support natural hydrologic processes and water quality.

Wetlands

Wetlands are an important part of the North Cascades ecosystem. Major wetland systems are found in Big Beaver, Little Beaver, Chilliwack, Thunder Basin, and Fisher Basin drainages on the west side of the Park Complex. In Stehekin, the Stehekin River and its tributaries have associated wetlands which provide important habitat in an otherwise dry east side ecosystem. Isolated wetlands occur in higher elevations often associated with lakes, streams, and ponds. These wetlands provide habitat for a variety of invertebrate and amphibian species. High elevation wetlands are very vulnerable to the effects of climate change and air pollutant deposition. Lower elevation wetlands adjacent to major river and stream channels offer valuable habitat for anadromous salmonids other fish species. All wetlands perform important hydrological processes such as flood abatement, sediment retention, groundwater recharge, nutrient capture, and decomposition of organic matter. Wetlands are particularly vulnerable to invasive plant invasions, which can degrade wetland habitat by changing sediment loading, surface and subsurface flows, and water table depth (Gordon 1998). There are several proposed projects that would take place within or near wetland environments. These include Big Beaver, Ross Lake, and Ridley Lake reed canarygrass, Skagit River knotweed and other riparian weeds, Lake Chelan reed canarygrass, Stehekin River knotweed and other riparian weeds, mill pond and maintenance yard, and airstrip wetlands.

The preferred alternative would not result in impairment because although there would be short-term, minor adverse impacts to wetlands as a result of herbicide treatments and mechanical removal, long-term beneficial impacts would occur as areas recover and natural conditions are improved. Special consideration for invasive plant treatments in or near wetlands would be taken, and include: treatments in seasonally flooded wetlands and riparian areas would be scheduled during the dry or low water phase of the year, or during reservoir draw down, and appropriately labeled herbicide formulations would be used in wetlands and within 10 feet of standing and moving water.

Vegetation

Great variation in vegetation exists in the North Cascades ecosystem due to the dramatic differences in rainfall, slope, aspect and elevation. Four broadly defined vegetation zones are found within the North Cascades: lowland forest, montane forest, subalpine parkland, and the alpine zone. Overlaying these are three biogeographic zones caused by two orographic barriers within the Park Complex: the Boston-Picket-Spickard Divide and the Cascade Crest. Temperate marine conditions are found west of the Boston-Picket-Spickard Divide, while areas east of the Cascade Crest lie in the semi-arid continental zone. The region between the Boston-Picket-Spickard divide and the Cascade Crest, essentially the Ross Lake drainage, comprises a transitional zone where vegetal and climatic characteristics are intermediate between the mild, wet conditions typical of the west side and the semi-arid conditions typical east of the Cascade Crest.

No federally listed endangered or threatened plant species are known to exist in the Park Complex; however, of the 72 plant species listed as sensitive, threatened, or endangered by the State of Washington, 39 of them have been documented within the Park Complex (See Appendix I).

Non-native vegetation in the Park Complex is most widely distributed in areas of human-caused disturbance including roadsides, visitor use areas, administrative use sites, campgrounds and trailheads. Other disturbed sites where non-native plant species have become established include seasonally flooded riparian areas, reservoir shorelines, and areas impacted by forest fires or prescribed burns. Although there are over 200 non-native plant species in the Park Complex, only a small percentage of these species display invasive characteristics, and an even smaller number have become distributed to the point where they have the potential to impact native ecosystem processes. Current surveys indicate that non-native, invasive vegetation infests approximately 3,100 acres (gross infested estimate) representing 0.5% of park lands.

Healthy, native terrestrial and riparian vegetation is necessary to fulfill the purposes for which the park units were established, and is key to the natural integrity and enjoyment of the park units. The preferred alternative would result in adverse impacts during invasive plant treatments, such as vegetation removal and non-target impacts to native vegetation, but would result in long-term beneficial impacts as areas recover and can better support natural ecosystem processes. Recruitment of native plants and an increase in native plant diversity would occur.

Fish and Wildlife, including Rare, Threatened, and Endangered Fish and Wildlife

The Park Complex provides essential habitat for a diverse array of wildlife species that require large tracks of remote, mountainous land to survive. Some species that require these attributes include grizzly bear, gray wolf, wolverine, mountain goat, white-tailed ptarmigan and Clark's nutcracker. This variable landscape supports over 320 vertebrate species. There are approximately 75 mammal species in 20 families and approximately 20 species of reptiles and amphibians representing at least five orders. The avian fauna of the Park Complex is composed of roughly 210 species in 38 families. At least 28 species of fish are known to be present within the Park Complex, and recent surveys have documented over 500 terrestrial invertebrate taxa and approximately 250 aquatic invertebrate taxa. These findings comprise an unknown, but most likely tiny, fraction of the actual number of invertebrate taxa living within the Park Complex.

There are 27 fish and wildlife species documented within the Park Complex that are listed as threatened, endangered, candidate, monitor, and/or sensitive species by the State of Washington and/or the federal government. Seven species of mammals, fifteen bird species, three fish species, and two species of amphibians have special status on federal and state listings because their populations and/or habitat are at risk of declining and becoming extinct, or they are recovering from a threatened or endangered status and need to be monitored. All of these species are closely watched by federal and state fish and wildlife services, specialists in other federal agencies and friends and interest groups with the goal of helping these species at risk back to a more stable population and habitat condition.

The preferred alternative would not result in impairment to fish or wildlife species because although there would be short-term, negligible to moderate adverse impacts to fish and wildlife as a result of herbicide treatments and disturbance, long-term beneficial impacts would occur as areas recover and are better able to support native fish and wildlife species. Habitat restoration efforts would benefit many listed fish and wildlife species.

Cultural Resources

Each project proposed in this EA constitutes a federal undertaking. Prior to any undertaking the NPS will make an assessment of its effect to cultural resources. There are three projects proposed to take place within National Historic Districts. These include the Buckner Homestead Historic District, the Stehekin Landing (includes the Golden West Historic District), and the Marblemount Ranger Station Historic District. Invasive plants would be treated at all three of the identified cultural resource sites. Other invasive plant project locations would undergo a cultural resource survey prior to treatment in order to prevent impacts to undiscovered cultural sites.

Cultural resources are key to the cultural integrity of the Park Complex and to the opportunity for enjoyment of the park. The preferred alternative would not result in impairment to cultural resources because mitigation measures would be followed to protect known cultural resource sites, and surveys would be conducted prior to treatments to detect previously undiscovered sites

Wilderness

The Stephen Mather Wilderness was established by Congress in 1988 by the Washington Park Wilderness Act. Over 642,000 acres of North Cascades National Park Service Complex was designated wilderness, including 99.95% of North Cascades National Park, 89% of Lake Chelan National Recreation Area, and 73% of Ross Lake National Recreation Area. Five thousand acres within Ross Lake NRA were designated "potential wilderness" contingent on Seattle City Light's plans to implement other hydroelectric projects.

Managers at the Park Complex use a Minimum Requirements Analysis (Appendix C) to determine if, when, and how administrative actions that might impact wilderness character can be implemented. Based on the MRA, the NPS concluded that treatment of invasive plants within wilderness is a necessary action, and therefore meets the minimum requirement for administration of the area as wilderness. Step 2 of the MRA involves an analysis of potential "tools" to accomplish invasive plant management within wilderness. Option D: Mechanical/herbicide treatments using human/stock transport and motorized equipment, reflects proposed actions in Alternative 2, and was chosen as the minimum tool.

Seven identified projects would be undertaken within designated wilderness: Stehekin Valley Cheatgrass, Stehekin Knotweed (less than one percent occurs within wilderness), Big Beaver Creek Reed Canarygrass, Ridley Lake Reed Canarygrass, Ruby Pasture, Thornton Lake Road, and Park-wide Trails. Short-term, moderate impacts to the untrammeled quality of wilderness character would occur, primarily because the Stehekin Cheatgrass project is relatively large in scope (almost 2,000 gross infested acres, a subset of which would be spot treated with herbicide). Evidence of human control or manipulation would be obvious after treatment, but temporary because as vegetation communities are restored, evidence of the project activities would disappear.

The use of a motorized water pump for the Stehekin Cheatgrass project would impact the undeveloped quality of wilderness character. This minor impact would be extremely localized and temporary, since the pump produces little noise and would only be used to fill water storage containers during project treatment.

Opportunities for solitude or a primitive and unconfined type of recreation would experience negligible impacts. The largest number of invasive plant treatments would occur under this alternative, but most would go largely un-noticed by most visitors. This impact would be mitigated by timing of treatments during shoulder seasons and/or the weekday when fewer visitors are in the backcountry.

Long-term beneficial impacts to the natural quality of wilderness character would occur under this alternative, as all infestations would be treated. These infestations would be eradicated and prevented from spreading further into wilderness, thus protecting naturalness.

Wilderness is necessary to fulfill the purposes for which the park units were established, and is key to the opportunity for enjoyment of the park units. The preferred alternative would not result in impairment to wilderness because although there would be short-term adverse impacts ranging from negligible to moderate that would occur to untrammeled, undeveloped, and opportunities for solitude or unconfined recreation, long-term beneficial impacts would occur to the natural quality.