Yosemite National Park

National Park Service
U.S. Department of the Interior

Invasive Plant Management Plan Update

Environmental Assessment
November 2010

Cover Photos:

Top
A Yosemite Valley meadow in spring; Photograph by Sue Beatty.
This photo shows what is being protected from non-native, invasive plants.

Left
Civilian Conservation Corps members hand pulling invasive non-native bull thistle (*Cirsium vulgare*) in Yosemite Valley Meadow; Photograph by Ralph H. Anderson, 1941.

Right
Controlling Himalayan blackberry (*Rubus discolor*) using herbicide in Yosemite Valley.

United States Department of the Interior

NATIONAL PARK SERVICE
Yosemite National Park
P.O. Box 577
Yosemite, California 95389

IN REPLY REFER TO:
L7617 (YOSE)

Dear Yosemite Friends:

On behalf of Yosemite National Park, I am pleased to present the *Invasive Plant Management Plan Update Environmental Assessment* (IPMP Update EA). This update builds upon the existing integrated pest management approach, and the goals and objectives approved in the *Invasive Plant Management Plan for Yosemite National Park* (NPS, 2008). The intent is to provide a more adaptive and comprehensive program that will allow managers to respond more effectively to the increasing challenges of managing invasive plants, to best protect the cultural and natural resources of the park.

This EA presents and evaluates environmental impacts of two action alternatives and a no-action alternative (Alternative 1, continue current management). Under Alternative 2, the limitations on use of herbicides would be modified to include protocol for evaluating methods and conditions for using herbicides within Wilderness and at the water's edge. Four additional herbicides (approved by the US Environmental Protection Agency, EPA) would be added for approved use within the park. Under Alternative 3 (NPS-preferred), the park would adopt an adaptive management protocol that would allow managers to evaluate new herbicides for addition to the park's toolbox, as needed, and as they become available (EPA-approved and field-tested). The protocol includes a review of current scientific literature, a decision-making tree for selecting methods and tools appropriate to the site and resource concerns, expert consultations, and public notification.

Public, tribal, and agency participation and consultation have played an important role in the development of this plan. Public scoping for the IPMP Update EA was held from April 14 to May 15, 2010. The public was invited to attend two open houses, where park staff introduced the purpose and need for updating the plan. The open houses were held at the Yosemite Valley Visitor Center Auditorium on March 31 and April 28, 2010, and included a field walk to identify issues and concerns. Park staff continued to provide information about the plan at open houses throughout the summer. Ideas generated during scoping have been incorporated into the alternatives and mitigations presented in this plan.

The publication of this IPMP Update EA commences a 45-day public comment period. We will host a public meeting on Wednesday, January 5, 2011, in El Portal at Clark Community Hall from 1-3 p.m. to present and discuss the plan. For full consideration, please submit written comments by January 30, 2011. A digital copy of the EA is available on the Planning, Environment and Public Comment (PEPC) website: http://www.parkplanning.nps.gov/YOSE. The public is encouraged to submit comments electronically, through PEPC. You may also submit written comments by mail or fax. Please note: the park no longer accepts comments via the yose_planning@nps.gov e-mail address.

Mail: Superintendent, Yosemite National Park
Attn: IPMP Update EA
P.O Box 577, Yosemite, California 95389

Fax: (209) 379-1294

The National Park Service will make a determination regarding the proposed action, to be documented in a Finding of No Significant Impact (FONSI). If approved, the park will implement the preferred alternative in spring 2011. We appreciate your interest and welcome your continued participation.

Sincerely,

Don L. Neubacher
Superintendent

Invasive Plant Management Plan Update for Yosemite National Park Environmental Assessment

Lead Agency: National Park Service

ABSTRACT

The National Park Service (NPS) is updating the *2008 Invasive Plant Management Plan (2008 Plan)* to create a more comprehensive and adaptive plan for protecting the natural and cultural resources of Yosemite National Park, California from non-native, invasive plants. Invasive plants are one of the greatest threats to the integrity of national park lands. Non-native plants invade an estimated 4,600 acres of federal land in the United States every day, and already infest millions of acres in national parks (NPS 1996). Over 200 non-native plant species are already established within Yosemite National Park, many of which have the potential for rapid spread.

This 2010 *Invasive Plant Management Plan Update Environmental Assessment* (*2010 Update*) evaluates a range of alternatives for managing invasive plants within the park. Actions common to all of the alternatives include preventing the introduction of new invasive plant species; prioritizing invasive plants for early detection and control; managing existing populations using a full range of physical, mechanical, and chemical control techniques; monitoring the efficacy of control actions; and fostering an understanding of invasive plant prevention and control through outreach and education. The management tools and methods used would comply with the service-wide Integrated Pest Management Program and would always consider the least toxic option.

Under Alternative 1, the no-action alternative, current invasive plant management practices would continue in the park. Park employees and volunteers would use an integrated pest management approach to prevent, detect, and control high and medium-high priority invasive plants (those with the highest potential to invade natural plant communities in the park) from spreading into noninfested areas. Park crews would use approved herbicides to control up to 22 invasive plant species if management objectives could not be achieved by the use of other control methods and if invasive plant populations met size and location thresholds. Even though the densities of targeted invasive plant populations would decrease, the park would not meet its management objectives for priority invasive plants.

Under Alternative 2, park employees and volunteers would continue to use an integrated pest management approach to protect park natural and cultural resources from displacement or other degradation resulting from the introduction and spread of priority invasive plants. Language in the no-action alternative that limits park resource managers' ability to protect natural and cultural resources from non-native invasive plants would change. This change would include limitations on herbicide use in Wilderness and near water. Four additional herbicides would be approved for use.

Under Alternative 3, the preferred alternative, an adaptive management protocol would be introduced to allow for effective protection of park natural and cultural resources from displacement or other degradation resulting from the introduction and spread of priority invasive plants. Herbicides would be assessed for inclusion in the park's toolbox using a decision tree, a literature review, and expert consultations. The need for application of herbicides in water for controlling aquatic invasive species would be assessed using a similar process.

CONTENTS

List of Tables

List of Figures

Appendices

EXECUTIVE SUMMARY

Purpose and Need

Invasive plants are one of the greatest threats to the integrity of NPS lands. Non-native plants invade an estimated 4,600 acres of federal land in the United States every day, and already infest millions of acres in the national parks (NPS 1996). Although Yosemite is in the early stage of invasion, over 200 non-native plant species have become established within park borders, many of which have the potential to spread rapidly. This 2010 *Invasive Plant Management Plan Update Environmental Assessment* (*2010 Update*) evaluates a range of alternatives to prevent the establishment and spread of invasive plants into non-infested areas of the park, and to quickly and effectively eradicate new infestations.

Legislative and Planning Context

The *2010 Update* must conform to federal laws, regulations, and policy guidance, including federal herbicide use regulations. In 1999, President Bill Clinton signed Executive Order 13112 to prevent the introduction and spread of invasive species. This federal directive provides guidance for the management of invasive species on federal land. The National Park Service Organic Act of 1916 is the legal foundation of NPS regulation and policy. The NPS *Management Policies* (NPS 2006b) are the primary policy documents of the NPS. The policies state, "Exotic species will not be allowed to displace native species if displacement can be prevented . . . In general, new exotic species will not be introduced into parks."

Legislation and policy specific to Yosemite National Park include the enabling legislation for Yosemite National Park, the California Wilderness Act of 1984, the *General Management Plan for Yosemite* (NPS 1980), the "Merced Wild and Scenic River Comprehensive Management Plan" (currently in development), and the "Tuolumne Wild and Scenic River Comprehensive Management Plan." The *General Management Plan* provides overall management direction for Yosemite National Park. The *2010 Update* tiers off of the *General Management Plan.* The action alternatives in the *2010 Update* are consistent with parkwide and NPS-wide legislation and policy, and reflect the categories identified in the national planning documents.

Overview of the Alternatives

This update to the *2008 Invasive Plant Management Plan Environmental Assessment* (*2008 Plan*) proposes and evaluates one no-action alternative and two action alternatives for a comprehensive invasive plant management (IPM) program in Yosemite. The Finding of No Significant Impact (FONSI) was signed in September of 2008. Each alternative includes an integrated pest management component that focuses on prevention, early detection and rapid response, control, education, research, and restoration actions to prevent the establishment and spread of non-native invasive species.

Under Alternative 1, the no-action alternative, current invasive plant management practices would continue in the park. Park employees and volunteers would use an integrated pest management approach to detect, control, and prevent high and medium-high priority invasive plants (those with the highest potential to invade natural communities in the park) from spreading into non-infested areas. Park crews would use on of the approved herbicides to control up to 22 invasive plant species if management objectives could not be achieved by the use of other control methods and if invasive plant populations met size and location thresholds. The extent of the land area in Yosemite treated for invasive plants would remain approximately the same over time.

Under Alternative 2, park employees and volunteers would continue to use an integrated pest management approach to protect park natural and cultural resources from displacement or other

degradation resulting from the introduction and spread of invasive plants. Language in the no-action alternative that restricts park resource managers' ability to protect natural and cultural resources from non-native invasive plants would be changed. This change would include removing limitations on herbicide use in designated Wilderness, near water, and in cultural use areas. Four additional herbicides are proposed for use.

Under Alternative 3, the preferred alternative, an adaptive management protocol would be introduced to allow for effective protection of park natural and cultural resources from displacement or other degradation resulting from the introduction and spread of priority invasive plants. Herbicides would be assessed for inclusion in the park's toolbox using a decision tree, a literature review, and expert consultations. The need for application of herbicides in water for controlling aquatic invasive species would be assessed using a similar process.

Environmental Analysis

Chapter III of this document discusses the affected environment and the environmental consequences of the *2010 Update*. The "Affected Environment" section in Chapter III describes the existing conditions of the areas affected by the alternatives described in Chapter II. The "Environmental Consequences" section in Chapter III analyzes the environmental effects associated with each of the alternatives. Table III-1 compares the environmental consequences for each alternative.

Environmentally Preferable Alternative

The NPS is required to identify the environmentally preferable alternative in the environmental documents it produces for public review and comment. The NPS, in accordance with the National Environmental Policy Act (NEPA) Section 101(b) (516 DM 4.10), defines the environmentally preferred alternative as the alternative that best promotes the national environmental policy. The Council on Environmental Quality's *Forty Questions* further defines the environmentally preferred alternative as "the alternative that causes the least damage to the biological and physical environment. . . [and that] best protects, preserves, and enhances historic, cultural, and native processes." Upon full consideration of Section 101 of NEPA, Alternative 3 represents the environmentally preferable alternative for the *2010 Update*. The analysis that supports this conclusion is presented in Chapter III.

Consultation and Coordination

A formal public scoping period was held for the *2010 Update* from April 14 through May 15, 2010. The park invited interested parties to attend two public meetings (open houses) and an interpretive site visit during the public scoping period. Resource management staff were available at the open houses to introduce the project, answer questions, and accept comments.

During the 30-day comment period, 5 public comment letters were received. These comments were analyzed to identify substantive concerns, and each distinct comment was summarized in a public scoping report. These comments were considered by the project team during development of alternatives for the *2010 Update*. In order to include a wider range of comments, the planning team revisited comments received on the *2008 Plan*, published in the 2008 Finding of No Significant Impact (FONSI) and available on the Planning Environment and Public Comment (PEPC) database, for relevancy and applicability to the new environmental assessment.

The public outreach called for in Section 106 of the National Historic Preservation Act (NHPA) was integrated with the NEPA scoping process, in accordance with a programmatic agreement between the National Park Service at Yosemite, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation.

I PURPOSE AND NEED

Introduction

Over sixty years ago, George Wright, an early advocate of science in the NPS, wrote, "The realization is coming that perhaps our greatest national heritage is nature itself, with all its complexity and its abundance of life, which, when combined with great scenic beauty as it is in the national parks, becomes of unlimited value." Non-native invasive plants are of great concern for natural resource managers across the globe because they threaten our natural heritage. These invaders can, often over the span of just years or decades, displace rich and complex native plant communities that have developed over thousands of years, resulting in simplified, invasive species-dominated communities that contain only scattered native plants (D'Antonio, Berlow, and Haubensak 2004).

Yosemite National Park, located in the central Sierra Nevada Mountains of California, is famous for its towering granite peaks and cliffs, waterfalls, wild and scenic rivers, giant sequoia groves, and vast wilderness. Yosemite is also recognized for its stunning biodiversity, which is a reflection of the park's range of elevations, climates, and habitats, as well as its untrammeled nature; the park contains one of the largest and least fragmented blocks of natural habitat in the Sierra Nevada. In recognition of the significance of its unique and spectacular geological and ecological features, the park was designated a World Heritage Site in 1984.

The park's 761,266 acres of foothill chaparral, woodlands, montane, subalpine and alpine meadows, and streams account for less than 1% of California's area. It includes 704,368 acres of designated Wilderness and 927 acres of potentially designated Wilderness; 2,908 acres of reservoirs (Eleanor and Hetch Hetchy); and 39,482 acres of non-Wilderness. Nearly 23% of the plant species in the state are represented in the park, including over 160 rare plants. Over 400 vertebrate species, including Pacific tree frogs, ground squirrels, acorn woodpeckers, and black bears can be found in the park. Some, such as willow and dusky flycatchers, yellow warbler, and Sierra Nevada yellow-legged frogs, are increasingly rare.

The threat to natural and cultural resources posed by non-native invasive plants has long been recognized in Yosemite National Park. Active control has been ongoing at least since the 1930s. Since 2005, park staff have worked to manage over 40 non-native plant species (NPS 2007), with over half of invasive plant management staff hours dedicated to the control of yellow star-thistle, Himalayan blackberry, and spotted knapweed (*Centaurea maculosa*).

Scope of the Environmental Assessment

This environmental assessment has been prepared to satisfy the requirements of the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190, 42 US C. 4321-4347, as amended), including Council on Environmental Quality regulations (40 CFR 1500 -1508), NPS *Management Policies* (2006b), and management directives. This environmental assessment facilitates compliance with Section 106 of the National Historic Preservation Act, Section 7 of the Endangered Species Act, the Wilderness Act, the Clean Water Act, and the Clean Air Act, as well as other applicable laws enacted for

the protection of the environment (see the "Legislative and Planning Context" section at the end of this chapter).

NEPA requires the documentation and evaluation of potential impacts resulting from federal actions on lands under federal jurisdiction. Federal actions may include projects financed, assisted, conducted, regulated, or approved by a federal agency. An environmental assessment discloses the potential environmental consequences of implementing the proposed action and other reasonable and feasible alternatives. NEPA is intended to provide decision makers with sound knowledge of the environmental consequences of the alternatives available to them. In this case, the superintendent of Yosemite National Park and the Pacific West Regional Director of the NPS are faced with decisions regarding how to manage non-native invasive plants within the park and its administrative areas.

An interdisciplinary team comprised of Yosemite staff, including natural and cultural resources specialists, determined the purpose and need for the project. Staff then assessed the likely beneficial and adverse effects of the proposed actions upon existing conditions for park resources.

Purpose

The purpose of the *2010 Update* is to provide a comprehensive and an adaptive framework that guides a program for protecting the park's natural and cultural resources from the impacts of non-native invasive plants. In Executive Order 13112, an invasive species is defined as *"non-native (or alien) to the ecosystem under consideration"* and *"likely to cause economic or environmental harm or harm to human health."* Invasive plants continue to spread into non-infested areas, making it increasingly difficult for the park to achieve its overarching goal of protecting natural and cultural resources. Although the *2008 Plan* provides the park with control options for treatment of invasive plants, it is not flexible enough to afford the park with the needed array of programmatic, adaptive management control methods and tools to eradicate or sufficiently limit the spread of invasive plants within the park.

The intent of the *2010 Update* is not to change or replace the main purpose or goals of the existing plan, but rather to build upon the plan and provide a more adaptive framework for responding to the challenges of managing invasive plants. An additional goal is to establish guidelines for the use of various management techniques and tools, including a framework for assessing the efficacy of additional herbicides while maintaining safety standards for workers and the environment. Specific deficits in the *2008 Plan* are addressed, such as minimum patch size and density limits on herbicide use, which limit the park's ability to eradicate new invasive plant populations while they are still of a manageable size. Limitations on methods used for managing invasive species, such as a 10-foot buffer near water, are addressed. The *2010 Update* assesses a no-action alternative (the existing *2008 Plan*), and two action alternatives for their effectiveness in managing non-native invasive plants and protecting these resources. Like the *2008 Plan*, this environmental assessment outlines programmatic invasive plant management decision-making and prioritization strategies. Both continue invasive plant management efforts that began in the 1930s with the Civilian Conservation Corps.

Need

The main impetus for updating the *2008 Plan* arose from the 2009 Big Meadow Fire, when park managers realized they did not have the flexibility to use the most effective tools available to combat the spread of cheatgrass (*Bromus tectorum*). A "transformer species," cheatgrass often forms monotypic stands, thus greatly altering native species' cover and richness, resource availability, trophic structure, and ecosystem productivity (Richardson, Pyšek, Rejmánek, et al. 2000). Disturbance regimes, including fire frequency and intensity, are also affected. Cheatgrass is still expanding its range into meadows and

grasslands in the Sierra Nevada, and has been documented at elevations above 9000 feet (D'Antonio et al. 2004). Following the fire, the Burned Area Emergency Rehabilitation Team recommended applying rimsulfuron, a preemergent herbicide, to prevent cheatgrass seeds from sprouting and overtaking Big Meadow. However, because the suggested herbicide was not evaluated and approved for use in the *2008 Plan*, the park was unable to use this tool. The inability to treat cheatgrass effectively is just one of the many invasive plant management challenges faced by the park.

With this *2010 Update*, as more effective herbicides are developed, tested, and approved for use on public lands in the western states, adaptive management protocols would allow the park to select herbicides that have greater efficacy and/or fewer undesirable effects than those currently used. Park staff would work cooperatively with university researchers and other experts to find the safest, most efficient, and most effective tools to protect Yosemite's biodiversity. The effectiveness of integrated pest management treatment actions would be monitored.

As was stated by Frank Eggler, a respected mid-20th century plant ecologist, "Ecosystems aren't only more complex than we know; they are more complex than we can know." The landscapes surrounding Yosemite National Park are now drastically altered from their natural condition. Agriculture, development, and non-native plants have displaced the once spectacular wildflower displays of the Central Valley west of the park, and non-native annual grasses have replaced the diverse shrub steppe of the Great Basin east of the Sierra Nevada. When considered in the context of the scale of the lands managed by the NPS and concurrent challenges such as wildfires, threatened and endangered species, and record levels of visitor use, as well as the very real limits to personnel and agency resources, no single plan can foresee all outcomes. Native species displacement, changes in nutrient cycling, and other invasive species impacts add multiple layers to this complexity. The resulting uncertainty and complexity point to the need for resource managers to have an adequate and adaptive *toolbox* of policies and techniques that allows resource managers to better respond and adapt to changing resource conditions, threats, and scientific advancements.

Yosemite National Park is not immune from invasion by non-native plants, and non-native species continue to invade the park at an alarming rate. Over 200 (13%) of the over 1,600 plant species found in the park are non-native (personal communication, Alison Colwell, botanist, Yosemite National Park, 2010). About 10 new non-native species are found every year (personal communication, Martin Hutten, Invasive Plant Management Program manager, Yosemite National Park 2010). Himalayan blackberry, velvet grass (*Holcus lanatus*), and other invasive plants dominate many low- and middle-elevation meadows, wetlands, and riparian zones. Non-native species such as cheatgrass and wild oat (*Avena* sp.) dominate the herbaceous understory of the foothill grasslands, chaparral, and woodlands along the park's western boundary. Species such as Canada thistle (*Cirsium arvense*), which have displaced native plants in other natural areas, can be found near the park boundary.

The introduction and spread of invasive species into Yosemite National Park is dynamic, as is our understanding of ecology and invasive plant management. The number of existing invasive species in the park is growing, as is their distribution and cover. This is occurring despite the best efforts of the park. As a result, the species-specific management objectives, and the tools and methods used to meet these objectives, must evolve over time. The harm that invasive species cause to Yosemite's natural and cultural resources will intensify over time if the efforts to prevent their introduction and contain their spread are insufficient. Invasive plant seeds enter Yosemite National Park as unintended hitchhikers on vehicles, carried by the wind, or as contaminants in gravel and other construction materials. They are also brought in intentionally, through the planting of ornamentals, for example. Wind, wildlife, hikers, and pack stock can then facilitate the spread of invasive plants down rivers and along the park's 800 miles of trails. Aggressive invasive plants such as cheatgrass and yellow star-thistle (*Centaurea solstitialis*) are capable of spreading rapidly, out-competing native plants and drastically altering ecosystem conditions and processes, even in pristine wilderness areas. Once they have become

established, eradicating these species is expensive and difficult—and sometimes impossible. A primary reason for this difficulty is that invasive plant propagules are continually being introduced from outside of the park. Even if all populations of a species are eradicated from Yosemite, the best that can be achieved is to move the species from the list of invasive plants that are actively managed, to the watch list of plants for early detection and eradication.

While the number and cover of invasive species typically declines with increasing elevation (Randall, Rejmanek, and Hunter 1998), land managers of high elevation habitats, such as Yosemite's Tuolumne Meadows, cannot be complacent about the threat posed by invasive plants. Recent studies from Rocky Mountain, Yellowstone, and other parks show that many non-native species can grow in high elevation environments (Pauchard, Kueffer, Dietz, et al. 2009; D'Antonio et al. 2004). Factors that limit plant growth at high elevation are changing. Scientific models suggest that global climate change and increased anthropogenic atmospheric concentrations of nitrogen and carbon will allow invasive species to expand their range upwards and/or into areas where they were previously excluded by low-nutrient soils (Pauchard et al. 2009).

The mandate for conserving Yosemite's precious resources was established in the founding documentation of both the park and the NPS. In 1864, President Abraham Lincoln signed an Act of Congress that ceded Yosemite Valley and the Mariposa Grove of Giant Sequoias to the state of California "*upon the express conditions that the premises shall be held for public use, resort, and recreation; shall be inalienable for all time.*" The 1916 Organic Act directs the NPS to "*conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations*" (16 USC 1). Other legislation and policy relevant to managing invasive species in the park are listed below in the "Legislation and Planning Context" section.

The NPS recognizes invasive species as one of the greatest threats to the ecological integrity of the lands it manages (NPS 2004). The spread of invasive species is recognized as a major factor contributing to ecosystem change and instability on a global scale, with many scientists considering the displacement of native species by exotic plant species to be the single greatest threat, after development, to biodiversity (Lovich, Egan, and DeGouvenion 1994). Frederick Law Olmstead wrote of the danger of losing many of the species of plants now flourishing in Yosemite in his 1865 preliminary report to the California legislature on Yosemite and the Mariposa Grove. Even then, he reported, "*Numbers of the native plants of large districts of the Atlantic States have almost wholly disappeared and. . . most of the common weeds of the farms are of foreign origin, having choked out the native vegetation*" (Olmstead 1865).

Integrated Pest Management

The park implements a comprehensive program that includes best management practices (Appendix D) and adaptive management protocols to ensure protection of park resources, using the best available science and tools, in the safest, most efficient, and most effective manner possible. Integrated pest management is a decision-making process that ensures the most effective techniques (cultural, physical, biological, or chemical) are used to protect resources, while having the least possible impact on people and the environment (NPS 2010). Elements include prevention, inventory, prioritization, treatment, monitoring, research, and education and outreach. Cultural techniques include changing land management practices to promote native species diversity. For example, prescribed fire can be used to maintain the overall natural diversity and functioning of an ecosystem, and potentially to exploit vulnerabilities in the life cycles of invasive plants. Two or more methods can also be combined to produce more synergistic results (such as burning before herbicide treatment to remove excess biomass or thatch). At a higher level, integrated pest management protocols bring together invasive plant management techniques with land management activities.

Management Goals and Objectives

The overriding goal of the *2010 Update* is to provide an integrated, comprehensive, and adaptive framework for protecting the park's natural and cultural resources from the impacts of non-native invasive plants. The management goals in this plan are based on those identified in national invasive species guidance, including the *National Invasive Species Management Plan* (NISC 2001), as well as on the goals previously laid out in the *2008 Plan*. Each goal has a set of related management objectives, which are statements of purpose that describe what must be accomplished for the plan to be considered a success in Yosemite National Park. Goals carried over from the previous plan include prevention and early detection, prioritization and control, outreach and education, monitoring and research, and ecological restoration. The lifespan of the *2010 Update* is anticipated to be 10-15 years.

Adaptive management, an integral part of the *2010 Update*, is a process that allows for decision making in spite of uncertainty, with an aim to reduce uncertainty over time via system monitoring. This process allows resource objectives to be met while information is gathered and lessons are learned, in hopes of continually improving future management (Holling 1978).

Specific goals and management objectives relating to each component of the plan include the six goals delineated below.

Goal 1 - Inventory: Initiate a comprehensive and systematic invasive plant inventory to establish a baseline from which to measure progress.

Management Objectives:

- Document the abundance and distribution of invasive plants in the park.
- Provide a foundation for prioritization of threats and for carrying out management planning efforts.
- Provide a foundation for the development of short- and long-term programmatic plans.

Goal 2 - Prioritization: Assess the degree to which individual invasive species or invasive species populations affect natural systems to focus management actions on those that pose the greatest threat to park resources.

Management Objectives:

- Attend invasive plant management conferences and consult periodically with regional experts; review scientific literature and state noxious weed lists to increase understanding of the invasive species that could threaten park resources.
- Identify and prioritize invasive species for control considering the level of threat to park resources, the size and extent of species infestations, and the likelihood of control.
- Periodically review species priority rankings and update watch list.
- Establish feasible invasive plant control objectives.

Goal 3 - Prevention and Early Detection: Use an integrated and strategic approach that emphasizes preventing the introduction of invasive species and the early detection and treatment of newly established populations in order to protect natural and cultural resources.

Management Objectives:

- Prevent and monitor actions that can bring new seed or reproductive material into the park (e.g., ground-disturbing construction, the import of road maintenance materials, contractor and concessionaire activities).

- Conduct periodic and systematic surveys for new populations of invasive plants, and respond quickly to eradicate incipient populations before control treatments become difficult and costly.
- Minimize conditions that favor invasive plant establishment and spread.
- Incorporate best management practice prevention measures associated with park operations that pose a risk of new infestations of invasive plants.

Goal 4 - Treatment: Treat invasive plant populations that pose the greatest threat to park resources.

Management Objectives:

- Respond adaptively to new invasive species, available tools, and resource management in order to achieve the best outcome based on current knowledge, gain knowledge, and improve future management.
- Use integrated pest management tools to find the most effective and appropriate tool, or combination of tools, to eradicate or reduce the impact of invasive plants.
- Provide training and implement safety protocols to reduce risks to staff.
- Minimize secondary impacts from control efforts.
- Establish protocols for assessing the need for, as well as the safety and efficacy of, new herbicides for potential use in the park.
- Reduce the impact of invasive plants on sites of cultural, scenic, and high ecological value, including habitat for federal and state threatened and endangered species, candidate species, and species of concern; Wild and Scenic River corridors; sites of special importance to American Indians; and iconic viewsheds.
- Restore ecosystems and key ecological processes that have been affected by invasive species to meet desired future conditions.
- Integrate ecological restoration practices in invasive plant control treatments to guard against reinfestations.

Goal 5 - Monitoring: Ensure that the invasive plant program is regularly monitored and improved, environmentally safe, and supported by science and research.

Management Objectives:

- Monitor and evaluate the overall program effectiveness in order to inform management regarding whether the program is of sufficient scope to meet program goals.
- Monitor and evaluate the effectiveness of control techniques by species and adapt as necessary, based on results.
- Monitor effects on native plant communities and, based on results, adapt control techniques.
- Identify vectors of spread to determine ways of preventing new species and populations from becoming established in the park.
- Promote research in the park upon which to base future management decisions.

Goal 6 - Education, Outreach, and Research: Educate, inform, consult, and collaborate with associated American Indian tribes and groups, park employees, concessioners, visitors, park partners,

private property holders, and gateway communities to share information and address invasive plant issues.

Management Objectives:

- Continue developing partnerships with the American Indian community to encourage its participation in the management of traditional gathering areas.
- Expand collaborative efforts among park neighbors, park partners, gateway communities, and the public to share methods of preventing and controlling the spread of invasive plants.
- Ensure that interested parties are well-informed about the timing and locations of upcoming invasive plant control treatments.
- Educate and inform park visitors on invasive plant issues.
- Provide stewardship opportunities for the public.
- Continue to support and develop invasive plant research.

Public Participation and Scoping

Public scoping plays an important role in the park planning process. Scoping assists the park in identifying issues and concerns to be considered in developing a range of alternatives, and fulfills public participation requirements under NEPA and Director's Order 12. In February of 2010, Yosemite park staff initiated internal scoping through a series of meetings and the development of an interdisciplinary team composed of NPS resource specialists. Consultation regarding the *2010 Update* was also initiated with American Indian tribes and groups in March of 2010. On March 31 and April 28, the park held public open houses to discuss the purpose and need for an update, listen to ideas and concerns, and answer questions. The April 28 open house included a field visit to view firsthand some of the continuing challenges of protecting park natural and cultural resources from invasive species. Public scoping was held from April 14 to May 15, 2010. Public concerns raised during this period are summarized in Table I-1.

The park received five formal comment letters during the public scoping period. The planning team also reviewed public comments received on the *2008 Invasive Plant Management Plan EA*, as many were still relevant (Table l-1), and comments received at open houses and site visits throughout the year-long planning effort. These comments and ideas from public scoping were taken into consideration in the development of the alternatives.

Legislative and Planning Context

Impairment of National Park Resources

An analysis of potential effects to determine environmental consequences of implementing the preferred and other alternatives, and to determine whether proposed actions would impair a park's resources and values is required under section 1.4 of *NPS Management Policies* (2006b). The stated purpose of the national park system, as established by the Organic Act and reaffirmed by the General Authorities Act and associated amendments, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, these laws also give the NPS the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that the NPS must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

Table I-1. Public Scoping Concern Statements (From *2008 Plan* and *2010 Update*)

Public Scoping Concern Statements Regarding Planning Process and Policy
• The park should consider whether the impacts of this plan are so great as to require an environmental impact statement. • The park should make the *2010 Update* an interim plan until a Merced River Plan is approved. • Prepare the *2010 Update* in collaboration with citizen organizations and agencies with knowledge and experience in controlling invasive species. • Post all public comments on the *2010 Update* to the Yosemite Planning Web page and make it easy to find (www.National Park Service.gov/yose/parkmgmt/invasive_docs.html). • The park should incorporate a process for continuing public involvement in the plan. • Directly involve Native American tribes with cultural ties to Yosemite National Park in invasive plant management. • Consult with Native American elders regarding preserving plants used for making baskets, medicines, and food. • Ensure that the planning process is clear and includes public participation. • Develop management options through coordination with other divisions in the park. • Include proposals for participation in prescribed fire planning. • Require a public review and comment period for each proposed herbicide or biological control method. • Develop a process to approve or reject the use of herbicides. • The park should devise a plan that establishes parameters, but is not so restrictive as to be counterproductive.
Public Concern Statements Regarding Methods and Techniques
• The park should not use or limit the use of herbicides. • The park should employ all reasonable, available, and promising technologies and herbicides to protect the park's ecosystems from invasive species. • The park should use goats to control invasive species. • The NPS should combine mechanical removal techniques with judicious hand application of time-tested and carefully selected new herbicidal agents that will be the most effective method of controlling the many noxious invasive plants invading and destroying the natural ecosystems in Yosemite National Park. • The NPS should place special restrictions on new herbicides because of their lesser track record. • Carefully examine the criteria for determining which plants are considered "non-native" and "undesirable." • Examine each proposed invasive plant treatment, and evaluate and weigh its positive and negative impacts. • Employ invasive plant control techniques and strategies based on knowledge of the disturbance regime of each ecosystem. • Ensure that methods used are based on the results of scientific research. • Yosemite National Park should review all new herbicides under consideration for use for efficacy, impacts to non-target plant and animal species, persistence, mobility, human toxicity, and other adverse environmental factors. • Examine the relationship between park development activities and the invasion of non-native plants. • Evaluate the need to use volunteers for invasive plant monitoring and control treatments. • Evaluate the costs and chance for success of the varied invasive plant treatment methods. • Call for the removal of the non-native invasive black locust tree from the park. • Consider all available invasive plant treatment options, except herbicides. • Articulate prioritization strategies. Control invasive plants but allow natural processes to prevail.

Public Concern Statements Regarding Potential Impacts or Environmental Effects
• Evaluate the potential for proposed actions to cause significant impact to designated Wilderness and Wild and Scenic River corridors. • Protect Wilderness areas. • Prescribe buffers for streams in the Tuolumne River watershed when herbicides are used. • Evaluate the secondary, unintended consequences of herbicide use on surrounding ecosystem, water quality, human health, and non-target species such as amphibians, invertebrates, and other species. • Do not propose the massive, indiscriminate use of herbicides. • Evaluate the potential unintended consequences of introducing non-native biological control agents into the park before considering them an invasive plant treatment option. • Evaluate the effects of using fire for invasive plant treatment on the park and on regional air quality. • Do not use clopyralid or triclopyr on vegetation that may be burned.
Public Concern Statements Regarding the Scope of the Plan
• Analyze the threat of invasive plants from outside park boundaries. • Address the effects of proposed actions on the park soils. • Consider restoring plant species that have been lost. • Include information about the invasion of exotic plants following road projects. • Do not propose removal of non-native plants that are not invasive. • Evaluate whether native trees should in some instances be controlled.

A prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that otherwise would be present for the enjoyment of those resources or values (NPS 2006b). Whether an impact meets this definition depends on the particular resources that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation 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.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further minimized. Impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park. Impairment findings are not necessary for visitor experience, socioeconomics, public health and safety, environmental justice, land use, park operations, and so on, because impairment findings relate back to park resources and values. Determinations of impairment for each of the three alternatives and thirteen resource topics considered in this plan are discussed in Chapter III.

Invasive Plant Policy

The *National Park Service Management Policies* (NPS 2006b) is the primary policy document of the NPS. It contains text relevant to the control of non-native plant species, including these statements: "Exotic species will not be allowed to displace native species if displacement can be prevented" and "In general, new exotic species will not be introduced into parks." In 1999, President Bill Clinton signed Executive Order 13112 to prevent the introduction and spread of invasive species. This federal directive provides overarching guidance for the management of invasive species, and emphasizes seven categories: leadership and coordination, prevention, early detection and rapid response, control, education, research, and restoration. Executive Order 13112 established the National Invasive Species Council to provide national leadership and ensure that "federal agency activities concerning invasive species are coordinated, complementary, cost-efficient, and effective." Executive Order 13112 also called for the preparation of the *National Invasive Species Management Plan* (NISC 2001). The updated *2008-2012 National Invasive Species Management Plan* was distributed for public comment from December 28, 2007 through February 11, 2008 (NISC 2008). The *2008 Plan* and this *2010 Update* follow guidance provided by the National Park Service Director's Order 77-7: *Integrated Pest Management.*

The Plant Protection Act (2000), which consolidated authorities in the Plant Quarantine Act, Federal Plant Pest Act, Federal Noxious Weed Act, and other plant-related statutes, authorizes the United States Department of Agriculture (USDA) to prohibit or restrict the importation or interstate movement of any plant, plant product, biological control organism, or plant pest. As required under the Federal Insecticide, Fungicide, and Rodenticide Act of 1978, and also Department of Interior policy, "*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, 7 U.S.C. 136r-1, Department of Interior Manual, Sec.517). One section, Section 15, of the Federal Noxious weed act of 1974 (PL 93-629) was not superseded by the Plant Protection Act of 2000. This section directs the management of undesirable plants on federal lands. The Carson-Foley Act of 1968 directs the heads of federal agencies to allow state officials to enter public lands to control noxious plants. Legislation and policy specific to Yosemite National Park include the enabling legislation for Yosemite National Park, the California Wilderness Act of 1984, and the *General Management Plan* (1980) for Yosemite, which provides overall management direction for Yosemite National Park. The *2010 Update* meets the *1980 General Management Plan* management objectives for resource management (NPS 1980). These objectives are listed below.

- Restore and maintain natural terrestrial, aquatic, and atmospheric ecosystems so they may operate essentially unimpaired.
- Conduct continuing research analysis to attain information necessary for managing natural resources.
- Restore altered ecosystems as nearly as possible to conditions they would be in today had natural ecological processes not been disturbed.
- Protect threatened and endangered plant and animal species, and reintroduce, where practical, those species eliminated from the natural ecosystems.
- Identify and perpetuate natural processes in park ecosystems.
- Limit unnatural sources of air, noise, visual, and water pollution to the greatest degree possible.
- Support an integrated system of compatible regional land uses providing opportunities for recreation, community development, preservation, and economic utilization of resources.

- Participate with government agencies and private interests in planning for compatible management and use of scenic, natural, cultural, and recreation resources.

Yosemite National Park's Resources Management Plan (NPS 1999) directs specific activities for the management of natural and cultural resources throughout the park. In 2000, the *Natural Resource Challenge Exotic Action Plan* created a funding roadmap to improve the NPS's response to harmful plant species. In 2006, the NPS finalized the *Invasive Species Action Plan*, building on the *Natural Resource Challenge Exotic Action Plan*, further addressing the categories required under Executive Order 13112 and the *National Invasive Species Management Plan*. The action alternatives in this plan are consistent with parkwide and servicewide legislation and policy.

Federal Herbicide Regulations

Federal agencies are required by law to "use Integrated Pest Management techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies" (7 U.S.C. §136r-1). The park must abide by federal regulations for herbicide use. Applicable legislation includes the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §136 et seq.) and the Occupational Safety and Health Administration's (OSHA's) Hazard Communication Standard (15 U.S.C. 2601 et seq.). Under the Federal Insecticide, Fungicide, and Rodenticide Act, the U.S. Environmental Protection Agency (EPA) must evaluate herbicides for potential adverse effects on the environment. Herbicides must be tested for safety and registered with the Office of Pesticide Programs. Under OSHA standards, employers must provide workers with training, protective equipment, and information about hazardous substances. In addition, NPS *Management Policies* (NPS 2006b) requires that all park service pesticide application be supervised by individuals licensed under the procedures of a federal or state certification system.

II ALTERNATIVES

This chapter describes three alternatives for managing non-native invasive plants in Yosemite National Park. Alternative 1, the no-action alternative, maintains current management as approved in the *2008 Invasive Plant Management Plan* (*2008 Plan*). Comments received from the public during scoping and public review of both the *2008 Plan* and the *2010 Update* were taken into consideration in the development of two action alternatives that are reasonable and feasible, and meet the purpose and need of the Invasive Plant Management Program. The alternatives were developed through a collaborative, interdisciplinary process that included input and reviews by technical experts, including park staff, other agencies, and academic researchers, as well as consultation with American Indian tribes and groups.

This chapter is organized as follows:

- Description of the Alternatives
- Actions Common to All Alternatives
- Alternative 1 - No-action; maintain current management
- Alternative 2 - Correct minor deficiencies of existing plan; add four new herbicides
- Alternative 3 - Adaptive management, including protocol for adding new herbicides
- Alternatives Considered but Dismissed
- Environmentally Preferred Alternative

Description of the Alternatives

Under **Alternative 1** (no-action/continue current management), the park would continue to work to meet management objectives based on prioritization, early detection, and eradication. High and medium-high priority species are those that pose the greatest threat to natural communities in the park, and have the highest feasibility for control. Proximity to water, cultural resources, and species of concern will also be considered in choosing a control method. When management objectives for priority species cannot be achieved with the use of physical or mechanical control methods, and when invasive plant populations meet size and location thresholds, park crews may use the herbicides glyphosate and aminopyralid to control up to 22 invasive plant species out of the over 200 non-native plants in the park.

Under **Alternative 2**, invasive plant size and area thresholds would no longer be used to determine what control method could be used. Rather, the most effective method would be chosen for managing a particular priority species. Herbicide treatment using aquatic formulations would be allowed within ten feet of standing or moving water. Restrictions on herbicide use in designated Wilderness would be removed. This alternative expands the number of Environmental Protection Agency-approved and tested herbicides available and provides a protocol for selecting the appropriate tool.

Under **Alternative 3** (preferred alternative), the program would emphasize applying adaptive management techniques, including establishing a protocol for selecting and evaluating new Environmental Protection Agency-approved and field-tested herbicides to add the latest and best

available science and technology to the invasive plant management toolbox. Results of monitoring would be used to inform, refine, and improve methods. An annual report that would identify any new adaptations or techniques to be implemented in the next season would be published online.

The following table (Table II-1) provides a summary comparison of the alternatives. The goal across all alternatives is to protect Yosemite National Park's natural and cultural resources from the establishment and spread of invasive species, now and in the future.

Table II-1: Alternatives Comparison

Common to All Alternatives	**Alternative 1—No-action (Continue 2008 Plan)**	**Alternative 2 (Add Additional Herbicides)**	**Alternative 3 (Utilize Adaptive Management)**
• Integrated pest management incorporates inventory, prioritization, prevention, treatment monitoring, and outreach and education • The online annual work plan identifies next season's treatment methods, tools, times, and areas • The minimum tool will be used in designated Wilderness • Only herbicides approved by the U.S. and California environmental protection agencies and the NPS will be used • Herbicides will be used according to federal label guidelines • Ongoing consultations with associated tribes will be conducted to protect cultural resources and cultural use plants, and to keep the tribes informed about invasive plant management	• *2008 Plan* guides current Invasive Plant Management Program • Glyphosate and aminopyralid are used to control priority invasive plants when this cannot be achieved by other methods, and when invasive populations meet size and density thresholds • Plan limitations: -Herbicides would not be used in traditional gathering areas -Herbicide use would be limited to 2 species in Wilderness and 22 in front country. -10' water setback -No herbicides in beds and banks of Wild and Scenic Rivers -100' spray buffer from blue elderberry to protect federally threatened elderberry longhorn beetle	• Address limitations in *2008 Plan* -Treatment in tribal gathering areas may include herbicides following consultation with tribes -Herbicide treatment allowed within 10 feet of waterline using aquatic formulations -No individual patch size and density limitations placed on herbicide use -10' buffer from drip line for blue elderberry -Use minimum tool in wilderness; no additional restrictions in wilderness • Add four new herbicides; rimsulfuron, triclopyr, chlorsulfuron, and imazapyr -Selected to manage broadest spectrum of invasive species already in or expected to enter park -Appropriate for use in wildlands -Recommended by toxicologists, university invasive species researchers, federal, state and conservation land managers - Impact analysis conducted on these herbicides	• Address limitations in *2008 Plan* (see Alternative 2) • Add four new herbicides • Includes adaptive protocol for evaluating new herbicides for use in park - Adaptive management would enable park to respond rapidly to new challenges and to apply new tools and methods - Periodic review of program to inform park management about effectiveness in protecting park resources from invasive plants • Protocol for evaluating new herbicides for addition to park's management toolbox • Protocol for considering the use of aquatic herbicides in water for extreme invasions such as hydrilla (*Hydrilla verticillata*)

Actions Common to All Alternatives

Development of the park's Invasive Plant Management Program has been guided by park policies and principles of integrated pest management, principles that have evolved and gained wide acceptance in the past 50 years. By law, federal agencies are required to use an IPM approach (Integrated Pest Management 7USC136r-1). The law applies to all activities involving planning, procurement, prevention, design, detection, control, and management of native and non-native pest species on Department of the Interior lands and properties. Integrated pest management is defined in Chapter 1; it includes inventory, prioritization, prevention, treatment, and monitoring. Research, along with education and outreach, is also discussed. Descriptions of the various alternatives are organized around these facets of integrated pest management.

Inventory

Comprehensive, systematic non-native invasive plant inventories inform resource managers about what species are present, as well as their location and extent. Inventories also provide essential baseline data by which the success of prioritization, monitoring, and control actions, especially actions that are adaptive, can be initiated and assessed. Not all invasive plants are equally problematic. Because it is not practical to inventory each of the 761,266 acres within Yosemite National Park, the inventory should be stratified to focus on areas most likely to be invaded, while including enough sampling within other areas to be valid. All survey efforts should be tracked even where no target species are present because understanding where invasive species do not occur can help test assumptions about areas and habitats that are more likely to be invaded and that are more likely remain free of invasive plants. Identifying pathways for invasive species entry and spread can help managers make informed management decisions regarding park operations and treatment methods. Maintaining an invasive species inventory is an ongoing process.

Goals include the following:

- Pending funding, initiate a comprehensive, strategic and systematic invasive plant inventory system from which to establish a baseline to guide and measure management progress.
- Organize existing location data into a single GIS easily accessible to resource managers.
- Use the inventory data as basis to develop short- and long-term programmatic plans.

Prioritization

Individual invasive species are strategically prioritized for control because it is not feasible to control all non-native species infestations and because project funding is limited and varies from year to year. Many of the more than 200 invasive plants found to date in Yosemite National Park currently are restricted to disturbed areas such as road corridors, campgrounds, and parking areas, and do not appear to be spreading into natural areas. These species are less of a concern than species that can invade remote, undisturbed lands. Some, called *transformer species*, have the potential to form monotypic stands, greatly altering resource availability, trophic structure, ecosystem productivity, and/or natural disturbance regimes (D'Antonio et al. 2004). Because of the large degree of harm these plant infestations cause, they demand more attention. Some highly invasive species (e.g., some Mediterranean grasses) are so widespread within Yosemite National Park and surrounding areas that their control is not currently feasible, and attempts to control them would be a waste of resources. Some species, such as Canada thistle, have not yet been found in the park, but are problem species in habitats similar to those found in the park. Where it is anticipated that these species may expand their range into the park, they are placed on a watch list (Appendix C).

Both known and watchlist invasive species in Yosemite National Park were evaluated and prioritized using a modified version of the USGS Alien Plants Ranking System (USGS 2000), an analytical software tool. The results were grouped into high, medium, and low priorities for each of the three categories—impact, threat, and difficulty of control—and were merged to create rankings for both known species (Appendix A) and watch list species (Appendix C). Following prioritization, resource managers consider whether invasive plants are likely to be found in areas of special protection such as pristine areas, meadow, or riparian habitats; wild and scenic river corridors; traditional gathering areas; or special status species habitat.

Generally, high and medium-high priority invasive species would be treated. However, the number of species and species infestations treated each year would vary according to available funding. Management is prioritized on an annual basis, and the species proposed for treatment each year will be reported in the Invasive Plant Management Program's annual work plan. The program manager and crew leaders may choose to treat lower-priority species where appropriate. For example, a crew leader could choose to treat puncture vine (*Tribulus terrestris*), a medium-priority species, along a residential roadside to protect residents from the thorny seeds.

Prevention

Prevention is the most effective first line of defense against invasive species. Once invasive plants are introduced, control can require significant expenditures of money and personnel that must be sustained over many years. Just over 200 non-native plant species occur in Yosemite National Park (Appendix B), with approximately 10 additional species found in the park every year. Species such as Italian thistle (*Carduus pycnocephalus*), common in the foothill communities surrounding Yosemite National Park, are poised to be added to that list.

Construction, roadside mowing, firefighting, and other operations can create conditions for the establishment of invasive plant populations. Fire can pose an immediate threat to some park resources; however, fire is also a natural part of Yosemite National Park's ecosystems. Invasive species brought in on construction or firefighting equipment can be thought of as a slow-moving emergency, and can pose a far greater long-term threat than fire to the park's natural and cultural resources. Prevention measures include identifying invasive plant seed-free sources for gravel, fill, topsoil, and other construction materials to reduce the spread of current infestations and the number of new infestations. Where possible, sources for earthen material such as gravel pits are inspected before these materials are brought into the park. Construction and materials staging areas should be inspected regularly. Yosemite National Park and the Delaware North Company currently feed stock using certified weed-free forage to minimize potential introduction of invasive plants. Construction and firefighting equipment and vehicles are required through park policies and contracts to be cleaned and inspected before entering the park. The Resource Management and Fire Management programs in Yosemite National Park would cooperate to ensure that fire vehicles and equipment are clean and free of invasive plant seeds and other popagules. The park conducts directed surveys for non-native species before, and for a minimum of two years following, completion of construction. Populations of species with long-lived seeds may require a longer monitoring period.

NPS and other federal and state agencies in California have signed a memorandum of understanding regarding the use of certified weed-free hay. Weed-free hay is already used to feed NPS and concessionaire pack stock in Yosemite, although it is not required for private pack stock. It is grown from fields inspected for the presence of state- and county-listed noxious weeds. However, just because hay is certified as being free of listed noxious weeds, this does not mean that the use of weed-free hay would prevent stock from introducing invasive species into the park. The primary grasses grown for forage in the United States include timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), and smooth brome (*Bromus inermis*). While these species are important agricultural commodities, they are

also serious invasive plant threats in many western wildlands. Problems could also arise should hay be brought in from other regions, as invasive species not yet present near Yosemite National Park could be introduced. Expansion of requirements for the use of weed-free hay would be considered as weed-free hay becomes more locally available. Requiring weed-free hay for private pack stock may be considered when these concerns are resolved. This tool will be used when certainty can be established regarding the weed-freeness of the hay.

Early detection and eradication is important because the probability of eradication is highest when invasions are caught early (Rozenfelds, Cave, Morris, et al. 1999; NISC 2008). Control is less costly, requires fewer personnel and tools that are less invasive, and is most likely to be effective when infestations are new and not yet widespread (Smith, Johnson, Honkweiler, et al. 1999). The cost of control increases dramatically, while the chance of success declines dramatically, with increasing infestation size; see Figure II-1 (Rejmanek and Pitcairn 2002). Early detection and eradication help minimize ecosystem degradation (Smith et al. 1999; Timmins and Braithwaite 2001).

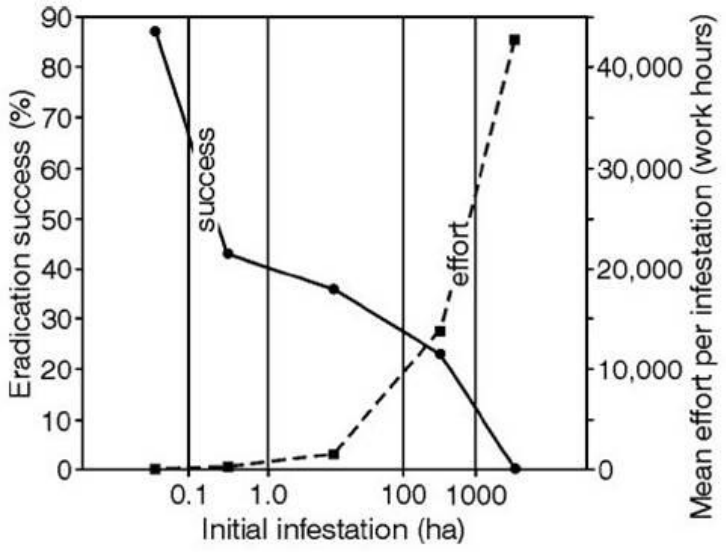


Figure II-1. Infestation Size versus Eradication Effort and Chance of Success

Potentially invasive plants are prioritized for early detection and eradication using the *Watch List for Invasive Plant Species Not Yet Found in Yosemite National Park* (Appendix C). This list is updated as new threats become known. Periodic early detection surveys concentrate on likely points of introduction and spread, such as roads, developed areas, stream/road confluences, areas of stock use, and construction and material storage areas. Annual monitoring will typically occur for five years to ensure that the population is eradicated. However, the length of monitoring may vary depending on the individual species' seed bank longevity.

Nearly 95% of Yosemite National Park is designated Wilderness, yet invasive plants currently are found in only a small portion of Wilderness lands in the park. The Wilderness Restoration Program in Yosemite's Resources Management and Science Division conducts early detection activities for high and medium-high priority invasive species populations.

Because of the number of potentially invasive species threatening the park, early detection surveys may be more effective when performed by people who are experienced with the park's native plant species. For example, a species of high concern, wall hawkweed (*Hieracium muriorum*), was recently found in the Tecoya housing area in Yosemite Valley by a botanist familiar with the park's vegetation. Hawkweed

is difficult to control and has spread rapidly in other western wildlands. The infestation was controlled using an herbicide and will be monitored.

Treatment

Treatment methods are tailored according to effectiveness, in the context of what is appropriate for resource protection and site-specific considerations. The following protocols are followed for selecting treatment methods. Non-native invasive plants are prioritized for treatment and species-specific management objectives are developed for the highest-priority species. Then, a determination is made regarding which priority species are responsive to herbicide use and which require herbicide use to meet management objectives (Appendix A). Special measures are followed in protection zones such as designated Wilderness, special-status species habitat, wetlands, riparian zones, cultural landscapes, and areas containing cultural use plants (Table II-2).

Table II-2. Cost and Effectiveness of Various Treatments for Controlling Spotted Knapweed

Treatment	Rate/acre and times applied	Plant Growth Stage	Application Date		Percent Control two years after treatment	Cost/Acre* two years after treatment
			Year 1	Year 2		
Hand pull (bolted plants)	2 times/year	Early and late bud	20-Jun 20-Jul	20-Jun 22-Jul	25	$13.900.00
Tordon 22K + Hand pull	½ pint, 1 time	Bolt (spray) Late bud (pull)	2-Jun —	— 21-Jul	94	$97.90
Mowing alone	2 times/year	Early and late bud	20-Jun 20-Jul	19-Jun 17-Jul	0	$200.00
Mowing + Curtail	1 time mowing; 1 quart sprayed 1 time	Late bud (mow) Fall regrowth (spray)	16-Jul 29-Sep	— —	91	$77.67
Curtail	1 quart, 1 time	Fall regrowth	29-Sep	—	68	$27.67
Tordon 22K	1 pint, 1 time	Bolt	2-Jun	—	95	$30.75

* Costs based on the following information: Hand pulling – wages $9/hour; mowing - $50/acre; Tordon 22K - $86/gallon; Curtail - $30.70/gallon; ground application - $20/acre.

Methods

Using integrated pest management, methods would include physical, mechanical, cultural, herbicide, and very limited biological control (see "Actions Common to All"). The most appropriate tool for the task is identified during the annual work planning phase, based on variable factors such as species, location, site conditions, level of threat, and resources available. No one tool or control method works for all species. Herbicides are most appropriate when non-chemical methods are not likely to be effective due to the plant's physiology (e.g. rhizomatous perennial plants), or when the invasive plant population is too large to be treated effectively before seed production. If herbicides are determined to

be the most appropriate tool, then the most effective herbicide for the particular species and situation is selected for use. Often, a combination of methods is most effective—for example, applying herbicides to the freshly cut stumps of trees and shrubs.

Treatment time, cost, and success vary tremendously by method. Table II-2 (Brown, Duncan, and Halstvedt 1999) shows the cost and effectiveness for hand pulling of spotted knapweed (*Centaurea maculosa*) verses various herbicide treatments. Given wages of $9 per hour, hand pulling over two years costs $13,900 per acre, with a control rate of 25%. This can be compared with the cost of $25 per acre for using Tordon, with a control rate of 95%. With a 95% control rate, total control could be obtained after several additional years of additional treatment, with less herbicide needed each successive year. At a control rate of 25%, eradication may not be possible.

In Yosemite Valley, physical control of Himalayan blackberry has been ongoing for at least 20 years. In one case, an Exotic Plant Management Team spent just over 500 hours digging up an acre of blackberry by the roots. That works out to a labor cost of over $10,000 per acre per year for a method that, even after so many years of effort, has not been successful. First year control costs using glyphosate range from $250 to $500 per acre. Cost and herbicide use decline significantly each year, and total eradication is achieved after approximately four years.

The following invasive plant control methods are used across all alternatives to treat invasive plant populations.

- **Physical Control.** Physical control methods can be labor-intensive and expensive. They are best suited to small populations. Examples include hand pulling, lopping, and cutting the plants below the root crown using shovels. Physical methods may be appropriate treatment for annuals and biennials such as shrubs and trees that will not stump sprout after cutting, or in areas where certain tools may not be appropriate. Where plants are in flower, flowering heads and seeds are bagged and disposed of properly. Physical control can be very effective and many methods can be readily transferred to volunteers. However, certain physical control methods cause extensive ground disturbance, which can create habitat conditions in which invasive plants rapidly reestablish.

- **Mechanical Control.** These commonly used and effective tools are suited to sites where an invasive plant has displaced other vegetation. Like physical control, these methods may be appropriate in certain situations when other methods, such as herbicide use in some traditional-use or spiritual areas, may not be appropriate. Hand-held motorized equipment such as brush cutters quickly remove the aboveground portions of invasive plants. The disadvantages are that these methods are labor-intensive, require more training, and may involve collateral damage to non-target vegetation, or additional hazards for workers. The latter is especially true when the work is conducted in steep and rough terrain. Tilling can be very effective when there is no other alternative. However, the results can be aesthetically displeasing because tilling can cause temporary collateral disturbance. Many mechanical control methods can be employed only during early season because of the late season fire hazards.

- **Herbicides.** Herbicides are one of the tools being used for wildland, terrestrial, and aquatic invasive plant management by the NPS, as well as by the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, The Nature Conservancy, and other agencies and organizations. Targeted herbicide applications kill invasive plant populations without soil disturbance, and limiting impacts to surrounding native plants. For many species, herbicide treatments are more effective than other methods. All application rates and methods would be consistent with the product labels.

  Herbicide application practices in Yosemite National Park are very different from those in agriculture and forestry. The potential impacts of using herbicides in Yosemite National Park are

weighed against the potential benefits resulting from increased protection of park natural and cultural resources from displacement or other degradation by non-native invasive species. For many species, especially rhizomatous perennials, control using physical methods can take many visits per season over many years, or has proven impossible. The use of herbicides increases the likelihood of controlling invasive plant populations, and of preventing populations from going to seed and infesting new areas of the park.

Herbicides selected for use in Yosemite National Park have been approved for use by the U.S. Environmental Protection Agency, the California Department of Pesticide Registration, the NPS national or regional integrated pest management coordinator, and resource management staff at Yosemite National Park. U.S. Forest Service Human Health and Ecological Risk Assessments, or similar risk assessments, were also reviewed, and toxicologists, university invasive species researchers, NPS resource managers, and other federal, state, and conservation land managers were consulted. Herbicide information sheets summarizing each herbicide selected for use in the park, including human toxicity and environmental fate and toxicity, can be found in Appendix G.

The following methods are currently used for treating invasive plants in Yosemite National Park:

- **Foliar Spray:** Leaves are sprayed with a mixture of herbicide, water, and non-ionic surfactant from a backpack or other sprayer. Precise mixes vary by plant species, phenology, and other factors.
- **Cut Stump and Frill:** Herbicides are applied to the freshly cut stump of a woody species (tree, shrub, or vine). With the frill method, multiple cuts are made into the cambium layer, followed by immediate herbicide application. This method has the advantage of being very selective, with high efficacy for some species. However, it is labor intensive.
- **Wiper:** Herbicides are applied to plant leaves with a wick, sponge, paintbrush, or similar tool. This method is also highly selective and labor intensive, but not always as effective as foliar spray.

Best Management Practices are followed for selecting a treatment or control method, as delineated below.

- Select the most appropriate tool for controlling individual species or infestations.
- Determine measures needed to protect natural and cultural resources such as cultural use areas, designated Wilderness, water resources, and sensitive species habitat (see Table II-3).
- Use only aquatic-approved formulations of herbicides in wetlands and within 10 feet of water.
- Follow all state and federal regulations pertaining to herbicide handling, application, and storage.
- Target only individual invasive species populations.
- Apply herbicides only when meteorological conditions are suitable (heat, wind speed and direction, humidity and precipitation), as defined on the label. Target invasive species patches and avoid spraying native plants to the greatest extent possible.

- **Cultural Tools**
  - **Controlled Burning.** Most plant communities in Yosemite National Park evolved in the presence of periodic fire. After being suppressed for decades, fire is now recognized as an important tool for maintaining the health of these communities, and in some cases, fire is useful as a tool for managing invasive species. Fire is part of the ecological drivers in many ecosystems in the park, and it can be used to treat large areas effectively. However, fire is non-selective and logistically

difficult to implement. Furthermore, implementing fire is potentially hazardous and risky, and it has the potential to compound invasive plant problems. During the post fire period of disturbance, the establishment and spread of invasive annual grasses such as cheatgrass is promoted. Such species have the capability to completely displace native plant communities. Firefighting equipment can be contaminated with invasive plant seeds, which is of particular concern when off-park crews are employed. To address these potential problems, monitoring would take place during the planning process and following prescribed fires. Pre and post fire invasive species treatment will take place as deemed appropriate by invasive plant and fire program managers.

- **Restoration.** Invasive plants are less likely to become established where diverse native plant communities are already established. Restoration activities may incorporate reseeding as appropriate to aid in recovery and prevent invasive plant reinfestation. Active restoration is particularly useful in heavily disturbed areas, such as roadsides that lack a native seed bank.

  Restoration planning is coordinated with park botanists and restoration ecologists. While it can be labor intensive and require significant planning and monitoring, restoration projects can help discourage the establishment and spread of invasive species.

- **Biological Control.** Yosemite National Park introduced a chrysomelid beetle (*Chrysolina quadridemina*) in Yosemite Valley to control St. John's wort (*Hypericum perforatum*) in the 1980s. In 1994 and 1995, the peacock fly (*Chaetorellia australis*), the hairy weevil (*Eustonopus villosus*), and the false peacock fly (*Chaetorellia succinea*) were introduced in El Portal to help control yellow star-thistle. Biocontrol can be an effective method of controlling some species. Currently, no invasive species in the park require the further release of biological control agents to meet management objectives. Under this plan, the only biocontrol agents that would be released in Yosemite National Park are the four species previously released to control yellow star-thistle and St. John's wort. Biocontrol can be very effective in large populations and quite inexpensive once established. This method is rarely effective for scattered or small populations and can result in non-target effects.

- **Other methods.** Less frequently used methods include smothering with mulch or solarizing with plastic.

Location. Managers must consider invasive plant locations when planning the appropriate treatment strategy.

Special Protection Zones. Some areas of the park have been identified as having highly sensitive resources that warrant special consideration during planning for invasive species control or treatment. The NPS is responsible for maintaining and protecting these sensitive resources, and staff must take special precautions in such areas. These areas include traditional gathering areas, play areas and school grounds, special status species habitats, designated Wilderness, and Wild and Scenic Rivers. Table II-3 describes these special considerations that managers must take into account.

Minimum Tool. The minimum tool would be used in Designated Wilderness. Invasive species are a threat to natural and cultural wilderness resources. Herbicides are the most effective and efficient tool for controlling many invasive species, particularly rhizomatous perennials. Herbicides are a minimum tool under each of the alternatives considered here. Work crews will follow all herbicide safety, storage, transportation, and use protocols outlined in this plan. Herbicide use shall meet the conditions of the Wilderness Minimum Tool Requirements Analysis, see Appendix J.

Table II-3. Special Protection Zones

Sensitive Resource	Special Considerations
Cultural Resources	• During planning phase, project managers will consult with park cultural resource specialists and park-associated American Indian tribes and groups in order to avoid adverse impacts on traditional cultural properties, archeological resources, and other culturally significant resources.
School Grounds and Recreation Areas	• Park staff will work with park partners, residents, and other interested parties to develop appropriate solutions and times for invasive plant control on school grounds, recreation areas, and pools. Residents will be informed before control efforts take place in these areas.
Special Status Plant Habitat	• Yosemite is home to 160 rare plants and numerous plant species of concern (see Chapter 3). During the planning phase, the spatial data layer for park special status plant species' occurrence will be reviewed during the planning phase to ensure that special status plants will not be adversely impacted by invasive plant management efforts. If federal-protected plant species occur in proposed work areas, the U.S. Fish and Wildlife Service will be consulted prior to control. No federally listed plants are currently documented in the park.
Wildlife Species of Concern and Critical Habitat	• When control is proposed where species of concern or critical habitat are present, the park's wildlife biologist will be consulted prior to beginning work (see Chapter 3 for a discussion of wildlife species of concern). Surveys may need to be performed to determine whether species are active or nesting in the area and to determine appropriate avoidance measures. Such measures would be implemented as appropriate, such as timing treatments to avoid or limit the duration of potentially disrupting activities, or selecting control methods that do not adversely affect species of concern and critical habitats.
Traditional Cultural Areas and Practices	• Invasive plant management program managers will use the annual work plan, meetings and other methods to consult with cultural resource specialists and culturally associated tribes and groups during the planning phase to ensure that control activities will not adversely affect traditional cultural properties or practices, or the health of those who gather cultural use plants.
Wetlands, Riparian Areas, and Wild and Scenic River Corridors	• When appropriate, invasive plant treatment in seasonally flooded wetlands and riparian areas would be scheduled during the dry or low water phase of the year. • Aquatic herbicide formulations would be used in wetlands and within 10 feet of standing and moving water. • Aquatic non-native invasive plants are present near the park boundaries. Should an aquatic invasive become a problem in the park, invasive plant program managers would evaluate the best options for treatment. If the threat from an aquatic invasive plant warrants such an action, treatment could include herbicide application in water.
Designated Wilderness	• A minimum tool analysis would be conducted to determine the appropriate tools and methods for controlling invasive species in designated Wilderness.
Zero Tolerance Areas	• Zero tolerance areas include earthen material storage areas, heavily used parking lots, new construction areas, livestock pens, and other areas where the introduction of non-native species into the park is likely. The establishment of priority invasive plants should not be allowed in these areas. These areas should be surveyed on an annual basis to ensure early detection and eradication.

Herbicide use in 2009 and 2010. Approximately 41 acres were treated with either glyphosate or aminopyralid in 2009, and approximately 81 acres were treated with these herbicides in 2010 (see Appendix M). The total number of acres treated with herbicides over these two years is very small, especially in comparison with the total acreage (761,266 acres) of Yosemite National Park. In the near term, herbicide use is expected to stay near current levels as the backlog of existing priority invasive plant populations is addressed. Once existing priority invasive plant populations have been brought under control, the program emphasis would increasingly focus on early detection and eradication, and the number of acres treated with herbicide is projected to decline.

Developed Areas. Roads, parking lots, trails, yards, landscaped grounds, construction zones, and earthen material storage areas are artificial habitats with conditions that are separate and distinct from those of the park's native ecosystems. These areas can provide appropriate conditions for the introduction of invasive species, and in turn, sources for spread throughout the rest of the park. Goals for these areas include preventing the introduction and establishment of new invasive plant seeds and other propagules, along with early detection and eradication of new infestations. The establishment of priority invasive plants should not be allowed in *zero tolerance areas.* These areas should be surveyed on an annual basis to ensure early detection and eradication.

Working within the Park with Park Partners and Neighbors. Because invasive species can spread across park boundaries, control efforts are coordinated with the park's volunteer program, facilities, park partners, and neighbors. This includes private landowners with inholdings, and concessionaires that operate and maintain facilities within the park. Invasive plant management policies and management actions apply equally throughout the park and its administrative areas. It also includes staff work with contractors to ensure that equipment and materials are inspected and free of contamination before entering the park. The park is conducting outreach and education, and is seeking greater cooperation with leases in managing invasive plants in park administrative areas.

Monitoring

Invasive plant control efforts are monitored to determine whether management objectives are being met and to ensure the effectiveness of control techniques. Monitoring provides valuable information on the abundance, location, extent, and rate of spread of non-native species over time, and offers insight into the mechanisms and vectors that promote their spread. The quality of monitoring data is dependent on the sufficiency of baseline inventory information. The extent of monitoring can vary from year to year depending upon the needs of the program and the availability of funding and staff. The most effective monitoring goals are those that are feasible, easily quantifiable, and time specific. Trend monitoring includes the following:

- *Efficacy monitoring* of control and prevention efforts, which helps determine whether objectives are being met through current management actions over a designated time.
- *Non-target effects monitoring*, which evaluates the unintended consequences of management actions on non-target resources.
- *Ecological restoration monitoring*, which evaluates the effectiveness of management actions for establishing natural ecosystem composition structure and ecosystem processes over a set time.
- *Corrective actions monitoring*, which provides justification for eliminating actions that are not working, or modifying management tools and methods to improve their effectiveness. If monitoring showed that sensitive resources were being adversely affected, immediate corrective

actions would be taken. These could include avoidance, halting specific treatment methods, adjusting methods, or consulting resource experts. Corrective actions and results would be documented.

Research, Education, and Outreach

Research informs invasive plant management decision making. Program managers conduct periodic literature research on published research relevant to invasion ecology and the management of invasive plants, which can be incorporated during annual review of the program's management objectives.

Outreach and education efforts can foster understanding of invasive plant prevention and control. Methods of outreach may include:

- *Volunteers*, who are essential to invasive plant management in the park. One paid staff member can lead a work effort composed of many volunteers. Volunteer efforts allow the public to become stakeholders in solving park resource challenges, and many people return to volunteer year after year.
- *Planning and information sharing*, which includes incorporating invasive plant information into park operations such as training, planning and design, construction, interpretation, maintenance, American Indian consultation, and resource management. Annual work plans can be posted on the park's website, as well as in newspapers, journals, conferences, brochures, visitor center exhibits, and other announcements. This strategy allows invasive plant research and other information to be summarized and distributed to park staff, partners, and visitors. It can include:
  - **interpretation programs** that educate the public about the threats posed by invasive plant species, and actions taken to protect park resources from their introduction and spread;
  - **open houses** that allow for public interaction with park staff, employees, and park partners, early detection training, invasive plant identification, and reporting and control. This increases the number of early detection eyes on the ground, and integrates the invasive plant management program more fully into park operations;
  - **partnerships**, which are especially important for prevention and early detection. Programs nationwide offer resources that aid efforts to combat invasive species; and
  - **other ideas**, which include creating incentive programs to encourage invasive plant awareness, placing invasive plant awareness messages at trailheads and information kiosks, and including weed prevention guidelines on wilderness permits and construction and commercial use authorizations.

Park Partners, Associated Tribes and Associated Groups, and Inholders

Provide opportunities for concessionaires and other park partners, American Indian tribes and associated groups, and inholders to participate in invasive plant management efforts, trainings, and information sharing regarding early invasive plant detection.

- Integrate landscaping and grounds management policy and regulations regarding high and medium-high priority species.
- Integrate management with Federal Highways, California Department of Transportation (Caltrans), Delaware North Corporation, Yosemite Institute, and the City and County of San Francisco Public Utilities Division (Hetch Hetchy Water and Power).

- Integrate management with adjacent United States Forest Service, Bureau of Land Management, California Department of Food and Agriculture, San Joaquin Noxious Weed Alliance, and other local governmental and non-governmental agencies.
- Conduct regularly scheduled meetings and/or site visits with members and traditional practitioners from each of the seven culturally associated American Indian tribes and groups to discuss the work plan and, as appropriate, adaptive changes in management strategies.
- Have program biologists collaborate with researchers to conduct studies to address the park's most dire invasive plant research questions.

Alternative 1: No Action (Continue Current Management)

Under Alternative 1 (the no-action alternative), the existing *2008 Plan* would be maintained. The existing plan guides a program staffed by park employees and volunteers for managing the priority invasive plant populations that pose the greatest threat to park natural and cultural resources, and that have the highest feasibility for control. Management is based upon the principles of integrated pest management, the components of which include inventory, prioritization, prevention (including early detection and eradication), control, and monitoring.

Physical and mechanical treatments would be emphasized, although, under certain conditions, two herbicides, glyphosate and aminopyralid, are used to control certain priority species. Eleven species throughout the park are currently treated using herbicides in the 5% of Yosemite National Park that is not designated Wilderness, and two species are treated using herbicides in Wilderness. Criteria used to consider the use of herbicides on new species or in new areas include prioritization, species-specific management objectives, herbicide effectiveness, and population size and location criteria thresholds. Annual work plans notify the public as to the time and planned locations for management efforts, as well as the methods and tools that would be used.

Program goals include: 1) prevention of the introduction of new invasive plant seeds and other propagules; 2) early detection and eradication of newly introduced populations; and 3) containment and, if possible, eradication of existing populations. Under Alternative 1, herbicide use is limited, especially near water. This restriction has made it difficult to meet the overarching goal of protecting the natural and cultural resources of Yosemite National Park from the threat of non-native plants, especially rhizomatous perennials, which are difficult to control using physical methods.

Inventory

See "Actions Common to All," which describes the process for creating an inventory of invasive plants in Yosemite National Park.

Prioritization

See "Actions Common to All," which describes the comprehensive method for prioritizing invasive plants in Yosemite National Park.

Prevention

See "Actions Common to All," which describes the comprehensive program for preventing the establishment of new invasive plant species in Yosemite National Park.

Treatment

See "Actions Common to All" for a description of baseline integrated pest management treatment options. Specific control methods allowed under Alternative 1 include: cultural (altering land management to give a competitive advantage to desired species), physical, chemical, and existing biological controls. Under Alternative 1, herbicide use is not allowed within 10 feet of standing or moving water, within the beds and banks of Wild and Scenic Rivers, in tribal gathering areas, or within 100 feet of blue elderberry plants. Only two herbicides, glyphosate and aminopyralid, are approved for use under this alternative. These herbicides were selected after consultations with toxicologists, university invasive species researchers, NPS resource managers, and other federal, state and conservation land managers. U.S. Forest Service Human Health and Environmental Risk Assessments for aminopyralid and glyphosate were also reviewed. Glyphosate and aminopyralid are appropriate for use in wildlands, and they have minimal associated human health concerns and non-target species and water quality impacts (see Appendix G).

Monitoring

See "Actions Common to All," which describes the protocols for monitoring the control of invasive plant populations in specific treatment areas in Yosemite National Park. The monitoring protocol does not include comprehensive monitoring for assessing the effectiveness of the overall program.

Education, Outreach, and Research

See "Actions Common to All," which describes the comprehensive program for integrating education, outreach, and research into invasive plant management in Yosemite National Park.

Alternative 2: Adding Additional Herbicides and Addressing Limitations of Existing Plan

Under Alternative 2, invasive plant management planning would be based upon the principles of integrated pest management, with control methods including physical, cultural, chemical, and very limited biological controls (see "Actions Common to All"). Compared with the no-action alternative, Alternative 2 incrementally increases treatment methods available for use, and includes the tools and methods necessary to meet the program's stated purpose and need. It builds upon the *2008 Plan* with two notable changes, expanding both the number of herbicides that may be used and the locations where herbicide application may be considered. Specific limitations within the *2008 Plan* that unnecessarily impede the ability of park resource managers to control invasive species would be remedied to allow the park to more effectively treat invasive plants in developed areas, adjacent to water features, and in designated Wilderness. As well as in "Actions Common to All," the actions specific to Alternative 2 are described below.

Inventory

See "Actions Common to All," which describes the process for creating an inventory of invasive plants in Yosemite National Park.

Prioritization

See "Actions Common to All," which describes the prioritization of management for invasive plant species in Yosemite National Park.

Prevention

See "Actions Common to All" and Appendix D, which describe a comprehensive program for preventing the establishment of new invasive plant species in Yosemite National Park.

Treatment

See "Actions Common to All" for a description of baseline integrated pest management treatment options. Chlorsulfuron, imazapyr, rimsulfuron, and triclopyr have been proposed for use in Yosemite National Park under Alternative 2. These herbicides were selected after consultations with toxicologists, university invasive species researchers, NPS resource managers and other federal, state and conservation land managers. U.S. Forest Service Human Health and Environmental Risk Assessments are available for aminopyralid, glyphosate, chlorsulfuron, imazapyr, and triclopyr. A similar risk assessment has yet to be completed for rimsulfuron. Yosemite National Park conducted an extensive literature review on the human and ecological effects and the environmental fate of these herbicides (see the Herbicide Information Sheets in Appendix G). The literature review of rimsulfuron included a review of four risk assessments. Chlorsulfuron, imazapyr, rimsulfuron, and triclopyr are appropriate for use in wildlands, have minimal associated human health concerns and non-target species and water quality impacts, and augment the two previously approved herbicides.

Triclopyr is effective on broadleaved species, especially woody species such as Himalayan blackberry and tree of heaven (*Alianthus altissima*). Chlorsulfuron is selective for both grasses and forbs. It is particularly effective on plants from the mustard family and on toadflaxes (*Linaria* spp.). Imazapyr, like glyphosate, is effective on a wide variety of species and can be used in aquatic situations. However, imazapyr is more selective than glyphosate in that it controls broadleaved plants without impacting graminoids (grasslike plants).

Rimsulfuron is a preemergent that has been shown to be effective in controlling cheatgrass and other invasive annual grasses. As such, it can provide an opportunity for managing a threat to the natural resources of Yosemite National Park that is not provided by the other herbicides currently used or proposed for use in the park. Rimsulfuron had previously received conditional approval from the NPS at the national level to control cheatgrass. However, because rimsulfuron can be either selective or non-selective depending upon very small differences in dose, application can be performed only by Exotic Plant Management Teams or other personnel authorized by the NPS regional or national invasive plant coordinator (personal communication, Rita Beard, national invasive plant coordinator, NPS, 2010).

Addressing Limitations in the Existing Plan

The *2008 Plan*, while thorough and programmatic, is a cautious document. The experience gained from two years of using herbicides alongside physical, mechanical, and other methods, showed that in some cases, barriers to herbicide use in the *2008 Plan* impeded the ability of resource managers to select the most appropriate tool for protecting the park's natural and cultural resources. Specific differences between the action alternatives (Alternatives 2 and 3) and the no-action plan are described in the following paragraphs. Refer to Table II-3 for actions taken to protect sensitive resources such as traditional cultural properties, wetland and riparian habitats, and land within 10 feet of standing and moving water.

No Spraying of Herbicides in Traditional Gathering Areas. Language in Table II-5 of the *2008 IPMP* states that "no herbicides would be used in traditional gathering areas." Invasive species are spreading in habitats that contain cultural use plants. Some invasive species have the potential to overrun these habitats, thus displacing the culturally significant species. Pulling, mowing, and other non-herbicide techniques can be effective for controlling some invasive species, but are ineffective on others, especially rhizomatous species. Additionally, the repeated trampling and ground disturbance associated with some physical methods of control has the potential for displacing important cultural use plants.

The emphasis under Alternative 2 is on protecting traditional cultural properties, spiritual areas, cultural use plants, and those who gather these plants. Ongoing consultations with culturally associated tribes and groups will be an integral component of the process for determining the most appropriate control method in these areas. The most appropriate method for controlling individual invasive plant species, which also protects the resources and the people who gather culturally significant plants, would be used. The traditional gathering areas for some cultural use plants change from year to year based upon local growing conditions and the preferences of the individual gatherers. Alternative 2 differs from Alternative 1 in that herbicide use may be allowed near cultural use plants in certain situations. In some circumstances, repeated, intensive physical controls may be preferable to chemical controls in areas where cultural use plants are gathered for food or particular traditional cultural practices.

Mitigations will include notification and ongoing consultation with associated tribes and groups about the invasive plant management planning process. An annual work plan, produced each winter prior to the field season, will be made available to both the associated tribes and the public. It will describe proposed locations, methods, and approximate times of proposed work for the upcoming field season. Invasive plant management planning and control efforts will be conducted in ways that show respect for these areas and the people who use them. Signage will be installed according to herbicide label requirements or as agreed to in the tribal consultation process. Treatments will, to the extent possible, be timed to avoid spraying plants when fruits are present. Mitigations could also include scheduling control in a particular area over several years to allow for ongoing resource gathering by associated Native American tribes and groups.

Ten-foot Setback from Standing or Moving Water. Alternative 2 differs from Alternative 1 in that aquatic herbicide formulations would be used within 10 feet of the waterline. Allowing the use of aquatic herbicide formulations up to the waterline would improve control of species such as Himalayan blackberry and velvet grass. The *2008 Plan* was insufficient for addressing the management of invasive plants in and near water. Aquatic formulations of glyphosate were allowed to be used within seasonal wetlands during the dry phase, but no herbicide use was allowed within 10 feet of standing or moving water.

These limitations can be problematic because wetland habitats are some of the most diverse and productive in the park. Riparian areas are linear features that provide links across habitats. As such, when invasive species are not treated near water, riparian areas can facilitate their spread into other areas of the park. Some of the greatest threats to the natural and cultural resources of Yosemite National Park come from wetland and riparian invasive plants such as Himalayan blackberry, velvet grass, and reed canary grass (*Phalaris arundinacea*). Himalayan blackberry is a rhizomatous species that is frequently found in riparian corridors and currently occupies about 100 acres within the park. Cultural, mechanical, and physical means of control do not always kill the belowground portions of invasive plants, such as blackberry. Digging invasive plants up by the roots can damage sensitive riparian and wetland habitats. Many species can resprout from small root or rhizome segments. Digging plants up by the roots and rhizomes, and the resulting disturbance, must be repeated again and again over many years in order to eradicate invasive plant populations. This disturbance can also stimulate invasive plant seed germination. Resource managers have been working to control this species for decades using physical methods, with only local success.

No Spraying within the Bed and Banks of Wild and Scenic Rivers. Table II-5 in the *2008 Plan* states, "Work crews would not apply herbicides below the ordinary high-water mark of Wild and Scenic Rivers or their tributaries." The Wild and Scenic Rivers Act mandates protecting outstanding and remarkable values, water quality, and unimpeded stream flow. It does not prohibit using herbicides in stream corridors. Again, many invasive species cannot be effectively managed using physical and cultural methods alone. Not using the most effective tool to control invasive species could allow the displacement or degradation of lake, stream, and wetland habitats by invasive plants. This course of action could threaten certain outstanding and remarkable values, and in some cases, water quantity and quality.

Wilderness. Herbicide use was allowed for only two species, Himalayan blackberry and velvet grass, in wilderness. Because herbicides can be so much more effective for controlling many invasive species, especially rhizomatous perennials, limits upon herbicide use in wilderness could negatively impact the *natural quality* of *wilderness character*.

Monitoring

See "Actions Common to All," which describes the process for monitoring the effectiveness of invasive plant management control actions in Yosemite National Park.

Education, Outreach, and Research

See "Actions Common to All," which describes the comprehensive program for integrating education, outreach, and research into invasive plant management in Yosemite National Park.

Alternative 3: Adaptive Management (Preferred Alternative)

The purpose of Alternative 3 is to ensure that the park has the necessary flexibility to use the best available methods to combat invasive plants. As is required by federal law (7USC136r-1) for actions conducted by federal agencies, Alternative 3 would also be based upon the principles of integrated pest management. Control methods would include physical, mechanical, cultural, herbicide, and very limited biological controls (see "Actions Common to All"). Four new herbicides would be added under Alternative 3, and specific limitations of the *2008 Plan* would be addressed.

Alternative 3 includes a protocol for assessing the introduction of additional herbicides for use in the park and for considering the use of herbicides near water to treat aquatic invasive plants (Figure ll-2). These protocols would be based upon a screening process that includes national, state, regional, local, and Yosemite-specific considerations.

Finally, Alternative 3 includes adaptive management, a process that promotes flexible decision making to allow for program adjustments in the face of uncertainties and ecosystem variability (Williams, Szaro, and Shapiro 2007; Prato 2006). Adaptive management builds upon traditional NEPA implementation processes because it includes monitoring and adaptive measures as part of the NEPA analysis. Using adaptive management, the invasive plant management program could be constantly improved by using the results of monitoring and new information to respond proactively to changing conditions with improved and innovative techniques as appropriate. Alternatives 1 and 2 are tacitly adaptive in that workers and managers generally strive to increase effectiveness and efficiency. However, the processes for justifying, assessing, and documenting flexible management responses are detailed in Alternative 3.

Adaptive management would provide park resource managers with the flexibility to 1) adjust decisions for practical reasons (for example, should a new invasive species be discovered); 2) address

unanticipated results of implementation (for example, selecting an alternative treatment when mechanical removal is ineffective); and 3) update the program based on new science or practical experience. Adaptive modifications to the program would be reported in annual work plans. The monitoring plan would establish a feedback loop to be evaluated on an annual basis with the purpose of informing park resource managers and the public as to whether adaptive management actions are effective, whether the actions described in this plan are being carried out, and whether the scope of the program is sufficient to protect park natural and cultural resources from impairment by the continued introduction and spread of invasive species.

Although the scientific basis and use of adaptive management is well-documented, the most common implementation obstacles are management and stakeholder comfort levels with uncertainty (Prato 2006). Uncertainty about management impacts is often expressed as disagreements among stakeholders who have differing views about the direction and magnitude of management actions. An adaptive approach considers these viewpoints and incorporates them into the decision-making process. In this way, conflicts can be resolved, understanding of the resource can be enhanced over time, and management can be improved. Uncertainty can be difficult to address under NEPA. Section 102(2) (C) of NEPA directs federal agencies to address actions significantly affecting the quality of the human environment and their environmental impacts, and to determine whether any adverse environmental effects that cannot be avoided are significant. In subsequent case law (for example, *Save the Niobrara River Association v. Andrus*), the court explained that "an agency need not eliminate all uncertainty and resolve differing views on a risk before undertaking a project," but added that "the nature and basis" of the uncertainty "and what is needed to remove it must be expressed in the [Environmental Impact Statement] so that a decision maker may weigh it on the scales."

There is broad consensus among resource managers and scientists that adaptive management is a practical way to implement ecosystem management (Brunner and Clark 1997; Heissenbuttel 1996; Ringold, Alegria, Czaplewski, et al. 1996 in Ruhl and Fishman 2010). Adaptive management has been used to manage other complex and changing national park ecosystems when there is uncertainty regarding the state of the ecosystem and ecosystem responses to management actions (Prato 2006). The Council on Environmental Quality also recognizes the value of incorporating the adaptive management model into the NEPA process (CEQ 1997).

Inventory

The procedures for inventorying invasive species are the same in all alternatives. Under Alternative 3, inventory also provides a feedback loop from which adaptive management could be assessed and implemented. Inventory can provide the baseline for predictive probability modeling for species where sufficient data exists. Known invasive species location data could be analyzed along with elevation, habitat, rainfall, temperature, and other data to predict where a particular species might be found or pose a problem.

Prioritization

See "Actions Common to All," which describes the prioritization of management for invasive plant species in Yosemite National Park. As part of adaptive management, if a more effective prioritization methodology is developed in the future, that methodology could be selected for use in the park. Adaptive management in prioritization means feedback loops would be used to establish prioritization for treatment among species. Based on priorities, the park would design and adjust treatment plans on an annual basis.

Steps involved in adaptive management of invasive plants include:

- ***Identify important natural and cultural resources.*** Yosemite's diverse plant communities provide habitat for a great variety of the Sierra Nevada's plant, animal, and invertebrate species.
- ***Assess current conditions.*** Currently, invasive species are causing significant adverse impacts on some native plant communities in Yosemite. For example, invasive plants have already displaced native grasses and forbs throughout Yosemite's foothill woodlands and low- and mid-elevation meadows. To assess current conditions, data are collected to gain a baseline understanding about what species are present, as well as their location and extent.
- ***Identify potential risks to the resource.*** Although over 200 invasive species have been found in the park, only some are spreading into wildlands and displacing native species, while others exist only along roadsides or within disturbed areas. Risk varies by species and by habitat. Some habitats, such as developed areas or wetlands, provide conditions that are more suitable for invasive species than others. Because current park staff and funding are limited, invasive species management is prioritized by species (see prioritization sections in Chapter II).
- ***Determine what data is relevant for management.*** Relevant data includes the presence of individual populations, the number of total populations, and achievement of management goals. Successful efforts would result in a decrease in the number and area of target invasive plant populations over time. The intensity of management efforts needed to control these populations and adverse impacts to park natural and cultural resources should also decline. Repeated monitoring will show what variables are most relevant to successful management of invasive species.
- ***Determine when management action is warranted and how to best protect the resource.*** This document focuses on the part of the program that is essentially responsive: how the park responds to the presence of invasive plants. When action should be taken would depend on species prioritization and other factors, such as whether the invasive plant population is located near cultural use species. Actions would be based upon current knowledge: The park would determine how to best protect the resource by using the best available tools and methods established for each species based upon species phenology, growth state, location, practical experience, and current science. Proximity to sensitive natural and cultural resources would also be considered.
- ***Refine or adapt control actions.*** This would include determining the results of control actions, and ongoing review of new studies of potentially safer and more effective treatments. Monitoring is critical to assess whether management actions are adequately protecting resources.

Prevention

See "Actions Common to All" and Appendix D, which describe a comprehensive program for preventing the introduction of new seeds or other invasive plant propagules into the park. Due to the nature of the expanded treatment options proposed in Alternative 3, the prevention plan would be more proactive than those proposed under Alternatives 1 and 2. Using adaptive management, vectors of introduction of new populations and species would be considered so that implementation of preventative measures could be improved. For example, if a new population was found and was determined to have entered the park via firefighting vehicles, clothing, or equipment, outreach and

education could be used to inform firefighters so that they would be more vigilant in preventing contamination of the park with invasive plant seed.

Treatment

The steps for determining invasive plant treatment methods are the same as those outlined in Alternative 2. However, using adaptive management, treatments would be adjusted continually based upon their level of success. Additionally, based upon science and research, new treatment tools and techniques would be introduced after they have proven to be effective and safe through use in control operations by other entities.

In Yosemite Valley, resource managers have worked for decades to control Himalayan blackberry, a perennial with an extensive horizontal stem that often sends out numerous shoots that can reproduce from small root fragments. Cutting the plant down and digging it up by the roots requires a great deal of effort on the part of both park staff and volunteers, resulting in local, but not cumulative, parkwide successful management. Herbicides were not part of the park's integrated pest management toolbox until 2008. Had herbicides been an available tool, and had monitoring taken place as part of an adaptive management framework, the ineffectiveness of these efforts would have been recognized earlier, and a more effective control method might have been selected. The use of an herbicide would have been more effective and would have required significantly less time and expense as compared with physical control.

Challenges associated with adaptive management include the following factors:

- Natural ecosystems are complex. Uncertainty exists regarding appropriate management strategies and desired outcomes for management actions.
- Park ecosystems face many internal and external threats. Some threats, such as those from climate change, invasive species, and landscape-scale habitat fragmentation, are growing over time.
- Preservation of the pristine environment is not always achievable. Even less-than-pristine environments can still have great cultural and ecological value.
- There are limitations and fluctuations in staffing and funding available for invasive plant management.
- Human intervention is not always capable of producing a predictable, desired outcome.

Addition of New Herbicides

New herbicides would be considered for addition to the park's toolbox if they 1) fulfilled a specific control need that was not addressed by currently used herbicides, or 2) were found to be safer and more effective than those herbicides currently used. New herbicides, surfactants, and adjuvants are always being developed. All herbicides considered for use in Yosemite National Park would be reviewed and approved for use by all appropriate agencies, including the U.S. Environmental Protection Agency (EPA), the California Environmental Protection Agency (CEPA), and regional or national integrated NPS pest management coordinators. New herbicides considered for use would also have a completed U.S. Forest Service Human and Ecological Risk Assessment, found at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml, or a similar assessment. Factors that would be

reviewed when assessing an additional herbicide for use in Yosemite National Park include an assessment of the risks to human health, mammals, birds, reptiles, amphibians, fish, and aquatic invertebrates, as well as efficacy, cost, and availability (Appendix G). Environmental fate and transport, including drift, leaching to groundwater, and runoff to surface streams and ponds would also be assessed. Figure II-2 shows a protocol for evaluating the addition of herbicides to the park's toolbox.

Use of Herbicides to Control Aquatic Invasive Plants

Herbicides are one of the tools being used for wildland aquatic invasive plant management in other units of the NPS, as well as of the Bureau of Land Management, U.S. Fish and Wildlife, The Nature Conservancy, and other areas throughout the United States. Based upon the spread of invasive plants over the last several years, Yosemite National Park resource managers recognized that the *2008 Plan* was insufficient for control of invasive plants near and in water. The existing plan prohibits the spraying of herbicides within 10 feet of standing or moving water, which limits the ability of park resource managers to protect park natural and cultural resources from wetland aquatic invasive species that do not respond well to physical or cultural treatments. A number of wetland and aquatic invasive plants including purple loosestrife (*Lythrum salicaria*), hydrilla (*Hydrilla verticillata*), and Brazilian waterweed (*Egeria densa*) occur in California. Purple loosestrife and hydrilla have been found in several of the counties bordering Yosemite National Park. The establishment of an aquatic invasive species in the park may represent a sufficient threat to justify the use of aquatic herbicides on plants in standing water.

Prior to the treatment of aquatic invasive species, park wildlife biologists, botanists, and hydrologists would assess potential impacts of chemical control actions and the possible spatial extent of impacts (see Figure II-2). After identifying a targeted species within an aquatic environment, integrated pest management and best management practices would be implemented to control the target species while maintaining management goals of protecting human health, water quality, and park natural and cultural resources. Cultural or physical methods would first be considered for controlling the target invasive species. All methods have risks and benefits. For example, physical control can reduce plant densities, but it can also encourage spread by creating viable fragments. The use of herbicides to control aquatic invasive species can raise concerns about water quality and effects on non-target plant and animal species. All actions would include an analysis of the risks and benefits of not treating aquatic invasive species as opposed to using physical and herbicide treatments. If it is determined that cultural or physical methods would effectively treat a priority species, then the use of herbicides would not be considered.

Should a special status species such as the Yosemite Toad be suspected to exist in the application area, the project manager would consult with park wildlife biologists. When needed, consultations with the U.S. Fish and Wildlife Service (USFWS) would take place. An assessment would be made to ensure an aquatic herbicide application would not negatively impact special status species or other aquatic flora or fauna. Surveys and other appropriate treatments methods, such as specifying times or areas for treatment, would be implemented to ensure that impacts on species of concern and their habitat areas were negligible. If the herbicide application would negatively impact these species, treatment would take place in consultation with the USFWS. Results of effectiveness and efficiency of control efforts of either herbicide (already approved or newly assessed and selected) would be monitored and documented.

Monitoring

See "Actions Common to All," which describes the process for monitoring the effectiveness of invasive plant management control actions in Yosemite National Park. If adaptive management is to be implemented successfully, monitoring must occur for long enough to determine whether the predicted effects were achieved (CEQ 1997). Agencies do not typically collect long-term data on the

environmental impacts of actions. Consequently, if agencies are to have the option of using adaptive management for NEPA implementation, there is a need to incorporate the "predict, mitigate, implement, monitor, and adapt" model into the NEPA process. This model requires monitoring and considers the effects of potential adaptive measures to allow for mid-course corrections without requiring new or supplemental NEPA review (CEQ 1997). Adaptive management for monitoring means that the park will continually adjust its monitoring program based upon the results of the monitoring. Baseline data collection provides the foundation from which management actions can be assessed.

Alternatives Considered but Dismissed

Yosemite National Park resource managers considered a range of actions when developing possible alternatives for the *Invasive Plant Management Plan.* Of the actions analyzed, some were dismissed for one or more of the following reasons:

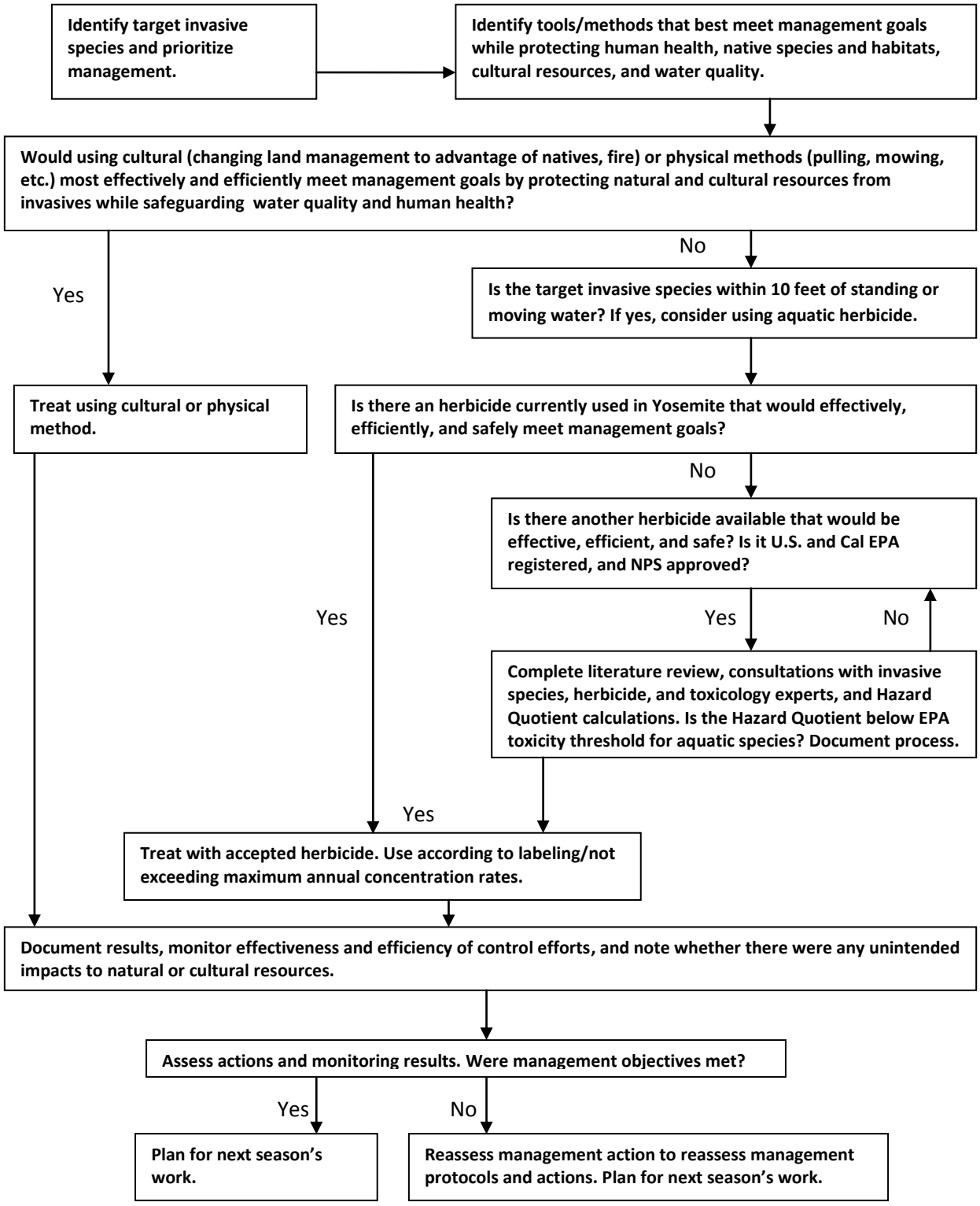
- The action did not meet the program's purpose and need.
- Less environmentally damaging options were available.
- The action would cause unacceptable environmental, cultural, or social impacts.
- The action presented unacceptable risks or constraints with an associated increase in costs.
- The action would be inconsistent with law, regulation, or policy.

No Use of Herbicides

In the *2008 Plan*, the park considered and analyzed an alternative that excluded the use of herbicides, but dismissed it because it would not meet the purpose and need. This option was suggested in public comment, and was again considered carefully, but was formally dismissed by the planning team during the alternatives development workshop because this approach would not allow the park to use the best available science and tools; nor would it adequately address the threat, or meet the park's directive to protect the park's natural and cultural resources for future generations. All methods of control have some risk. Herbicide treatments have proven to be far safer for workers than timed mowing treatments of yellow star-thistle on steep slopes. Herbicides are widely accepted tools for managing invasive species that are currently used by land management agencies and groups, including the NPS, the United States Forest Service, the Bureau of Land Management, The Nature Conservancy, and The Audubon Society. Monitoring from Yosemite National Park and elsewhere has shown that herbicides are more effective and efficient in controlling Himalayan blackberry than hand pulling. This increased efficiency has huge implications for meeting management goals and achieving resource mandates for a three-quarter million acre park such as Yosemite.

Use of Domestic Herbivores to Control Invasive Plant Populations

Goats, cattle, and other herbivores can be used to control invasive species. For example, goats have been shown to be effective at controlling yellow star-thistle. However, a majority of the yellow star-thistle in Yosemite National Park is located on very steep slopes with thin soils that could be stripped of vegetation and topsoil if goats were released to control this species. Goats can also cause unintended and unwanted secondary impacts by trampling or consuming native vegetation and by altering nutrient cycles. Domestic herbivores can also be vectors for the spread of invasive species. As a result, this action was dismissed because it would cause unacceptable environmental impacts.



*Adapted from *Northern Great Plains Exotic Management Plan and EA* (NPS 2005), http://www.northern greatplains-nps.com.
**Treatment decisions based upon the management needs of each individual species in each individual habitat.

Figure II-2. *Invasive Plant Management Tool Selection Protocol*

Use of Biological Control Agents

Biological control (also known as biocontrol) involves the introduction of herbivores or pathogens, such as insects or fungi, that infest invasive species and reduce their ability to persist and produce seeds. An effective biological control agent introduced to attack invasive plant populations must be highly host-specific. The biological control agent must affect only the target plant, and show little or no affinity for native species that may be closely related to the invasive plant. Biological control agents undergo rigorous laboratory and field testing by the U.S. Department of Agriculture and the state of California before approval for use in agricultural or natural settings.

Currently, no invasive plant species in Yosemite National Park require the release of a biological control agent to meet management objectives. The only biocontrol agents that might be considered in the future are the four species that have been used in the past to control yellow star-thistle and St. John's wort: a chrysomelid beetle, the peacock fly, the hairy weevil, and the false peacock fly.

Use of Aircraft for Aerial Herbicide Application

Program managers briefly discussed and dismissed the possibility of using aircraft (such as airplanes and helicopters) for aerial application of herbicides (often used in agriculture), noting that such a broadscale application method was not necessary or appropriate for use in the park at this time, as more targeted and less intrusive options for herbicide application are available to meet management objectives.

Environmentally Preferable Alternative

The NPS is required to identify the environmentally preferable alternative in the environmental documents it produces for public review and comment. In accordance with NEPA Section 101(b) (516 DM 4.10), the environmentally preferable alternative is the alternative that best promotes the national environmental policy. The Council on Environmental Quality's *Forty Questions* further defines the environmentally preferred alternative as "the alternative that causes the least damage to the biological and physical environment… [and that] best protects, preserves, and enhances historic, cultural, and native processes." The environmentally preferable alternative must meet the following six requirements described in Section 101 of NEPA:

- 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.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Alternative 1, the no-action alternative, seeks to meet the environmental policy goals by initiating a program to protect non-infested areas of Yosemite National Park from invasions of high and medium-

high priority invasive plants. The park would selectively use herbicides only in the event that park staff is unable to meet management objectives via physical or mechanical control methods. The park would use two herbicides—glyphosate and aminopyralid—to control 22 invasive plant species that meet identified thresholds.

Alternative 2 seeks to meet environmental policy goals by adding four additional herbicides to control a broad range of invasive plant species. Additionally, limitations within the *2008 Plan* are addressed. These changes would improve the effectiveness and efficiency of invasive plant management actions within Yosemite National Park.

Alternative 3, like Alternative 2, adds four additional herbicides and addresses limitations within the *2008 Plan.* However, Alternative 3 builds upon Alternative 2 by including adaptive management. The adaptive management decision-making process would promote flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

Alternative 3 is the environmentally preferable alternative because, overall, it would best meet the requirements in Section 101 of NEPA. Compared with the no-action alternative and Alternative 2, it more effectively fulfills the responsibilities of each generation as trustee of the environment for succeeding generations by allowing for better, more efficient control of non-native plants and the impacts they create on the environment. Through the use of adaptive management, the immediate addition of four additional herbicides to control a wide range of invasive species, and addressing limitations with the existing plan, it allows for non-native plant control while avoiding or minimizing resource degradation, health and safety risks, and other undesirable or unintended consequences. More effective management of non-native plants is necessary to preserve important natural and cultural aspects of our national heritage. Without such management action, non-native species will continue to adversely impact native vegetation and the wildlife that depends on it.

III AFFECTED ENVIRONMENT/ENVIRONMENTAL CONSEQUENCES

Introduction

This chapter describes the existing environment for 13 Yosemite National Park resources that could be affected by actions proposed in the *2010 Invasive Plant Management Plan Update Environmental Assessment* (*2010 Update*). It also analyzes both beneficial and adverse impacts that could result from implementation of the alternatives associated with managing non-native invasive species described in Chapter II. The rationale used for dismissing other impact topics is discussed. Resource topics are also evaluated for potential cumulative impacts. The Council on Environmental Quality (CEQ, 40 CFR 1508.7) describes a cumulative impact as an:

> *impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

Chapter Organization

The chapter begins with a discussion of impairment. The remainder of the chapter is organized by resource topic. The existing affected environment of each resource topic and the environmental consequences of each alternative on this environment are described. Resource topics were selected for detailed environmental analysis based on their potential to be affected by the alternatives; federal law, regulations, and executive orders; National Park Service (NPS) management policies; and concerns expressed by the public, Yosemite National Park staff, or other agencies during the scoping process. Topics that were dismissed from further analysis are listed below.

Resource Topics

The following Natural and Cultural Resource topics were selected for analysis based on federal law, regulations, Executive Orders, NPS *Management Policies* (NPS 2006b), park staff subject matter expertise, and concerns expressed by other agencies or members of the public during scoping and comment periods.

- Soils
- Vegetation
- Special Status Wildlife
- Traditional Cultural Properties and Ethnographic Resources
- Hydrology and Water Quality
- Special Status Plants
- Designated Wilderness
- Cultural Landscapes
- Wetlands
- Wildlife
- Archeological Resources
- Visitor Experience and Recreation
- Park Resources

Natural Resources

The federal and state of California Endangered Species Acts (and associated legislation) as well as the Clean Water Act, Clean Air Act, and National Environmental Policy Act (NEPA) require that the effects of any federal undertaking on natural resources be examined. The Wild and Scenic Rivers Act specifies guidelines for the determination of appropriate actions within the bed and banks of a Wild and Scenic river, and requires managing agencies to determine whether water resource projects would adversely affect the free flow or outstandingly remarkable values (ORV) of a designated river. In addition, NPS management policies and guidelines call for the consideration of natural resources in planning proposals. The natural resources analyzed here include soils, hydrology and water quality, wetlands, vegetation, specials status plants, wildlife, special status wildlife, and designated Wilderness.

Cultural Resources and Historic Properties

The National Historic Preservation Act (NHPA), Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, and NEPA require that the effects of any federal undertaking on historic properties and cultural resources be examined. In addition, NPS management policies and cultural resource management guidelines call for the consideration of historic properties and cultural resources in planning proposals. The 1999 Programmatic Agreement (PA)between Yosemite National Park, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding Planning, Design, Construction, Operations, and Maintenance, was developed in consultation with seven American Indian tribes associated with park lands and the National Trust for Historic Preservation, in compliance with Section 106 of the NHPA. The 1999 Programmatic Agreement is governed by 36 Code of Federal Regulations (CFR) Part 800 implementing regulations that were in place at the time of its execution. Cultural and historic properties exist within the project area and adjacent areas, and could be affected by the alternatives. The social resources analyzed here include traditional cultural properties and ethnographic resources, archaeological resources, and cultural landscapes.

Sociocultural Resources

The analysis of sociocultural resources examines the effects of the *2010 Update* on the social environment within the park. Stewardship requires the preservation of Yosemite's unique natural and cultural resources and its scenic beauty. Also central to the NPS's mission is to ensure that these resources are made available to visitors for study, enjoyment, and recreation. The social resources analyzed here include visitor experience, recreational opportunities, and park operations.

Impact Topics Dismissed from Further Analysis

Environmental Justice

Environmental Justice commonly refers to Executive Order 12898, which requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Environmental Justice was dismissed from further analysis because none of the plan alternatives would result in effects such as the destruction or disruption of community cohesiveness and economic vitality; the displacement of public and private facilities and services; increased traffic congestion; and/or the exclusion or separation of minority or low-income populations from the broader community.

Geology and Geologic Hazards

Geology and geologic hazards were dismissed from further analysis because the actions proposed in this plan would not result in impacts related to geology, or increase or decrease the potential for geologic hazards in the project area.

Prime and Unique Agricultural Lands

Prime and unique agricultural lands were dismissed from further analysis because none exist in the project area, and the actions described in the alternatives would not have any indirect effects on downstream agricultural lands.

Socioeconomics

Socioeconomics was dismissed from further analysis because implementation of this plan would not result in measurable effects on the regional or gateway community economies, or cause changes in visitor attendance or visitor spending patterns.

Noise

This topic was analyzed in the *2008 Plan*, but is dismissed from further analysis here because motorized string trimmers and chainsaws are used only in the 5% of the park that is not designated Wilderness, and for only a small fraction of control efforts within Yosemite. Further, noise created by the use of these machines is insignificant relative to the total noise in the park created by the heavy vehicle traffic on the park's roads, and by similar tools used by the Division of Facilities Management personnel to maintain park landscaping and buildings. The minor noises associated with invasive plant scientific data collection, outreach and education, and physical control activities would not result in measurable additional noise in the park.

Air Quality

This topic was analyzed in the *2008 Plan*. Yosemite National Park is classified as a mandatory Class I area under the Clean Air Act (42 United States Code 7401 et seq.). This air quality classification aims to protect national parks and wilderness areas from air quality degradation. The Clean Air Act gives federal land managers the responsibility of protecting air quality and related values— including visibility, plants, animals, soils, water quality, cultural resources, and public health—from adverse air pollution impacts. The proposed herbicide formulations under Alternatives 2 and 3 are not considered volatile (Dow AgroSciences 2006; Monsanto 2005). The amount of herbicide proposed to be used would have negligible adverse impacts on air quality, even should some of it be volatilized as a hydrocarbon. Due to the lack of additional impacts proposed in this plan, this resource topic was dismissed from further analysis in this document.

Scenic Resources

This topic was analyzed in the *2008 Plan*. Impacts on scenic resources consist of substantial changes that would alter important viewpoints in terms of: 1) existing landscape character, whether foreground, intermediate ground, or background; 2) access to historically important viewpoints or sequences of viewpoints; or 3) the visibility of a viewpoint or sequence of viewpoints. The action alternatives would not impair the above qualities. Due to the lack of additional impacts resulting from this plan, this resource topic was dismissed from further analysis in this document.

Affected Environment

The broader regional setting is described in the following paragraphs. Details about conditions relevant to specific impact topics are described below in each impact topic section.

Regional Setting

Yosemite National Park lies on the western slope of the Sierra Nevada, 170 miles east of San Francisco. The 761,266-acre park ranges in elevation from approximately 1,600 feet along the Merced River on the western boundary of the El Portal Administrative Site to 13,114 feet along the Pacific crest. This steep elevation gradient greatly influences the distribution of both native and invasive plants. While only about 25% of Yosemite lies below 7,000 feet, most invasive species populations occur on sites well below 7,000 feet. Higher elevations are generally free from the impacts of invasive plants, yet are highly vulnerable to non-native plant invasion (see "Purpose and Need" for further discussion).

The Sierra Nevada divides central California from more arid lands to the east. The range is home to three national parks (Yosemite, Kings Canyon, and Sequoia), two national monuments (Devils Postpile and Sequoia), nine national forests, and numerous state parks. About two-thirds of its land area is publicly owned. Despite management, over 200 non-native plant species are present in both Yosemite National Park and Sequoia and Kings Canyon National Parks (Gerlach, Moore, Johnson, et al. 2003).

During the 16th century, some of California's most widespread invasive plants first arrived as hitchhikers on explorers, their livestock, and crops. After introduction, their spread was exacerbated by drought, animal grazing, and the burning practices of American Indians (Hendry 1934). The California Exotic Pest Plant Council lists about 140 of the 1,000 non-native plants on its list of *Plants of Greatest Ecological Concern.* One of these species, yellow star-thistle, is found in 55 of the state's 58 counties and is the most widespread invasive plant in the state's natural areas (CDFG 2003).

The herbaceous biomass of foothill grasslands in Sequoia National Park is 99% invasive species (Parsons and Stohlgren 1989). Invasive species impacts are far lower in park montane, subalpine, and alpine habitats. However, at least 10 new species have been found each year in recent years, some of which have the demonstrated potential to spread into natural areas.

Methodology for Assessing Environmental Consequences

Following a description of the affected environment, the potential environmental consequences or impacts that would occur as a result of implementing each alternative are analyzed and presented for each resource topic. Direct and indirect effects, as well as impairment to park resources, are discussed for each resource. Potential impacts are described in terms of context, duration, intensity, and type (see below). Where impact definitions for a specific resource topic differ from those described below, this difference is described in the text. General definitions for all resources except for historic properties subject to requirements of the NHPA are as follows; specific impact thresholds (intensity) are described at the beginning of each environmental consequences section.

Context describes the area or location in which the impact would occur. Are the effects site-specific, local, regional, or even broader?

Duration describes how long an effect would last, either short-term or long-term:

- *Short-term* impacts typically occur only during implementation, can be quickly reversed, and/or last less than one year.
- *Long-term* impacts are reversed more slowly, typically remaining for more than one year.

Intensity describes the degree, level, or strength of an impact.

- *Negligible impacts* are local and not measurable or at the lowest level of detection.
- *Minor impacts* are local and slight but detectable.
- *Moderate impacts* are readily apparent and appreciable.
- *Major impacts* are severe and highly noticeable.

Type describes the classification of the impact:

- *Adverse impacts* change the affected environment in a manner tending away from the natural range of variability.
- *Beneficial impacts* change the affected environment toward the natural range of variability.
- *Direct impacts* are caused and take place in the same time and place as an action.
- *Indirect impacts* take place at a different time and/or place than the action, and include changes such as species composition, structure of the vegetation, or range of wildlife. Indirect impacts, such as erosion-related impacts, or general economic conditions tied to park activities, can take place off-site.
- *Cumulative impacts* are those impacts on the environment that result from the addition of direct and indirect impacts on other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

Impairment

The NPS *Management Policies* requires analysis of potential effects to determine whether actions would impair park resources (NPS 2006b). The fundamental purpose of the national park system, established by the Organic Act (16 United States Code [USC] 1) and reaffirmed by the General Authorities Act, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or minimize to the greatest degree practicable, adverse impacts on park resources and values. The laws give the NPS the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values.

In addition to determining the environmental consequences of the alternatives, NPS *Management Policies* (2006b) and Director's Order 12 require an analysis of potential effects to determine whether actions would impair park resources. As such, an impact that would harm the integrity of the park resources or values, including the opportunities that otherwise would be present for those resources or values, would constitute impairment. In this environmental assessment (EA), determinations of impairment are provided in the conclusion section under each applicable resource topic for each alternative. The impairment determinations included for each resource topic and alternative analyzed in the text of this chapter address only the 1999 Programmatic Agreement.

1.4.3 The NPS Obligation to Conserve and Provide for Enjoyment of Park Resources and Values

As is mentioned above, the fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. This mandate is independent of the separate prohibition on impairment and applies all the time with respect to all park resources and values, even when there is no risk that any park

resources or values may be impaired. NPS managers must always seek ways to avoid, or to minimize to the greatest extent practicable, adverse impacts on park resources and values. The laws do give the NPS the management discretion, however, to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment of the affected resources and values.

The fundamental purpose of all parks also includes providing for the enjoyment of park resources and values by the people of the United States. The enjoyment that is contemplated by the statute is broad; it is the enjoyment of all the people of the United States and includes enjoyment both by people who visit parks and by those who appreciate them from afar. It also includes deriving benefit (including scientific knowledge) and inspiration from parks, as well as other forms of enjoyment and inspiration. Congress, recognizing that the enjoyment by future generations of the national parks can be ensured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to predominate. This is how courts have consistently interpreted the Organic Act.

1.4.4 The Prohibition on Impairment of Park Resources and Values

While Congress has given the NPS the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the federal courts) that the NPS must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the NPS. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities to enjoy them.

The impairment of park resources and values may not be allowed by the NPS unless directly and specifically provided for by legislation or by the proclamation establishing the park. The relevant legislation or proclamation must provide explicitly (not by implication or inference) for the activity, in terms that keep the NPS from having the authority to manage the activity so as to avoid the impairment.

1.4.5 What Constitutes Impairment of Park Resources and Values

The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or is key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or is identified in the park's general management plan or other relevant NPS planning documents as being of significance.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further minimized. An impact that may, but would not necessarily, lead to impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessionaires, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park.

1.4.6 What Constitutes Park Resources and Values

The "park resources and values" that are subject to the no-impairment standard include: the park's scenery, natural and historic objects, and wildlife and the processes and conditions that sustain them, including, to the extent to which they are present in the park, the ecological, biological, and physical processes that created the park and continue to act upon it; scenic features; natural visibility, both in daytime and at night; natural landscapes; natural soundscapes and smells; water and air resources; soils; geological resources; paleontological resources; archeological resources; cultural landscapes; American Indian traditional uses; historic and prehistoric sites, structures, and objects; museum collections; native plants and animals; appropriate opportunities to experience enjoyment of the above resources, to the extent that can be done without impairing them; and the park's role in contributing to the national dignity, the high public value and integrity, and the superlative environmental quality of the national park system.

1.4.7 Decision-making Requirements to Identify and Avoid Impairments

Before approving a proposed action that could lead to an impairment of park resources and values, an NPS decision maker must consider the impacts of the proposed action and determine, in writing, that the activity will not lead to an impairment of park resources and values. If there would be impairment, the action must not be approved.

Although Congress has given the NPS the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values. Although an impact to a park resource or value may constitute impairment, an impact would be more likely to constitute impairment if it has a major or severe adverse effect on a resource or value whose conservation is:

1. Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
2. Key to the natural or cultural integrity of the park; or
3. Identified as a goal in the park's general management plan or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. A determination on impairment is made for each of the resources under each alternative. However, impairment determinations are not made for health and safety, visitor use, maintenance, operations, socioeconomic resources, or other non-natural or cultural resources topics. Impairment determinations are not necessary for visitor experience, socioeconomics, public health and safety, environmental justice, land use, park operations, and so forth, 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 in the same way that an action can impair park resources and values.

Table III-1. Summary of Environmental Consequences

Resource	*Action*	*Environmental Consequence*	*Potential for Impairment?*
Soil Quality			
Alternative 1	Manage invasives using early detection, physical and cultural control, and two herbicides.	Moderate long-term parkwide beneficial impacts from controlling invasives. Short-term negligible beneficial and adverse impacts where herbicides are used	No
	Inability to use herbicides near water, cultural use plants, and elderberry longhorn beetle habitat could allow spread of rhizomatous invasive plant populations through park.	Potential long-term parkwide moderate adverse impacts if invasive plants not effectively controlled near water	No
Alternative 2	Use of four new herbicides	Short-term minor or negligible adverse impact and long-term moderate beneficial impact	No
	Allowing herbicide use near water would result in more effective invasive control.	Short-term minor or negligible adverse impact and long-term moderate beneficial impact	No
Alternative 3	Adaptive management would allow more effective herbicides to be added as they become available. This greater efficiency would reduce the chemical load on soils.	Similar to Alternative 2. Potential to further minimize short-term minor adverse impacts on soils	No
Hydrology and Water Quality			
Alternative 1	Physical control could cause sediment loading or turbidity and bank instability.	Negligible short-term increases of contaminant inputs to park waters	No
	Limited herbicide use	Short-term localized negligible adverse impacts on water quality, birds, mammals, fish, and invertebrates	No
Alternative 2	Use of four new herbicides	Similar to Alternative 1. Additional herbicide use would result in short-term negligible adverse effect and a long-term negligible positive benefit as invasive plant populations are controlled.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective herbicides and other tools.	Similar to Alternatives 1 and 2. Greater efficiency would reduce chemical load on park waters, resulting in a negligible long-term beneficial impact on water quality.	No

Wetlands			
Alternative 1	Physical and mechanical control	Physical/mechanical controls would result in short-term localized negligible adverse and moderate long-term beneficial impacts.	No
	Limited herbicide use	Restrictions on the use of herbicides could result in long-term moderate adverse impacts on native wetland plant communities.	No
Alternative 2	Use of four additional herbicides	Physical/mechanical: Similar to Alternative 1. Herbicide: Long term, moderate beneficial impacts on park wetlands, lake shores and riparian areas	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Greater efficiency would result in long-term moderate beneficial impacts on park wetlands, lake shores, and riparian areas.	No
Vegetation			
Alternative 1	Physical and mechanical control	Physical/mechanical: Long-term minor beneficial impacts	No
	Limited herbicide use	Restrictions on the use of herbicides could result in long-term moderate adverse impacts on native wetland plant communities.	No
Alternative 2	Use of four additional herbicides	Physical/mechanical: Similar to Alternative 1. Herbicide use near water would result in a parkwide long-term moderate benefit on native vegetation.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Potential to further minimize short-term negligible adverse impacts as more effective products become approved	No
Special Status Plants			
Alternative 1	Physical, mechanical, and limited herbicide use	Special status plants in wetlands and riparian corridors remain at risk for invasive plant propagules because herbicide use is not allowed near water. This could result in long-term minor to moderate adverse impacts.	No
Alternative 2	Use of four additional herbicides	Physical/mechanical: Similar to Alternative 1. Herbicide: Long-term moderate beneficial impact on special status plants	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Potential to further minimize short-term negligible adverse impacts on non-target species as more effective products become approved	No

Wildlife			
Alternative 1	Physical, mechanical, and limited herbicide use	Long-term moderate beneficial or adverse impacts. Control of invasive species would be beneficial; restrictions on herbicide use near water could have long-term moderate adverse impacts due to risk of invasive species along riparian and wetland habitats.	No
Alternative 2	Use of four additional herbicides	Physical/mechanical: Similar to Alternative 1. Herbicide: Short-term negligible adverse impacts; long-term moderate to major benefit to wildlife because, as invasive plant populations are controlled, less herbicide would have to be used	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Potential to further minimize short-term negligible adverse impacts as more effective products become approved	No
Special Status Wildlife			
Alternative 1	Physical, mechanical, and limited herbicide use	Moderate long-term adverse impacts on habitats near water and on the special status species dependent upon those habitats	No
Alternative 2	Use of four additional herbicides	Long-term moderate benefits where invasive plants are not allowed to displace special status wildlife habitat. Overall, a long-term negligible beneficial impact on the valley elderberry longhorn beetle population	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Potential to further minimize short-term negligible adverse impacts	No
Wilderness			
Alternative 1	Physical, mechanical, and limited herbicide use	Possible short-term negligible or minor adverse impacts on the untrammeled, experiential, and undeveloped qualities of Wilderness character; however, these would be outweighed by the positive impacts on the natural quality of Wilderness character. Overall, long-term and moderate beneficial impact on Wilderness character	No
Alternative 2	Use of four additional herbicides	Similar to Alternative 1	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternatives 1 and 2	No

Archeological Resources			
Alternative 1	Physical, mechanical, and limited herbicide use	Ground disturbance could occur. Impacts would be mitigated according to the 1999 Programmatic Agreement. Adverse impacts would not result from Alternative 1.	No
Alternative 2	Use of four additional herbicides	Similar to Alternative 1. Herbicides used to the water line, thus minimizing ground disturbance and potential damage or unearthing of archeological resources. Adverse impacts would not result from Alternative 2.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternatives 1 and 2. More effective treatment would reduce impacts. Adverse impacts would not result from Alternative 3.	No
Traditional and Cultural Properties			
Alternative 1	Physical, mechanical, and limited herbicide use	Management actions have short-term minor adverse impacts on the ability to gather traditional use plants. Traditionally gathered plant populations can be displaced by the continued spread of invasive plants, so the former generally benefit from the latter's removal. No use of herbicides in traditional gathering areas. Alternative 1 would result in no adverse impact.	No
Alternative 2	Use of four additional herbicides	Additional herbicides may be used when appropriate, minimizing ground disturbance, therebu reducing the potential to damage or displace traditionally gathered plant populations. Impacts would be mitigated according to the 1999 Programmatic Agreement. Adverse impacts would not result from Alternative 2.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternative 2. Adverse impacts would not result from Alternative 3.	No
Cultural Landscape			
Alternative 1	Physical, mechanical, and limited herbicide use	Reduce the spread of invasive plants that have the potential to alter the cultural landscape. No adverse impacts would result from Alternative 1.	No
Alternative 2	Use of four additional herbicides	Similar to Alternative 1. Adverse impacts would not result from Alternative 2.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternatives 1 and 2. Adverse impacts would not result from Alternative 3.	No

Visitor Experience and Recreation			
Alternative 1	Physical, mechanical, and limited herbicide use	Possible short-term minor to moderate adverse impact on visitor experience from localized treatments and visitor perspectives; long-term moderate beneficial impact on visitor experience from protection of native vegetation.	No
Alternative 2	Use of four additional herbicides.	Long-term minor beneficial impact on scenic aspect of visitor use in Yosemite. Alternative 2 would protect the visitor experience from invasive species better than Alternative 1.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective, tools.	Similar to Alternative 2. Alternative 3 would protect the visitor experience from impacts resulting from the establishment and spread of invasive species.	No
Park Operations			
Alternative 1	Physical, mechanical, and limited herbicide use	Minor impacts on park operations over the long term due to additional staffing needs.	No
Alternative 2	Use of four additional herbicides	Similar to Alternative 1. Short-term minor adverse impact resulting from increased management efforts and a long-term minor beneficial impact on park operations as invasive species are controlled. Herbicides use to the water's edge would result in minor long-term beneficial impacts on park operations.	No
Alternative 3	Adaptive management would allow for better protection and safer, more effective tools.	Similar to Alternatives 1 and 2. Improved program effectiveness resulting from adaptive management would result in minor long-term positive impacts.	No

Impact Topics

The "Affected Environment/Environmental Consequences" chapter is long and complex. To help the reader differentiate between the findings for the individual impact topics, the impact topics are numbered.

1. SOILS

Affected Environment

Soils form over time through complex interactions between geologic source materials, climate, topography, and living organisms, resulting in about 120 soil types in the Yosemite region (USDA 2006). Yosemite soils are derived primarily from granitic bedrock, and are of similar chemical and mineralogical composition. Metamorphic bedrock, found along the park's western edge and along the eastern edge of the Sierra Crest, underlies less than 5% of the park area. Most high-country soils developed in place from bedrock parent material or developed in glacial material (NPS 2004).

Soil in Yosemite constitutes a diverse, intact, and functioning ecosystem that is home to a wide range of microbial and animal groups, including bacteria, protozoa, nematodes, and fungi. Invasive plant communities can alter nitrogen levels (Evans, Rimer, Sperry et al. 2001), phosphorus cycling (Zabinski 2002), soil biota (Belnap and Phillips 2001), and soil moisture (Enloe, DiTomaso, Orloff et al. 2004). These changes can foster invasive plant infestations and reduce native plant diversity.

Environmental Consequences

The capacity of soil to maintain and promote a healthy ecosystem depends on the resistance of the soil to degradation. Resistance to degradation is the ability of a soil system to function without change through a disturbance (Pimm 1984). Disturbances that can lead to soil degradation include trampling, climate change, alterations in hydrologic processes, and introduction of invasive species. Invasive plant control activities, such as tilling and herbicide use, can have local effects on soil quality that are similar to those resulting from agriculture.

This environmental assessment considers impacts on three categories of soils: *sensitive soils*, *resilient soils*, and *other soils*. *Sensitive soils* support or have the potential to support highly valued vegetation communities, such as meadows and wetlands. They have an aggregate structure and chemistry that are easily affected by disturbance. *Resilient soils*, typically well-drained upland sandy soils, are capable of withstanding alteration and heavier use without permanent deformation, or recover easily from alteration and disturbance. *Other soils* are not considered highly valued or resilient soils. These soils are generally more abundant than other park soils. They do not support rare or notably diverse plant communities.

The duration of an impact is the time required for soil to recover after treatment. The impact on soil quality is considered short-term if soil system recovery would take less than 20 years, and long-term (or

permanent) if recovery would take over 20 years. The duration of impact for all actions described in this plan is expected to be much less than 20 years.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Impacts are discussed below.

1) Preventing future infestations and limiting the spread of current infestations would keep invasive plants from displacing native plant communities. This process would result in moderate long-term parkwide beneficial impacts on soil microorganisms, soil chemistry, and hydrologic cycles in areas where invasive plant populations are removed, and in long-term minor benefits at the scale of the entire park.
2) The limited use of the herbicides glyphosate and aminopyralid, and their associated adjuvants, surfactants, and "inert" ingredients, would have a short-term negligible adverse impact on soil quality in the immediate area where they are used (see Appendices F, G, and H). Using herbicides instead of physical methods would result in reduced soil disturbance where plants would otherwise be pulled or dug up by their roots. This would result in a short-term negligible site-specific positive impact on soil quality.
3) Herbicide use is not allowed within the 10-foot buffer from standing and moving water, near cultural use plant populations, or within 100 feet of longhorn beetle habitat. Many rhizomatous, perennial plant species are not responsive to physical controls. Digging up plant roots can result in the germination of seeds from the invasive plant seed bank, thus promoting their dispersal. If rhizomatous, perennial invasive plants are not controlled near water, displacement of native plant communities by rhizomatous invasive species could result in long-term moderate adverse impacts on soils where invasive plant populations exist. However, invasive plant management program actions, whether physical, cultural, chemical, or other, that are taken to control invasive species would not result in more than localized short-term negligible adverse impacts on park soils.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on soil microorganisms and chemistry, Alternative 1 would not result in impairment of the park's soils for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the park would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr and triclopyr) would be added under this alternative. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. The minimum amount of low-toxicity herbicides necessary to meet management goals would be used.

1) Impacts on soil microorganisms, chemistry, and hydrologic cycles would be similar to those under Alternative 1.
2) The use of four additional herbicides would not result in impacts on park wetlands different from those under Alternative 1.
3) Allowing herbicide use to the water line and within the beds and banks of Wild and Scenic rivers would allow for more effective control of invasive species on wetland and riparian soils. This would result in a short-term negligible adverse impact on soil quality in the immediate area where they are used. As compared with Alternative 1, this would result in a long-term moderate benefit to wetland and riparian soils as the vegetation growing on these soils was prevented from being displaced by non-native plants.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on soil microorganisms and chemistry, Alternative 2 would not result in impairment of the park's soils for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides in question must: 1) be approved for use by the U.S. and California environmental protection agencies, 2) be tested in a wildland setting and have no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., in the case of an aquatic threat such as hydrilla (*Hydrilla verticillata*)).

1) Impacts from Alternative 3 would be similar to those described in Alternatives 1 and 2.
2) The primary difference between Alternative 3 and Alternatives 1 and 2 would be the potential to further minimize short-term minor adverse impacts on soils. Adaptive management would allow more effective products to be added to the park's toolbox as they become available. Greater efficiency would reduce the chemical load on soils.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on soil microorganisms and chemistry, Alternative 3 would not result in impairment of the park's soils for future generations.

Cumulative Impacts

Analysis of cumulative impacts on soil resources is based on past, present, and reasonably foreseeable future regional actions, combined with the potential effects of the three alternatives presented here. During the past 150 years, activities associated with urbanization (such as storm water discharge and construction), agriculture, and forestry have contributed to adverse impacts on soils. Impacts range from direct loss of soil ecosystems to indirect losses such as changes in water flows that saturate wetland soils. The overall effect of statewide activities on soil ecosystems and soil quality has been adverse, long-term, and major.

California's widespread and severe invasive plant problems have also adversely impacted soil resources (Bossard, Randall, and Hoshovsky 2000). While fewer than 10% of the 1,000-plus (Hickman 1993) non-native plant species currently established in California are recognized as serious threats, non-native plants have changed the state's landscapes dramatically. Some alter soil chemistry, making it difficult for native species to survive and reproduce (Bossard et al. 2000). Present and future park actions would restore native habitat, enhancing the biological quality of native soils. Inspection of equipment that enters the park to ensure it is free from mud and other materials that could import invasive plant seeds, and prescribed fire and managed wildland fire activities that remove litter, allowing oxygen to reach the soil and returning bound nutrients, provide localized long-term minor benefits to soils.

Combined national, state, and local programs would address the growing invasive species crisis facing California and the NPS. Control would benefit soils resources because invasive plants can alter nutrient cycling (Zabinski 2002) and other biotic and physical processes (Belnap and Phillips 2001). Regional invasive plant control actions sponsored by the California Department of Transportation (Caltrans), California Department of Food and Agriculture, Mariposa County, Tuolumne County, Madera County, the Sierra-San Joaquin Noxious Weed Alliance, and the federal agencies adjacent to Yosemite National Park (Sierra National Forest, Stanislaus National Forest, Inyo National Forest, and the Bureau of Land Management (BLM), Merced Canyon) each take a variety of actions to control invasive plants. These invasive plant actions protect or restore native habitat, fostering native soil ecosystems. Past impacts on soil ecosystems and soil quality have been adverse, long-term, and major.

Present and foreseeable future invasive plant management actions resulting from the three alternatives presented here would contribute in a local way to reversing the major adverse impacts on soils resulting from past actions, and would produce long-term moderate beneficial effects on soils. Current invasive plant treatments include hand pulling, shovel shearing, mowing, changing management practices to the advantage of native species, and using herbicides. Most invasive plants found in the park are found in developed areas such as roadsides and campgrounds. Based upon acreages treated with herbicide by August 19, 2010, it is estimated that 81 of the Park's total 761,266 acres will be treated using herbicides during the 2010 season. Only 40.7 acres were treated using herbicides in 2009. Combined adverse impacts on soils from all invasive plant treatment methods would be local, short-term, and negligible. Overall, invasive plant management efforts in Yosemite National Park are expected to have local long-term minor beneficial impacts on soils.

Conclusion

Under Alternative 1, ground-disturbing activities may result in short-term negligible adverse effects on soil microorganisms, soil chemistry, and hydrologic cycles, but would not result in impairment. Alternatives 2 and 3 would meet integrated pest management goals because work crews would use physical and cultural means, as well as the minimum amount of low-toxicity herbicides necessary, to meet management goals. While some control actions, such as digging up invasive plant roots, might result in localized negligible to minor adverse impacts on soils, there would be long-term moderate beneficial impacts on soil microorganisms, soil chemistry, and hydrologic cycles as invasive plant populations are controlled. Overall, both action alternatives would result in a short-term minor or negligible adverse impact on soils and a long-term moderate beneficial impact on soils.

2. HYDROLOGY AND WATER QUALITY

Affected Environment

Yosemite has a Mediterranean climate, with the majority of precipitation occurring during the winter months as rain or snow, depending upon elevation. Other than occasional high-elevation thunderstorms, precipitation rarely occurs from late spring to late summer. Groundwater and surface water typically recharge during the spring snowmelt.

Surface waters include over 3,200 lakes, the Merced and Tuolumne rivers and their associated streams, and multiple wetlands. Subsurface flow paths and rates, as well as basin groundwater residence times, have been little studied in Yosemite, but they are likely to play a large role in regional hydrologic cycles. With over 94% of the park designated as Wilderness, surface and subsurface flow is largely unaltered by human activities.

Water quality is important to the health of habitats throughout the park. It is generally excellent, with most surface and subsurface waters having low concentrations of minerals and organic contaminants. The direct input of contaminants into Yosemite's water bodies is small, and it is localized in areas that are used heavily by visitors (NPS 2000). The surface water quality throughout most of Yosemite is beneficial to freshwater habitat (California Regional Water Quality Control Board Central Valley Region 1998). Surface water in the park exhibits considerable variability in chemical composition, despite the relative homogeneity of bedrock chemistry (Clow, Mast, and Campbell 1996). Surface water in most of the Merced River basin is diluted and lacking in dissolved solids, making the ecosystem sensitive to human disturbances and pollution (Clow et al. 1996).

Recent Park Herbicide Use and Expected Water Quality Impacts from Herbicide Use

The Tuolumne River watershed, which includes the Hetch Hetchy Reservoir, provides 85% of San Francisco's total water needs. Because of its high quality, water from the Hetch Hetchy Reservoir is treated, but not filtered. Herbicides, if they are not used according to their labels, can have an adverse effect on drinking water quality and sensitive wetland, lake, and riparian habitats and species. Such effects will not occur in Yosemite, as herbicides will not be used at rates that exceed those stated on the label. Park managers carefully considered whether water quality monitoring would be necessary in conjunction with herbicide use. Relevant studies were reviewed. Toxicologists, university scholars, and resource managers were consulted. The results of the analysis led park managers to conclude that water quality monitoring would be unnecessary given the low human and environmental toxicity of the herbicides selected for use, and the very limited current and expected use of herbicides in Yosemite National Park. For example, during the 2009 and 2010 field seasons, a total of 26.9 gallons of glyphosate and 2.2 gallons of aminopyralid were applied to 120 acres of the park (Figure llI-2). This amounts to 0.01% of Yosemite's 761,266 acres having been treated using herbicides over those two years. The entire area treated during those two years is dispersed throughout the park and is cumulatively smaller than most agricultural operations.

Aerial application of herbicides is not included in any of the alternatives; however, studies analyzing the impacts of this application type can inform the park as to possible impacts on surface water quality and wildlife (see studies listed below). Studies performed on working forest lands have analyzed the impacts on water quality resulting from aerial pesticide applications performed at the landscape scale. In these studies, the scale of application was far larger than is used within Yosemite National Park. In these forestry studies, herbicides were applied across areas tens or hundreds of acres in size. In Yosemite National Park, herbicides are applied using targeted applications from a backpack handline attached to a truck-mounted sprayer or wands connected to a backpack-mounted sprayer. The gross area of

herbicide application is generally less than an acre. Spot spraying of targeted plants results in direct application of herbicides to only a fraction of the gross area. In spite of these differences, the following forestry studies can inform the park as to possible impacts on surface water quality and wildlife resulting from the relatively far more limited herbicide applications in Yosemite:

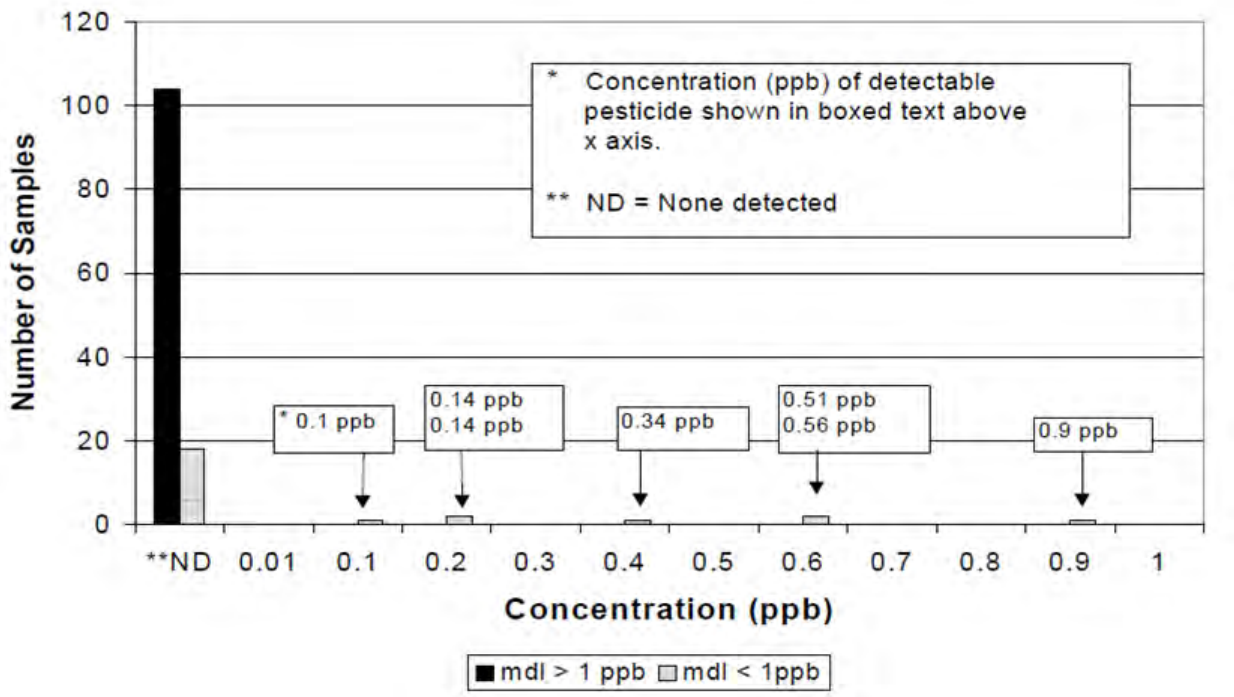
1) In a 2004 California study, herbicide drift and impacts on amphibians were assessed in conjunction with aerial applications of clopyralid, used to treat yellow star-thistle (DiTomaso et al.).The study found that even where aerial applications were made almost to the water's edge, concentrations in the water were less than 0.25 parts per billion. Even when clopyralid was deliberately applied directly into standing water where larval toads were present, a worst-case scenario, the resulting herbicide concentrations in water were below concentrations toxic to amphibians.
2) A study from the Oregon Department of Forestry (Oregon Department of Forestry 2002) that assessed the possible impacts of drift or post rain runoff from pesticide use in natural areas found no discernable residue in water samples. In this study, herbicides, fungicides, insecticides, and rodenticides were applied aerially to forest plots to aid in the reestablishment, growth, and survival of forest tree species throughout Oregon. Buffer zones of 0, 60, or 300 feet were established, depending upon stream or wetland classification. Five samples and a control sample were collected at 26 sites. No pesticides were detected at greater than method detection levels of 1 part per billion. Twenty-five post spray samples were also tested at method detection levels that ranged from 0.04 to 0.5 parts per billion, with seven detections (Figure Ill-1). These results were similar to those of other studies conducted in Oregon and Washington in the 1980s and 1990s. The results indicated that the majority of the 24-hour-average composite samples contained either no detectable residue or less than 1.0 part per billion of the applied pesticide (Oregon Department of Forestry 1992; Rashin and Graber 1993).
3) In 2007, The Sierra National Forest, located west and south of Yosemite National Park, conducted water quality monitoring for glyphosate (personal communication, Joanna Clines, forest botanist with Sierra National Forest, 2007) to control yellow star-thistle in the Merced River Canyon. During water quality sampling following the application, no residual herbicides were detected.

Environmental Consequences

Invasive plant control activities under the three alternatives could result in two types of impacts on water quality: 1) changes in sediment loading due to soil disturbance from hand pulling, trampling, or digging of roots, and 2) direct inputs of pollutants due to herbicide use. Five risk assessment factors were analyzed for each of the six herbicides: 1) toxicity, 2) bioaccumulation, 3) acute impact, 4) half-life in water and soils, and 5) mechanisms of degradation. Details for each herbicide are summarized in the alternatives sections. A thorough discussion of each herbicide is located in Appendix G.

As part of the analysis for this plan, park scientists evaluated the potential of each alternative to increase turbidity and chemical contaminants in the park's surface and subsurface waters. Disturbances to the land surface can increase the quantity of sediment in surface waters, which can adversely affect aquatic habitat and biota.

Duration of Impact. The duration of an impact is the time required for water quality to return to pretreatment conditions. The impact is considered short-term if water quality would return to pretreatment conditions in several hours. The impact is considered long-term if it would take longer than several hours for water quality to return to pretreatment conditions.



Notes: A method detection level equal to 0.04 to 1.0 part per billion. Seven out of twenty-five samples tested at method detection levels of less than one part per billion contained trace concentrations of pesticide. (Oregon Department of Forestry 1992)

Figure III-1. Concentrations of Pesticides Detected in 129 Post-Spray Samples from 26 Operations

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species outside of, and 2 species inside, designated Wilderness. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Risks for the chemicals currently being used were assessed in terms of toxicity, bioaccumulation, acute impact, half-life in water and soil, and mechanism of degradation. Impacts and risk assessments are described below.

The information below is summarized from Appendices F, G, and H.

1) **Toxicity:** Glyphosate and aminopyralid mimic plant hormones called auxins. Glyphosate has been tested on a variety of wildlife, birds, and mammals in both laboratory and wildland environments. Because these herbicides function in ways specific to plant and not animal physiology, they are of low toxicity to animals, including fish, amphibians, and insects.
2) **Bioaccumulation:** The two chemicals used currently, glyphosate and aminopyralid, are passed through urine and feces unchanged and are thought not to bioaccumulate (Schuette 1998). In a study cited in Franz, Mao, and Sikorski (1997), scientists found that rats excreted 97.5% of an

administered dose in their urine and feces. Other metabolism studies have found that glyphosate residues have minimal tissue retention and are eliminated rapidly from various animal species, including mammals, birds, and fish (Franz et al. 1997). In oral ingestion studies, less than 0.73% of ingested aminopyralid was recovered in animal tissues.

3) **Acute Impact:** Most studies involving glyphosate have shown no adverse effects on soil microorganisms, including soil nitrogen cycling processes. Glyphosate is no more than slightly toxic to fish, and practically non-toxic to amphibians and aquatic invertebrate animals. LD50 for glyphosate in mammals ranges from 1700-6,000mg/kg; for aminopyralid, LD50 is >5,000mg/kg/day. For comparison, LD50 for caffeine is 127 mg/kg (Science Lab 2005a) and for table salt (sodium chloride) is 3,000 mg/kg (Science Lab 2005b).
4) **Half-life in water and soil:** The half-life for glyphosate in water is a few days to two weeks. Because glyphosate binds quickly and strongly to soils, it is not mobile, does not displace easily, and is no longer available to plants. The half-life in soil for glyphosate ranges from 1-197 days. The half-life of aminopyralid ranges from 6-533 days, with the latter being the case assuming that all "non extractable residues" were the parent chemical (PMRA 2007).
5) **Mechanisms of degradation:** Glyphosate is biodegraded in both water and soil, primarily by microorganisms. Aminopyralid is likely to degrade aerobically by metabolism in the soil. On the surface, photo-degradation occurs with a half-life of 72 days.

Considering the risk assessment, impacts could include the following:

1) Ground-disturbing activities from physical removal of invasive plant roots near streams could result in negligible short-term increases in sediment loading or turbidity. The use of weed trimmers and other motorized and non-motorized equipment would result in negligible short-term increases of contaminant inputs to park waters.
2) Because of low toxicity and targeted application, the use of aquatic glyphosate formulations using standard application rates and techniques have short-term localized negligible adverse impacts on water quality, birds, mammals, fish, and invertebrates (U.S. Forest Service 2003; Relyea 2005a; Thompson, Solomon, Wojtaaszek, et al. 2006).
3) Because of aminopyralid's low toxicity and short half-life, its use according to the application rates and techniques approved on the label (see Appendices G and H) would result in short-term negligible adverse impacts on water quality.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on water quality and aquatic flora and fauna, Alternative 1 would not result in impairment of the park's water quality for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Alternative 2 introduces four herbicides to treat invasive species that the herbicides under the existing plan cannot efficiently treat. The additional herbicides are approved by the U.S. and California environmental protection agencies and have been recommended by invasive plant researchers, toxicologists, and resource management specialists. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals. Impacts and risk assessments are described below. Risk assessment for Alternative 2 includes the

assessment for the chemicals currently being used in addition to the four proposed herbicides. They were assessed for toxicity, bioaccumulation, acute impact, half-life in water and soil, and mechanisms of degradation.

After reviewing the above studies, and because of the very limited current and expected use of herbicides in Yosemite National Park, resource managers at Yosemite National Park have decided not to conduct water quality monitoring for the four herbicides proposed for use under Alternative 2. This decision was supported by Joel Trumbo, staff environmental scientist with the Pesticides Investigations Unit of the California Department of Fish and Game, and Joseph DiTomaso, non-crop weed specialist, Department of Vegetable Crops, University of California, Davis. The experts concurred that at current and proposed rates of herbicide application, expected rates of detection for herbicides in surface waters in Yosemite could be in the parts per quadrillion, that is, below detection limits.

Studies show that the four additional chemicals being proposed in Alternatives 2 and 3, triclopyr, imazapyr, rimsulfuron, and chlorsulfuron, are practically non-toxic to fish and mammals, rapidly eliminated in urine and fecal matter, and thought to not bioaccumulate (Appendix G). They have half - lives in aqueous environments ranging from 0.5 days for triclopyr to 23 days for chlorsulfuron. The small amounts of herbicide use being proposed, coupled with application occurring during the dry time of the year, minimizes risks to wildlife.

The information below is summarized from Appendix G.

1) **Toxicity:** Triclopyr mimics plant compounds known as auxins. Imazapyr, rimsulfuron, and chlorsulfuron inhibit the enzyme acetolactate synthase. Because these herbicides function in ways specific to plant physiology, they are of low toxicity to animals, including fish and insects. There is no evidence of acute or chronic neurotoxicity resulting from exposure to imazapyr. Chlorsulfuron presents little hazard to the environment because it is used at low rates and degrades relatively quickly in most field situations.
2) **Bioaccumulation:** When fed to test animals, triclopyr was excreted unchanged; imazapyr was excreted rapidly in the urine and feces with no residues accumulating in the liver, kidney, muscle, fat, or blood; rimsulfuron was rapidly eliminated via urinary and fecal excretion in rats; and chlorsulfuron passed through the digestive tract largely unmetabolized and unchanged. These studies suggest bioaccumulation of these herbicides does not readily occur.
3) **Acute Impact:** Acute toxicity levels (LD50) for triclopyr for mammals ranged from 310-713 mg/kg and for ducks was 1698 mg/kg; studies suggest triclopyr is not an endocrine disruptor. Imazapyr LD50 for rats was >5000 mg/kg; studies suggest imazapyr is not a carcinogen and has no known reproductive effects. LD50 for rimsulfuron is >5,000 mg/kg for rats and >2,000 mg/kg for rabbits. LD50 for chlorsulfuron was between 5,000 and 6,000 mg/kg for rats.
4) **Half-life in water and soil:** Half-lives in aqueous solutions were relatively similar for three of the four chemicals: triclopyr- 0.5-7.5 days; imazapyr- 3-5 days and; rimsulfuron- 0.2-4.6 days. The rate of hydrolysis of chlorsulfuron is influenced by pH and can range from 23 days (pH=5) to 53 days (pH=>7.5). In soils, dissipation rates varied. Triclopyr ranged from 2.8-5.8 days; 19-34 days were necessary for imazapyr; 18-21 days at 25°C under aerobic and anaerobic conditions were needed for rimsulfuron; and 14 to 320 days were needed for chlorsulfuron.
5) **Mechanisms of degradation:** Microbial degradation is the main dissipation route of triclopyr. Degradation of imazapyr takes place mainly through photolysis in an aqueous environment. There is little to no photodegradation of imazapyr in soil, and the herbicide is not readily degraded by other chemical processes. 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. Degradation by hydrolysis appears

to be the most significant mechanism for degradation of chlorsulfuron, but is significant only in acidic environments. Soil microbes break down chlorsulfuron, and breakdown takes place faster in moist soils and at higher temperatures. In forest dissipation studies, triclopyr, imazapyr, and rimsulfuron show the potential for groundwater contamination to be minimal. Chlorsulfuron has a high potential to contaminate groundwater, but due to its relatively rapid degradation in plants and soils, low use rates, and low toxicity, it is not likely to cause significant contamination.

Considering the risk assessment, impacts could include the following:

1) Impacts of Alternative 2 would be similar to those under Alternative 1.
2) The ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. This additional herbicide use would have a negligible adverse effect on water quality in the short term, and a negligible positive benefit to water quality in the long term as invasive plant populations near water are controlled.
3) More herbicides could be used as they become a regular part of the park's invasive plant management toolbox. This increase would be countered by the fact that smaller amounts of more effective herbicides could also be used for treating invasive plant populations. There would be a long-term benefit because, as invasive plant populations are controlled, less herbicide would have to be used. The use of four additional herbicides would not result in impacts on park wetlands different from those under Alternative 1.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on water quality and aquatic flora and fauna, Alternative 2 would not result in impairment of the park's water quality for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements adaptive management that establishes protocols for the introduction of additional tools. Additional herbicides may be approved for use if they: 1) are approved for use by the U.S. and California environmental protection agencies, 2) have been used and tested previously in a wildland setting and have minimal adverse impacts, and 3) provide functionality and safety that herbicides that are currently used and proposed do not provide (e.g., in cases of aquatic threat such as purple loosestrife and hydrilla). Additionally, there is potential to further minimize short-term negligible adverse impacts on water quality as more effective products become available and replace what is being used. Greater efficiency resulting from adaptive management would reduce chemical load on park waters, resulting in a negligible long-term beneficial impact on water quality.

Considering the risk assessment, impacts could include the following:

1) Impacts of Alternative 3 would be similar to those of Alternatives 1 and 2.
2) Any additional herbicides would undergo an assessment of risks to human health, water quality, and aquatic wildlife and non-target plants before being approved for use (Appendix G). Additional herbicides would not be considered if their use would cause more than a minor adverse short-term impact on hydrology and water quality.

3) Work plans proposing aquatic herbicide use (i.e., spraying directly in a water source) would go through the environmental compliance process. Only low-toxicity aquatic herbicide formulations would be used. Spraying in water would not be considered if such an action would cause more than a minor adverse short-term impact on hydrology and water quality.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on water quality and aquatic flora and fauna, Alternative 3 would not result in impairment of the park's water quality for future generations.

Cumulative Impacts

Cumulative impacts on hydrology and water quality resources are determined based on analysis of past, present, and reasonably foreseeable future actions in California and the Yosemite region in conjunction with the potential effects of these alternatives. Over the past 150 years, activities associated with urbanization in California have contributed to adverse impacts on water flow patterns and water quality. Municipal and industrial installations such as power plants, wastewater treatment facilities, factories, and oil refineries continue to have an adverse affect on water resources due to alteration of water flow and discharge of effluents. Agriculture and silviculture practices have led to erosion of soils and non-point source discharge of nutrients and chemicals into streams, rivers, and coastal waters.

In the Sierra Nevada, chemical water quality may be impaired downstream of urban centers, mines, and extensive land use zones (Centers for Water and Wildland Resources 1996). Many low- to middle-elevation reservoirs accumulate near-toxic levels of mercury. Water diversions have increased salinity in lakes on the east side of the Sierra Nevada. Dams and diversions have profoundly altered the timing and amount of stream flows. The overall effect of statewide activities on hydrologic flows and water quality has been adverse, long-term, and major.

Present and future regional activities in the Yosemite region would have both beneficial and adverse impacts on hydrology and water quality. Planning efforts regarding large-scale watersheds such as the Merced and Tuolumne Wild and Scenic comprehensive management plans would protect and enhance Wild and Scenic river values. Hydrologic and ecosystem restoration efforts would produce local long-term minor beneficial effects on hydrology, including natural inundation periods.

Past impacts on hydrology and water quality have been adverse, long-term, and major. Present and foreseeable future actions would contribute to reversing the major adverse impacts of past actions on hydrology and water quality in California and the Yosemite region, and would produce long-term minor beneficial effects on hydrology and water quality. These past, present, and future effects, along with the long-term negligible adverse impacts of all three alternatives, would result in long-term adverse minor impacts.

Conclusion

Under Alternative 3, ground-disturbing activities may result in short-term negligible adverse increases in sediment loading or turbidity. Because the proposed actions would be expected to result in negligible adverse impacts on water quality, Alternative 1 would not result in impairment.

Increased prevention, early detection, and monitoring under the action alternatives would have a negligible beneficial impact on water quality. Proposed ground-disturbing activities would result in a negligible increase in sediment loading. Because there would be limited herbicide use and limited reductions in other sources such as weed trimmers and equipment, the impact on water quality would be long-term, negligible, and adverse. Because the action alternatives would be expected to result in

negligible adverse impacts on water quality, they would not result in impairment of the park's water quality for future generations.

3. WETLANDS

Affected Environment

Wetlands are defined by the U.S. Fish and Wildlife Service (USFWS) and the NPS as lands in transition between terrestrial and aquatic systems, where the water table is usually at or near the surface, or shallow water that covers the land (at least seasonally). Three key features characterize wetlands: the presence of standing water throughout part of the growing season, unique wetland soils, and vegetation adapted to or tolerant of saturated soils. Hydrology is the primary driver of wetland ecosystems, leading to the development of wetland soils and biotic communities.

Wetlands provide major contributions to ecosystem productivity, as well as structural and biological diversity. Many Sierra Nevada plants and animals depend entirely on wetlands. Wetlands also perform vital hydrological processes such as flood abatement, sediment retention, groundwater recharge, nutrient capture, and decomposition of organic matter.

Yosemite wetlands occur in and near meadow, riparian, and pond habitats. The NPS uses a system created by the USFWS (Cowardin, Carter, Golet et al. 1979) as the standard to define, classify, and inventory wetlands. In 1995, the USFWS mapped over 19,100 acres of wetland habitat in Yosemite as part of the National Wetlands Inventory (USFWS 1995). The actual acreage of wetlands in Yosemite is probably larger, as national wetlands inventory mapping misses many wetlands smaller than 5 acres. Wetlands are particularly vulnerable to invasive plants. Although wetlands constitute less than 6% of the earth's land mass, 24% of the world's most invasive plants are wetland species (Zedler and Kercher 2004). Invasive plant infestations can degrade wetland habitat by changing sediment loading, surface and subsurface flows, vegetation structure, soil chemistry and biota, and water table depth (Gordon 1998). Wetlands with a history of hydrological disturbance tend to be more invaded than undisturbed wetlands. This is evident in Yosemite Valley, particularly in meadows where culverts and ditches have altered surface and groundwater flows. Such meadows are now dominated by non-native perennial grasses.

Of the over 200 species of non-native plants known to occur in Yosemite, 29% have the potential to occur in wetlands (USFWS 1997) (Appendix B). Wetland invasive plants typically follow the same elevation pattern as native species, and are more widespread at lower elevations and less common at higher elevations. A 2005 Yosemite inventory of non-native plants in riparian habitats (typically wetland habitats) found non-native plant species in 46% of the riparian plots surveyed (Kane, Heath, and Kuhn 2006).

One relatively recent invader, velvet grass, documented on over 285 acres, forms one of the largest invasive plant infestations in Yosemite wetlands. A prolific seed producer, it often forms monocultures that displace native plant habitats and the wildlife that depend upon these habitats. This includes amphibians, some of which are park species of concern

Himalayan and cut-leaved blackberry (*Rubus laciniatus*) are the primary invaders of wetlands in Yosemite Valley. Over 85 acres are infested by non-native blackberry in Yosemite Valley. Blackberry is

also scattered in low- and mid-elevation wetlands and riparian areas in other areas of the park. Black locust and tree-of-heaven are other higher-priority invasive plants that have been documented in park wetlands.

A total of 3.5 canopy acres of Himalayan blackberry and velvet grass were treated in seasonally dry wetlands using herbicides in 2009. Based upon acres treated as of August 19, 2010, an estimated 5.5 canopy acres of Himalayan blackberry will be treated in wetlands in 2010. That constitutes 0.0002% of the park's estimated 19,100 total acres of wetlands. Herbicide use is expected to rise slightly for the next five years as the backlog of existing-priority invasive plant populations is controlled. Once existing-priority invasive plant populations are brought under control, the program emphasis would switch to early detection and eradication, and herbicide use in wetlands would be expected to decline.

Environmental Consequences

The NPS manages wetlands in compliance with Executive Order 11990 (Wetland Protection), the Clean Water Act, and the Rivers and Harbors Appropriation Act of 1899, and in accordance with the procedures described in NPS Director's Order 77-1: *Wetland Protection.* Executive Order 11990 directs the NPS to: 1) provide leadership and take action to minimize the destruction, loss, or degradation of wetlands; 2) preserve and enhance the natural and beneficial values of wetlands; and 3) avoid direct and indirect support of new construction in wetlands unless no practicable alternatives exist. This analysis focuses on the potential for actions to affect the natural and beneficial values of wetlands. Examples of wetland functions and values include the following:

- biotic functions such as supporting habitat and fish, wildlife and special status species diversity, floral and faunal productivity;
- hydrologic functions such as flood attenuation, stream-flow maintenance, groundwater recharge and discharge, water supply, erosion and sediment control, and water purification;
- cultural values such as aesthetics, education, historical values, archeological values, recreation and interpretation; and
- research/scientific values such as reference sites for research on unaffected ecosystems.

Duration of Impact. The duration of an impact is the time required for wetlands to return to pretreatment conditions. Short-term impacts are those that would last up to 10 years following implementation of an alternative. Long-term impacts would last longer than 10 years after implementation of an alternative.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species outside of and 2 species inside of designated Wilderness. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts are described below.

1) Invasive plant prevention and early detection and eradication and prevention would have long-term moderate beneficial impact on wetlands

2) Physical and mechanical invasive plant removal could result in localized short-term negligible adverse impacts on wetland soils.

3) The use of herbicides would allow the park to meet management objectives for nine invasive plants with the potential to invade non-Wilderness wetlands: Himalayan and cut-leaved blackberry, velvet grass, perennial pepperweed, giant reed, bull thistle, ox-eye daisy, tree-of-heaven, and black locust. Herbicides would be used on Himalayan blackberry and velvet grass only in the 95% of the park that is designated Wilderness. Glyphosate would be used in wetlands and riparian areas at least 10 feet from standing water during the dry season. Glyphosate applications, and the trampling associated with herbicide applications, could result in localized short-term negligible adverse impacts on adjacent native vegetation.

4) The use of glyphosate to control wetland invasive plants would have a localized negligible adverse effect on native amphibians and other wetland wildlife (see "Wildlife" section, Chapter III). Glyphosate is not expected to affect wetland water quality (see "Hydrology and Water Quality" section in this chapter).

5) Compared with physical and mechanical treatments, the use of herbicides would reduce the extent and intensity of disturbance to wetland soils, and would more effectively treat some invasive species, particularly rhizomatous perennials. Native species' abundance and diversity would increase in restored sites, thereby enhancing natural habitat for native wildlife. There would be no impacts on hydrologic functions (e.g., flood attenuation, stream flow maintenance, groundwater recharge and discharge, water supply, erosion and sediment control, water purification).

6) Under the *2008 Plan*, no herbicide treatment would occur within 10 feet of standing or moving water. Only two species, Himalayan blackberry and velvet grass, would be treated with herbicides in wetlands located in designated Wilderness. The success of physical methods for controlling these species has been limited in the park because physical control, especially for rhizomatous species, requires multiple labor- and time-intensive treatments per year over many years. Staffing and monetary resources for such intensive efforts are limited. Restrictions on the use of herbicides to treat invasive species near water and within the bed and banks of Wild and Scenic rivers could limit the ability of resource managers to control wetland and riparian invasive species, allowing these species to spread further throughout the park. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on park wetlands.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on wetland, riparian, and lakeshore soils, hydrology, and wildlife, Alternative 1 would not result in impairment of the park's wetlands for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan to allow for more effective treatment of a wider range of invasive species. The additional herbicides are U.S. and CAL EPA approved, and recommended by toxicologists, invasive plant researchers, and resource management specialists for their efficacy, negligible human health effects, and low environmental effects. Introducing an additional aquatic herbicide and the ability to spray to the water line would be of

particular importance in the control of certain non-native invasive species. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals. Impacts could include the following:

1) Impacts would be similar to Alternative 1. The use of four additional herbicides would not result in impacts on park wetlands different from those under Alternative 1.
2) Herbicide use in wetlands has been, and is expected to remain, very limited; an estimated 5.5 canopy acres of wetland, or 0.0002% of the park's total wetland acreage, were treated in 2010. Should Alternative 2 be adopted, this acreage is expected to rise slightly as more herbicides are used near water. Even if this acreage quadrupled under Alternative 2, only 22 acres, or 0.001% of Yosemite Park wetlands, would be treated in any one year. The total acreage treated is expected to decline significantly after five years, as priority species are controlled and program emphasis switches to early detection and control.
3) Allowing the use of herbicides to control invasive species to the water's edge would result in more effective control of wetland and riparian invasive species. This is very important for protecting the integrity of the park's native vegetation communities, as rivers and streams are a primary vector for the spread of invasive species propagules. This would result in long-term moderate beneficial impacts on park wetlands, lakeshores, and riparian areas.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on wetland, riparian, and lakeshore soils, hydrology, and wildlife, Alternative 2 would not result in impairment of the park's wetlands for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements adaptive management, which provides protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. If new herbicides are to be used, they must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and display no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., against aquatic threat such as hydrilla). Impacts could include the following:

1) Impacts would be similar to those in Alternatives 1 and 2.
2) There is potential for short-term localized negligible adverse impacts on wetland water quality, soils, wildlife, and native plants resulting from the physical and chemical controls listed under Alternative 3.
3) Greater efficiency may result from adaptive management and the introduction of safer or more effective herbicides; in addition, the ability to consider the use of herbicides on plants growing in standing water would result in better protection of park resources, and thus in long-term moderate beneficial impacts on park wetlands, lakeshores, and riparian areas.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on wetland, riparian, and lakeshore soils, hydrology, and wildlife, Alternative 3 would not result in impairment of the park's wetlands for future generations.

Cumulative Impacts

Cumulative impacts on wetland resources are based on analysis of past, present, and reasonably foreseeable future actions in the Yosemite region in conjunction with the potential effects of these alternatives. Over half of the wetland area around the globe has been lost, and much of the remaining wetland area is degraded (Zedler and Kercher 2004). Drainage for agriculture has been the primary cause of wetland loss; as of 1985, 26% of the global wetland area has been drained for purposes of intensive agriculture. Wetlands are the most altered and impaired habitat of the Sierra Nevada, and, as a small proportion of the landscape, are relatively rare (Hughes 1934; SNEP 1996). Dams, roads, and diversions in the Sierra Nevada have had a profound effect on streamflow patterns and water temperatures. Broad valleys with wide riparian wetlands were often used as reservoir sites. Much of the flat water on the western slope of the Sierra Nevada below 5,000 feet in elevation is artificial. These past actions have had long-term adverse effects on regional wetland habitats.

Present and future regional activities would have both beneficial and adverse impacts on wetlands. Some of the regional and local actions listed in Appendix I, such as the Utilities Master Plan, could take place near wetlands. Yosemite National Park and other agencies ensure there would be no net loss of wetlands to follow the mandates of the Clean Water Act. Parkwide planning efforts, such as the Merced and Tuolumne Wild and Scenic comprehensive management plans, are mandated to protect and enhance river values within each watershed. Present and future park actions would restore native wetland habitat. Present and future regional actions would have localized long-term moderate beneficial impacts on wetlands.

Past impacts on wetlands have been adverse, long-term, and major. Present and foreseeable future actions would contribute to reversing the major adverse impacts of past actions, and would have a long-term minor beneficial effect on wetlands. Continuing impacts from these past, present, and future actions, along with the local long-term negligible adverse impacts of the alternatives, would result in long-term adverse minor impacts on wetlands.

Conclusion

Early detection and prevention measures would have a long-term minor beneficial impact on wetlands. Implementation of comprehensive measures to protect wetlands would have a long-term minor beneficial impact on wetlands. Control actions would have a short-term minor adverse impact and a long-term minor beneficial impact. Integrated pest management goals would be met because work crews would use the minimum amount of herbicides necessary to meet management goals. Overall, the alternatives represent a long-term minor and moderate beneficial impact to wetlands. Because long-term impacts on wetlands associated with these alternatives would be minor and beneficial, they would not result in impairment of the park's wetland resources for future generations.

4. VEGETATION

Affected Environment

Over 1400 native vascular plant species have been documented in Yosemite National Park (personal communication, Alison Colwell, botanist, Yosemite National Park). Additional species continue to be discovered. Although Yosemite constitutes less than 1% of the area of California, nearly 23% of all plants in the state are represented within the park. The remarkable floristic diversity over such a relatively small area can be attributed in large part to the steep elevation gradient of the Sierra Nevada, as well as other physical factors such as hydrology and climate.

Non-native Plant Species

Invasive species are increasingly considered to be important drivers of global ecological change (Mack, Simberloff, Lonsdale, et al. 2000). Invasive species have been shown to displace native organisms (Tilman 1999), damage populations of rare species (King 1985), degrade ecosystem structures, alter nutrient cycling and soil chemistry(Vitousek and Walker 1989; Ehrenfeld 2003), and change water availability for native plants and animals (D'Antonio and Mahall 1991). Relationships among plants, animals, soil, and water that have taken thousands of years to form are being altered over a short period through the introduction of invasive plants.

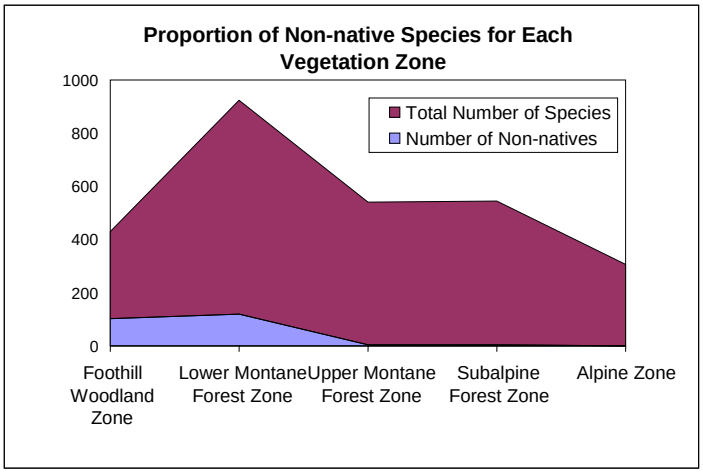


Figure III-2. Proportion of Non-native Species per Elevation Zone in Yosemite National Park

Over 200 non-native plant species have been documented within Yosemite National Park and the El Portal Administrative Unit (see Appendices B and O). These non-native plants are not evenly distributed across Yosemite's landscape (Figure III-2). Vast expanses of the highest elevations of Yosemite National Park remain free of non-native plants, while non-native plants dominate many low-elevation areas. Areas that are free of invasive plants are susceptible to future invasions, as illustrated by the widespread plant invasions in other high-elevation mountain regions in western North America (Pauchard et al. 2009; D'Antonio et al. 2004).

Non-native plant invasions occur in three phases: introduction, colonization, and naturalization (Groves 1986; Cousens and Mortimer 1995). Non-native plants can be introduced either intentionally

or through accidental means. Most dispersal is the result of human action (Mack and Lonsdale 2001). Not all introduced plants become established. Intentional introductions occur when plants are brought in for ornamental or other economic reasons and then spread beyond their initial location. The colonization phase of invasion is characterized by rapid population growth.

Soil degradation and other types of ecological disturbances can promote the introduction and establishment of invasive plants. Disturbances due to foot and vehicular traffic off of paved roads can also create suitable habitat for invasive species (Hobbs and Huenneke 1992; D'Antonio, Dudley, and Mack 1999). The types of environmental changes that promote plant invasion range in scale and intensity from local disturbances (such as moderate foot traffic along a trail or within a construction site) to large-scale impacts (such as increased atmospheric nitrogen deposition and climate change (Weiss 1999). Natural disturbances such as floods or herbivory by native animals can also facilitate the establishment and spread of invasive species. In Yosemite, sites such as campgrounds, pack stations, staging areas, road corridors, recent construction sites, and riparian corridors are particularly vulnerable to new infestations of invasive plants.

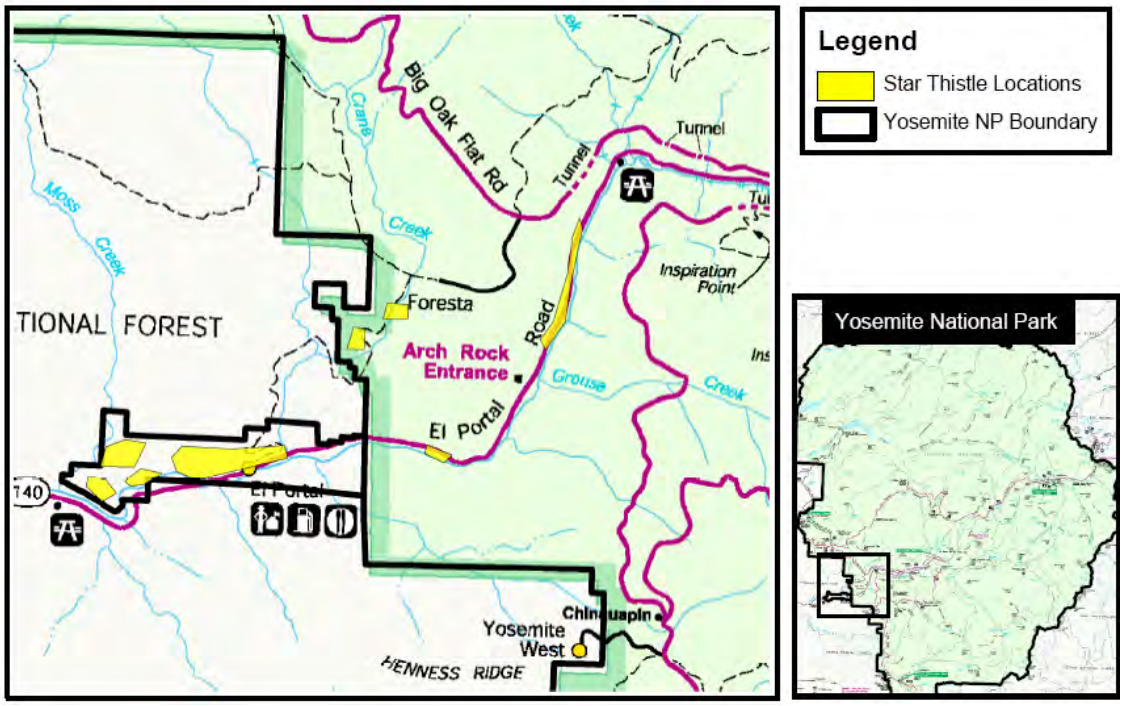


Figure III-3: Yellow Star-thistle Populations in Yosemite National Park and the El Portal Administrative Area

Nearly 100 acres in the park are grossly infested with yellow star-thistle, and the plant threatens thousands of additional acres of park land (Figure III-3). The vast majority of the yellow star-thistle in Yosemite is found on the steep slopes of Merced Canyon above El Portal. Since 1995, the park has made substantial strides in controlling the spread of yellow star-thistle in the lowest reaches of the park. In these areas, many native plants have returned. Monitoring results have shown a twofold increase in native species richness, as well as an increase in invasive annuals, in places where yellow star-thistle has been removed (NPS 2006d). NPS staff has effectively treated infestations of yellow star-thistle using hand-held weed trimmers and hand pulling. However, yellow star-thistle persists in dense patches on steep, rocky, less accessible slopes throughout the El Portal Administrative Area. These infestations are being treated by staff that has high angle safety and ropes training.

NPS staff, Yosemite Institute students, and volunteers have been treating Himalayan blackberry infestations in Yosemite Valley for decades. Workers have largely been using hand tools to cut and dig up the extensive belowground root system. This method is slow and difficult, and it requires many years of follow-up treatments. Because of the large thorns found on Himalayan blackberry, this work is also hazardous to park staff and volunteers. The park has slowed the spread of Himalayan blackberry into non-infested areas, but has not been able to substantially reduce the overall impact of this invader (NPS 2006a; NPS 2006d). Mechanical methods disturb the soil significantly, and, as a result, other invasive plant species such as velvet grass and bull thistle (*Cirsium vulgare*) often colonize areas where blackberry has recently been removed.

In 1997, spotted knapweed was detected in the initial stages of invasion in Foresta. Since discovering spotted knapweed, the park staff have been treating the population annually. Although park staff have continued to discover and treat new individuals every year since treatment began, knapweed has not spread beyond its initial area, and its ecological impact has been minimal thus far. Most of the time and effort spent on this species involves the detection of the few remaining individuals.

Vegetation Zones

In Yosemite National Park, five broad vegetation zones generally follow the elevation gradient: foothill woodland, lower montane forest, upper montane forest, subalpine forest, and alpine zone (Figure III-4). Invasive species cause much greater impacts in the lower elevations of the park and the Sierra Nevada (Randall et al. 1998).

Foothill Woodland Zone (below 2,000 feet). The lowest elevation zone in Yosemite is found along the western boundary of the park. This zone is characterized by a Mediterranean climate; winters are cool and wet, and summers are hot and dry. Nearly all precipitation takes place within the winter months, generally in the form of rain. Vegetation communities in this zone range from scattered trees and shrubs with a dense understory of herbaceous annual species to dense, shrub-dominated stands. Plants in the foothill woodland zone must be able to withstand the hot, dry summers. The El Portal Administrative Unit and areas below Hetch Hetchy Reservoir are the only two park locations within this zone.

> ***Non-native species:*** The foothill woodland zone is substantially more influenced by invasive and non-native plants than Yosemite's other vegetation zones. Non-native species constitute much of the herbaceous vegetation throughout this zone. According to *An Illustrated Flora of Yosemite National Park* (Botti 2001), 23% of the vascular plant species that live within this zone are non-native. Annual grasses native to the Mediterranean region dominate the herbaceous layer within the woodland areas of this zone.
>
> El Portal is abundant in non-native species and is highly susceptible to new introductions. Non-native species are not restricted to disturbed areas; they dominate portions of the landscape despite the absence of human-caused ground disturbance for decades. Established invasive plant populations in this zone may serve as a primary propagule source for the spread of these species into the park's higher vegetation zones.
>
> Examples of invasive species of concern in this zone include yellow star-thistle, Himalayan blackberry, black mustard (*Brassica nigra*), French broom (*Genista monspessulana*), tocalote (*Centaurea melitensis*), tree-of-heaven, and giant reed grass (*Arundo donax*).

Lower Montane Forest (3,000 to 6,000 feet). This mid-elevation zone is the lowest zone that regularly receives a majority of its precipitation in the form of snow. Increasing elevation brings increasing precipitation. The lower montane forest is dominated by conifers, with intermittent riparian areas and meadows. Dominant trees in this zone are incense cedar (*Calocedrus decurrens*), black oak (*Quercus*

kellogii), ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), and sugar pine (*Pinus lambertiana*). Giant sequoia (*Sequoiadendron giganteum*) groves also occur in this zone. Developed areas within the lower montane forest zone include Yosemite Valley, Wawona, Hodgdon Meadows, and the infrastructure around Hetch Hetchy.

Non-native species: This zone contains relatively fewer non-native species than the foothill woodlands zone. Approximately 13% of the documented species in this zone are non-native (Botti 2001). However, invasive plants can be found in many of the meadows and open sites within this zone, especially those that are near developed areas and roads. Farming and grazing in many of the meadows within this zone took place during the late 19th and early 20th centuries (Botti 2001). A majority of the forested areas remain free of non-native plants. In this zone, meadows and riparian areas are the most susceptible to the impacts of invasive plants. Many of the non-native species that are abundant in the foothill woodland zone reach their upper limits in this zone.

Many invasive plant species have the potential to invade this zone, but have not yet spread into Yosemite. Examples of invasive species of concern in this zone include Himalayan blackberry, velvet grass, black locust (*Robinia pseudoacacia*), bull thistle, spotted knapweed, and cheatgrass.

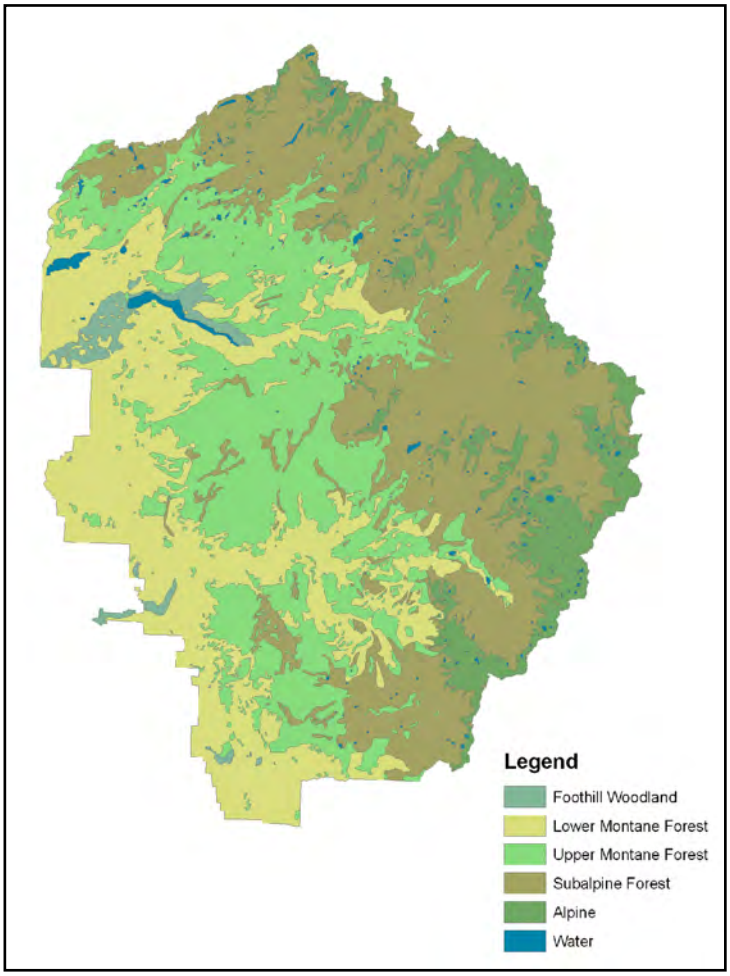


Figure III-4. Vegetation Zones in Yosemite National Park

Upper Montane Forest (6,000 to 8,000 feet). The climate in this zone is characterized by short, cool summers and cold winters. Nearly all precipitation in this zone occurs as snow. Upper montane forest is a forest-dominated zone interspersed with biologically diverse meadows. The dominant trees in this zone include lodgepole pine (*Pinus contorta* spp. *murrayana*), Jeffrey pine (*Pinus jeffreyi*), and red fir (*Abies magnifica*). Upper montane forest encompasses 216,000 acres (87,000 hectares). Developed areas within the upper montane forest zone include Crane Flat, Tioga Road, and Glacier Point Road.

Non-native species: A small number of established non-native plant populations live in natural areas within this zone. Less than 1% of the plant species documented in this zone are non-native. Scattered populations of non-natives are found along road corridors, trails, and developed areas, but these populations diminish rapidly away from disturbed sites. Examples of invasive species of concern in this zone include bull thistle, cheatgrass, and dandelion (*Taraxacum officinale*).

Subalpine Forest (8,000 to 9,500 feet). This zone encompasses 297,000 acres (120,000 hectares) in the park, and has a shorter growing season than the upper montane forest due to the long, cold, snowy winters. This zone typically accumulates 3-10 feet of snow during the winter. Forests of western white pine (*Pinus monticola*), mountain hemlock (*Tsuga mertensiana*), and lodgepole pine are interspersed with numerous subalpine meadows throughout this zone.

Non-native species: Nearly all of the non-native plant populations in the subalpine zone are restricted to frequently disturbed sites, such as road corridors and campgrounds. Even in these areas, non-native species are uncommon. Scattered non-natives grow infrequently along trails and meadow edges throughout the zone. No known persistent populations of non-native plant species exist outside the Tuolumne Meadows area. This zone may be highly susceptible to invasion in the future due to changes in climate and the presence of non-native species that thrive in this environment.

Alpine Zone. This zone is easily distinguished from the lower elevation zones by its lack of forests. Herbaceous plants found in this zone tend to be low in stature due to the harsh environment. This zone covers 54,362 acres (22,000 hectares) in the park.

Non-native species: No known persistent populations of non-native plants exist within this zone (Botti 2001). The short growing season and the limited human disturbances have likely slowed the spread of non-native plants into this zone. The alpine zone contains no developed areas. No invasive species are species of concern in this zone.

Environmental Consequences

Changes in the size, continuity, and integrity of native vegetation community structure were used to evaluate impacts on vegetation due to invasive plant control activities. Impacts on these communities were assessed in terms of type, duration, and intensity of impact.

Duration of Impact. The duration of an impact is the time required for native plant communities to recover to pretreatment conditions. Short-term impacts on vegetation are those that would last up to 20 years following implementation of an alternative. Long-term impacts would last longer than 20 years after implementation of an alternative.

Impacts common to all proposed alternatives. Under the action alternatives, detecting species early in the invasion process and executing the appropriate response reduces the intensity and extent of invasive plant control efforts in diverse vegetative communities. Prevention practices would keep invasive plant species that already exist within park boundaries from establishing elsewhere in the park, and would prevent new invasive species from entering the park. Prevention techniques would also reduce the extent and intensity of measures needed to control or eradicate invasive plant populations.

Monitoring would continue to take place to determine whether management objectives had been met, and to evaluate the effectiveness of control techniques. Under all alternatives, park staff would work with outside researchers, and would conduct applied research to improve their understanding of invasive plants in the park.

The outreach and education components of the alternatives would continue to inform visitors, employees, and residents of the importance of preventing new invasions in the park. For example, visitors and employees would continue to be educated about bringing items into the park that could be infested with non-native propagules. The NPS would provide information on the need to control existing populations and prevent new infestations of invasive plant species.

The early detection and rapid response, prevention, prioritization, monitoring, outreach, and education components of the comprehensive program under these alternatives would have a long-term minor beneficial impact on vegetation communities in the park.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts are described below:

1) Prevention, and early detection and eradication, would result in long-term moderate beneficial impacts on park vegetation as actions prevent the displacement of native plant communities by invasive species.
2) The use of physical and mechanical treatments, especially during removal of belowground portions of plants, could result in localized short-term negligible adverse impacts on adjacent vegetation. However, these would be outweighed by positive impacts of protecting native plant communities from displacement by invasive species.
3) The use of herbicides would allow the park to meet management objectives for up to 22 invasive plants with the potential to invade natural ecosystems. One herbicide, glyphosate, would be used in a formulation approved for aquatic application. Applications of glyphosate to invasive species could result in localized short-term negligible adverse impact on adjacent vegetation. Compared with physical and mechanical treatments, the use of herbicides would reduce the extent and intensity of disturbance to soils. Native species' abundance and diversity would increase in restored sites, thus enhancing natural habitat for native wildlife.
4) Invasive species control would have a long-term minor beneficial impact on park vegetation. However, the currently implemented physical, mechanical, and limited chemical control techniques would not allow the park to meet management objectives for priority rhizomatous invasive species, especially those found near water, which could result in moderate negative impacts on riparian and wetland vegetation. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on park vegetation.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 1 would not result in impairment of the park's vegetation for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan. The introduction of aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. Alternative 2 introduces four herbicides that would be used under threat conditions that the current plan cannot efficiently treat. The

additional herbicides are U.S. and CAL EPA approved, and are recommended by toxicologists and resource management specialists. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals. Impacts could include the following:

1) Impacts of Alternative 2 would be similar to impacts under Alternative 1. The use of four additional herbicides would not result in impacts on park vegetation different from those under Alternative 1.
2) The ability to use herbicides to control of invasive plant populations near water would result in a parkwide long-term moderate benefit to native vegetation, since invasive plant populations near water can be a source for invasive plant seeds. Additionally, rivers and streams are important vectors for invasive plant dispersal.
3) There would be a long-term moderate benefit because, as invasive plant populations are controlled, less herbicide would be applied in the future.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 2 would not result in impairment of the park's vegetation for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2. However, Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools. This includes introducing herbicides should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and have no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g. against aquatic threat such as hydrilla). Impacts could include the following:

1) Impacts are similar to those listed under Alternatives 1 and 2.
2) The application of aquatic herbicides in water could result in localized short-term minor impacts on native aquatic vegetation. However, aquatic invasive species such as hydrilla and purple loosestrife, two species currently present in California, have been shown to spread rapidly and form dense cover. Using herbicides to keep these species from becoming established in Yosemite could result in a long-term moderate benefit to native aquatic plant species.
3) There is potential to further minimize short-term negligible adverse impacts on vegetation as more effective products become available and replace what is being used. Greater efficiency resulting from adaptive management and the use of more effective management tools would reduce chemical load on park lands and non-target species, resulting in a negligible long-term beneficial impact on vegetation.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 3 would not result in impairment of the park's vegetation for future generations.

Cumulative impacts

Cumulative impacts on vegetation are based on analysis of past, present, and reasonably foreseeable future actions in California and the Yosemite region in conjunction with the potential effects of these alternatives. In the past 150 years, activities associated with urbanization in California (e.g., building construction, utility installation, road and bridge building, storm water discharge), livestock, and agriculture contributed to adverse impacts on vegetation (D'Antonio et al. 2004). Impacts range from direct loss of ecosystems to indirect losses such as changes in water flows that sustain vegetative habitat. The overall effect of statewide trends on vegetation has been adverse, long-term, and major. In addition, climate change and resultant changes in vegetation should increase in intensity or rate as the climate continues to change (D'Antonio et al. 2004; Mutch, Goldin Rose, Heard, et al. 2007).

The magnitude of past impacts on vegetation correlates with the spread of invasive plants in California. While fewer than 10% of the 1,000-plus (Hickman 1993) non-native plant species that have established in California are recognized as serious threats, non-native plants have dramatically changed the landscape of California.

Parkwide activities would have both beneficial and adverse impacts on vegetation. Some of the regional and local actions listed in Appendix I, such as the Yosemite Lodge Area Redevelopment, involve soil and vegetation disturbance. These activities would disturb ground, creating conditions that encourage the growth of invasive plants. Where vegetation is disturbed, Yosemite National Park and other agencies prescribe mitigations to preserve the genetic integrity of native plants and reduce the risk of importation and spread of invasive plants. For example, developed areas in Yosemite National Park are landscaped with native plants propagated from site-specific local seeds and cuttings.

Present and future actions such as the Merced and Tuolumne Wild and Scenic comprehensive management plans would provide large-scale watershed protection to plant communities. Prescribed fire and managed wildland fire activities would greatly reduce the threat of large high-severity catastrophic fires, and would reduce the potential for vegetation type conversion.

The combined actions of state and local programs to control invasive plant species would have a long-term beneficial impact on vegetation. The Sierra-San Joaquin Noxious Weed Alliance (Weed Management Area) addresses invasive plant issues that cross jurisdictional boundaries. Regional invasive plant control actions sponsored by Caltrans, Mariposa County, Tuolumne County, Madera County, and the federal agencies that abut Yosemite National Park (Sierra National Forest, Stanislaus National Forest, Inyo National Forest, and the BLM, Merced Canyon) support invasive plant actions to control invasive plants. These invasive plant actions protect or restore native habitat, thereby fostering native plant communities. Present and future regional actions would have local long-term moderate beneficial impacts on vegetation.

Past impacts on vegetation from invasive plants have been adverse, long-term, and major. Present and foreseeable future actions would contribute to reversing the major adverse impacts of past actions on vegetation in California, and would produce long-term moderate beneficial effects on vegetation. These past, present, and future effects, along with the beneficial long-term moderate impacts of the control techniques proposed under these alternatives, would result in a long-term moderate beneficial impact on native vegetation by preventing invasions into non-infested areas.

Conclusion

Alternative 1 would not result in impairment of the park's vegetation resources for future generations. Under the action alternatives, control and treatment actions would reduce the density of invasive plants in targeted areas. As more invasive plant populations are eradicated or controlled, work crews would expand their treatment area. Reduced ground disturbance would reduce the risk of secondary invasive

plant invasion (a situation where new invasive plants establish in sites where invasive species have been removed). The targeted application of herbicides to invasive plants could result in a short-term minor adverse impact on adjacent native vegetation. For example, the application of aminopyralid to yellow star-thistle populations could infrequently harm some native plant species that are growing within large yellow star-thistle populations. Because long-term impacts on vegetation associated with all the alternatives would be moderate and beneficial, they would not result in impairment of the park's vegetation resources for future generations.

5. SPECIAL STATUS PLANTS

Affected Environment

Special status plants in Yosemite reflect the complex geologic substrate, diverse topography, and wide elevation range found in the park. Over 150 special status plant taxa (including vascular plant species, subspecies, and varieties) are known to inhabit Yosemite National Park and the El Portal Administrative Site (USGS 2005). Special status plants in Yosemite include species listed under the federal Endangered Species Act of 1973, as amended; species listed under the State Endangered Species Act; and sensitive plant species designated by park staff.

No federally listed plants are documented within Yosemite National Park or the El Portal Administrative Site. Four species listed as Rare by the state of California are present (see Table III-2). An additional 146 special status plants found within park boundaries are designated Park Sensitive.

Table III-2. State of California Rare Plants Known to Live in Yosemite National Park or the El Portal Administrative Site

Common Name and Scientific Name	**Habitat Type/Occurrence**
Yosemite onion *Allium yosemitense*	Confined to open metamorphic slabs, talus slopes, and scree - Restricted to the Merced River watershed in foothill woodland and lower montane zones.
Tompkin's sedge *Carex tompkinsii*	Limited to foothill oak woodland and chaparral areas and along low talus slopes. Found sporadically from Arch Rock to El Portal in the Merced River canyon
Congdon's woolly-sunflower *Eriophyllum congdonii*	Occurs on dry ridges on rocks, scree, and talus in foothill woodland and lower montane zones. Restricted to dry, mostly south-facing metamorphic and meta-sedimentary outcrops.
Congdon's lewisia *Lewisia congdonii*	Restricted to moist, shady, mostly north-facing slopes and metamorphic rock faces in foothill woodland and lower montane zones.

The NPS *Management Policies* (NPS 2006b), in particular, prescribes the management of special status species in conformance with the federal and state endangered species acts. This policy states that the NPS would undertake active management programs to inventory, monitor, restore, and maintain listed species' habitats, *control detrimental non-native species*, control detrimental visitor access, and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend (emphasis added). The NPS would inventory, monitor, and manage state- and locally listed species in a manner similar to its treatment of federally listed species.

Invasive plant populations can affect special status plants in several ways. Aggressive invasive plants intercept light, moisture, and nutrients, and can directly out-compete special status plants. Invasive plants can indirectly cause the decline or extirpation of special status plants by altering their habitat to a degree that affects the interactions of predators, pollinators, and other elements of a functioning ecosystem (Gordon 1998). Invasive plants in Yosemite threaten special status plants in a number of habitats, particularly low-elevation foothill woodland, meadow, and forested habitats.

The four California State Rare species known to occur in Yosemite are all found in the foothill habitats of El Portal, the site of large populations of the invasive yellow star-thistle. In low-elevation meadow habitat, non-native perennial grasses and herbs alter native plant communities. Intact meadow habitat supports Park Sensitive plants such as round-leaved sundew (*Drosera rotundifolia*), northern bedstraw (*Galium boreale* ssp. *septentrionale*), false pimpernel (*Lindernia dubia* var. *anagallidea*), and ladies' tresses (*Spiranthes porrifolia*). Special status plants found at higher elevations are currently free from non-native plant invasion, although invasive plants such as Kentucky bluegrass and velvet grass have the potential to spread into the high-elevation habitat of special status plants.

Environmental Consequences

This analysis considers the effects of the alternatives on special status species and their habitats. Each special status species was evaluated to determine its known or likely occurrence or preferred habitat in the vicinity of invasive plants. The analysis also evaluates the potential for direct physical loss or fragmentation of special status species habitat.

Duration of Impact. The duration of an impact is the time required for special status plants to recover after invasive plant control treatments. Short-term impacts are those that would immediately affect a special status plant species, but would not cause long-term declines in population or species viability. Long-term impacts would lead to a loss in population or species viability as exhibited by a decline in overall species abundance, viability, and/or survival.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts are described below.

1) Physical, mechanical, and herbicide treatments would allow the park to meet management objectives for many, but not all, priority invasive species that have the potential to invade natural ecosystems. Herbicide use may result in a short-term negligible adverse impact on adjacent vegetation. The impact would be negligible because the targeted species tend to grow in

monocultures, making it possible to isolate specific populations during the herbicide applications. Native species' abundance and diversity would increase in restored sites, thereby enhancing natural habitat for native flora, including special status plants.

2) Wetlands and riparian corridors would remain a source for the dispersal of invasive plant propagules into special status plant habitat. This could result in long-term minor to moderate adverse impacts on special status plant populations.

3) Park botanists maintain a spatial data layer that shows the locations of special status plants. The habitats for these 150 species, including the four state-listed species—Yosemite onion, Tompkin's sedge, Congdon's woolly-sunflower, and Congdon's sedge—are generally known, and many populations have been mapped. This layer would be reviewed during invasive plant management planning where rare plants directly co-occur with priority invasive plants that are slated for treatment. Where special status plant species are present in proposed invasive plant treatment areas, Botany Team staff would work with invasive plant management staff to create a treatment plan to avoid damage to special status species occurring in treatment areas. Botany and invasive plant program managers would further develop data collection protocols that automatically record where priority invasive species co-occur with special status plant species on a finer spatial scale. Should high priority invasive plants slated for treatment be discovered in habitat occupied by special-status plants, an assessment would be made that would consider negative impacts of any particular means of control upon special status plant habitat or individuals (for example, digging up Himalayan blackberry roots) versus the benefits of protecting their habitat from displacement by invasive plants. Protection efforts could include flagging of special status species. Invasive plant management workers could implement hand pulling or other rare plant protective measures during control activities including painting invasive plants with herbicide, or draping special status plants to protect them from *overspray*. Where an invasive species has the potential to displace habitat for a particular species across a wide geographic area, impacts of invasive plant management actions for individuals or individual species populations in a particular area would be weighed against the benefits of protecting habitats and populations on larger spatial scales.

4) Under Alternative 1, herbicides would not be used in special status plant habitat. While this decision could protect individual plants or species populations from localized short-term minor adverse impacts resulting from herbicide use, it could also result in long-term moderate impacts on larger spatial scales. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on special status vegetation.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 1 would not result in impairment of the park's special status plants for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species, protecting and enhancing native flora.

Alternative 2 introduces herbicides that would be used under threat conditions that the current plan cannot treat efficiently. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of herbicides having low-toxicity to wildlife necessary to meet management goals. Impacts could include the following:

1) Impacts of Alternative 2 would be similar to impacts under Alternative 1. The use of four additional herbicides would not result in impacts on park special status plants different from those under Alternative 1.
2) Resource managers would weigh the costs and benefits of invasive plant management actions for individuals or individual species populations in a particular area against the costs and benefits of protecting habitats and populations on larger spatial scales. The tools or methods that best protect park natural and cultural resources would be used. An herbicide could be the proper tool, even where it may result in a short-term localized adverse impact on a special status individual or population, if it protected the habitat of a special status species from being displaced across large spatial scales by a particular invasive species.
3) The use of herbicides in the beds and banks of Wild and Scenic rivers and near water would have a long-term moderate beneficial impact on special status plants. Many rhizomatous perennial species do not respond well to physical controls. Allowing herbicides to be used to control species such as Himalayan blackberry in wetlands and riparian corridors would prevent these areas from acting as a source for the dispersal of invasive plant propagules into special status plant habitat. There would be a long-term moderate benefit because, as invasive plant populations are controlled, less herbicide would have to be used.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 2 would not result in impairment of the park's special-status plants for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and show no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., against aquatic threat such as hydrilla). Impacts could include the following:

1) Impacts are similar to those under Alternatives 1 and 2.
2) There is potential to further minimize short-term negligible adverse impacts on non-target species as more effective products become available and replace what is being used. Greater efficiency resulting from adaptive management would reduce chemical load on park native flora, resulting in a negligible long-term beneficial impact to native flora and their associations.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 3 would not result in impairment of the park's special-status plants for future generations.

Control

The action alternatives would employ multiple control techniques, including the use of additional herbicides, to treat existing invasive plant populations. The judicious use of these additional herbicides would increase the number of acres of non-native invasive plants that can be treated. Control actions under the action alternatives would result in a long-term moderate beneficial impact on special status plants.

Cumulative Impacts

Cumulative impacts on special status plant species are based on analysis of past, present, and reasonably foreseeable future actions in California and the Yosemite region in conjunction with the potential effects of these alternatives. Past impacts, including urbanization and agricultural conversion, alteration of natural processes that sustain plant habitat, and introduction of non-native plants and animals threaten special status plant habitat throughout California. Special status plants are often dependent on specialized habitats that are fragmented, degraded, or completely eliminated (CNPS 2001). The impact of overall loss of native plant and special status plant habitat in California has been adverse, long-term, and major.

Some of the regional and local actions listed in Appendix I, such as the El Portal Road Improvements Project, involve soil and vegetation disturbance. Where vegetation is disturbed, Yosemite National Park and other agencies ensure that mitigation is included to protect special status plants. Parkwide planning efforts, such as the Merced and Tuolumne Wild and Scenic comprehensive management plans, would provide large-scale watershed protection to plant habitat. Prescribed fire and managed wildland fire activities would greatly reduce the threat of large high-severity catastrophic fires, and would reduce the potential for vegetation type conversion. Present and future actions would restore native plant habitat that could sustain special status species.

The combined actions of state and local programs to control invasive plant species would have a long-term beneficial impact on special status plant species. The Sierra-San Joaquin Noxious Weed Alliance (Weed Management Area) addresses invasive plant issues that cross jurisdictional boundaries. Regional invasive plant control actions sponsored by Caltrans, Mariposa County, Tuolumne County, Madera County, and the federal agencies that abut Yosemite National Park (Sierra National Forest, Stanislaus National Forest, Inyo National Forest, and the BLM, Merced Canyon) support invasive plant actions to control invasive plants. These invasive plant actions protect or restore native plant communities that often sustain special status plants. Present and future regional actions would have local long-term moderate beneficial impacts on special status plant habitat.

Past impacts on special status plants have been adverse, long-term, and major. Present and foreseeable future actions would contribute to reversing the major adverse impacts of past actions on special status plants, and would produce long-term minor beneficial effects on special status plants. These past, present, and future effects, along with the local long-term minor beneficial impacts of all the no-action and action alternatives, would result in long-term adverse minor impacts on vegetation.

Conclusion

Across all three alternatives, implementation of prevention and control practices would have a long-term minor beneficial impact on special status plants in Yosemite. However, limits on herbicide use, especially near water, may result in moderate negative impacts on special status plant populations that grow near water should physical methods of control be insufficient for controlling invasive species. The control methods described for the action alternatives would have a long-term moderate beneficial impact on special status species due to the potential to eliminate invasive species the no-action

alternative would not be able to treat, especially near water. Overall, the action alternatives would have a long-term moderate beneficial impact on special status plant habitat. The action alternatives would not likely affect special status vegetation species in Yosemite. Because long-term impacts on special status plants under these would be moderate and beneficial, the action alternatives would not impair the park's special status plant resources for future generations.

6. WILDLIFE

Affected Environment

Yosemite provides habitat for over 270 species of native vertebrates, including fish, amphibians, reptiles, birds, and mammals. The park also contains thousands of species of invertebrates. This diversity results in part from the wide elevation span of park habitat types, which range from foothills to alpine. For wildlife populations to be viable, resources and environmental conditions must be sufficient for animals to forage, hide, nest or den, and disperse. Breeding individuals need well-distributed habitat over a broad geographic area to interact spatially and temporally within and among populations. The distribution, type, and amounts of territory, shelter, water, and food must be sufficient for the basic needs of self-sustaining wildlife populations on a daily, seasonal, annual, and multi-year basis.

Non-native plants can change the qualities of natural habitats needed to support the park's wildlife species. These shifts can result in highly detrimental effects on native wildlife species. Such changes are most prevalent at lower elevations of the park, where the majority of invasive plant species are found. However, the park's higher elevations are not immune to invasion. These effects include alterations in vegetation type and structure, reductions in natural food and cover plant species, and changes in natural fire regime.

In rare situations, certain species may actually benefit from the presence of non-native plants. For example, lesser and American goldfinches (*Carduelis psaltria* and *C. tristis*) may benefit from feeding on yellow star-thistle fruits. Black bears (*Ursus americanus*) and other species feed heavily on Himalayan blackberries, which provide an unnatural food source. While the presence of the blackberry may allow a given area to support more black bears, this non-native plant alters the natural ecology of the bears. Moreover, the greatest blackberry concentrations occur in Yosemite Valley, where conflicts between humans and black bears are common. The presence of blackberries likely exacerbates these conflicts by increasing the abundance of black bears above natural levels. Invasive plants may benefit individual animals, but they cause perturbations in the relationship between wildlife and their habitats. In a national park, where the mission is to protect and restore natural ecosystems, such effects are not acceptable.

Yosemite is not exempt from the well-documented global decline in amphibian population numbers (Drost 1996). Extensive speculation exists regarding the cause of this global decline (Alford and Richards 1999). The spread of a fungus fatal to many amphibian species, *Batrachochytrium dendrobatitus*, has been identified as a significant factor in the global decline of amphibians, including the federal candidate for endangered status species Sierra Nevada yellow-legged frog (*Rana sierrae*) and Yosemite toad (*Bufo canous*) (Rachowicz, Knapp, Morgan, et al. 2006). Chemical toxicity is another possible reason. Pesticides sprayed in the Central Valley have been shown to be carried on air currents into the Sierra Nevada (Blaustein, Romansic, Kiesecker, et al. 2003; Collins and Storfer 2003). Non-

native trout have been introduced throughout the historic range of the Sierra Nevada yellow-legged frog. Fish have severely impacted this species (Bradford, Graber, and Tabatabai 1993; Knapp and Matthews 2000; Vredenburg 2004; Knapp 2005; Knapp, Boiano, and Vredenburg 2007).

Environmental Consequences

Protecting native plant communities from invasion and displacement by non-native plants, and restoring these communities by controlling existing invasive plant populations, would have primarily beneficial impacts on wildlife. Certain wildlife could also experience minor adverse impacts resulting from the removal of non-native plants that may be providing food and cover in place of native plants. Control activities would also result in the unavoidable removal or disturbance of native plants. Direct effects on wildlife are also possible if physical, mechanical, or chemical controls disturb reproducing wildlife, such as ground- or shrub-nesting birds.

The **Duration of Impact** is the time required for wildlife to recover after treatment. Short-term impacts are those that would last up to five years following implementation of an alternative, while long-term impacts would last longer than five years after implementation of an alternative.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts are described below. The use of herbicides allows the park to meet management objectives for up to 22 invasive plants with the potential to invade natural ecosystems. Glyphosate is used in a formulation approved for aquatic use.

1) Applications of glyphosate on non-native blackberry, giant reed, and other invasive plants may have a localized short-term negligible adverse impact on adjacent plant species and wildlife. The impact would be negligible because invasive plant populations tend to grow in monocultures, making it possible to isolate the targeted species during herbicide applications. Additionally, aminopyralid and glyphosate have low toxicity to wildlife.
2) Alternative 1 would result in a long-term moderate beneficial impact on wildlife in the park as their habitat is protected from displacement by invasive species. The use of terrestrial or aquatic formulations of glyphosate or aminopyralid in terrestrial environments (applied according to label requirements) carries little to no risk to amphibians and other wildlife. However, this benefit might not occur for certain species (for example, rhizomatous plants such as Himalayan blackberry) near water. Invasive species dispersed along riparian areas can provide seeds and other propagules that allow for dispersal into adjacent upland habitats. The inability to control certain invasive species near water could also result in long-term moderate adverse impacts on park wildlife habitats. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on park wildlife.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 1 would not result in impairment of the park's wildlife for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives regarding priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species, protecting and enhancing wildlife habitat.

The additional herbicides are U.S. and CAL EPA approved, and are recommended by toxicologists and resource management specialists. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals. Impacts could include the following:

1) Impacts of Alternative 2 would be similar to those under Alternative 1.
2) This additional herbicide use may have a short-term negligible adverse effect on wildlife species. More herbicides may be used as they become a regular part of the park's invasive plant management toolbox. This would be countered by the fact that smaller amounts of more effective herbicides for treating invasive plant populations would likely be used.
3) There would be a long-term moderate to major benefit to wildlife because, as invasive plant populations are controlled, less herbicide would have to be used. The range reflects uncertainties in available program funding, given the current national economy.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 2 would not result in impairment of the park's wildlife for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and show no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., in regard to an aquatic threat such as hydrilla). Impacts could include the following:

1) Impacts from Alternative 3 are similar to Alternatives 1 and 2.
2) There is potential to further minimize short-term negligible adverse impacts on wildlife as more effective products become available and replace what is being used. Greater efficiency resulting from adaptive management would reduce chemical load on diverse park habitats, resulting in a negligible long-term beneficial impact on wildlife.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 3 would not result in impairment of the park's wildlife for future generations.

Control

In Yosemite, two of the most invasive plants, velvet grass and Himalayan blackberry, are found in riparian areas and in seasonally flooded wetlands. To control these invasive plants in seasonally flooded wetlands, work crews would use aquatic-approved herbicide formulations. When possible, work would be performed during the dry season. All applications would consist of physically applied applications from backpack sprayers, hand-held wands extending from truck-mounted tanks, or individual containers of herbicide and a wiper tool (such as a paintbrush) to minimize the potential for drift. Work crews would not use aerial applications, such as from an airplane or helicopter or from truck-mounted tanks with boom attachments.

Since the toxicity of herbicides and other chemicals has been suggested as one possible reason for the well-documented global decline of amphibians (Blaustein et al. 2003; Collins and Storfer 2003), this section begins with a focus on potential impacts of herbicides on amphibians. Key factors that influence amphibian mortality include the type of herbicide mix used (terrestrial or aquatic), the application rate (at or below labeling restrictions), and the application method (aerial, ground, broadcast, or spot spray).

Current literature indicates that aquatic herbicide formulations, used correctly, pose little to no risk to amphibians. However, the *surfactants* used in terrestrial formulations such as Roundup® are toxic to amphibians, which is why such formulations cannot be used in or over water (Feng and Thompson 1990; Feng, Thompson, and Reynolds 1990). Used alone, glyphosate, aminopyralid, chlorsulfuron, imazapyr, triclopyr, and rimsulfuron have a low to non-toxicity to amphibians, except at very high doses. When applied in terrestrial situations, glyphosate appears to come out of solution quickly; the herbicide binds to soil and organic particles and is no longer dissolved in the water. Both action alternatives provide for the use of aquatic herbicide formulations during the dry portions of seasonally flooded wetlands and within 10 feet of standing or moving water. This process would reduce the use of terrestrial surfactants and eliminate the risk of accidentally applying terrestrial formulations to water. The appropriate use of terrestrial or aquatic formulations of herbicides, following labeling instructions, without aerial application, in terrestrial environments, carries little to no risk to amphibians.

Aerial applications of terrestrial-use herbicides (such as Roundup®), often used in agricultural settings, carry a risk of depositing harmful chemicals into aquatic environments, and are not being considered for use in Yosemite National Park.

The action alternatives would result in a long-term moderate beneficial impact on wildlife by providing effective tools for controlling non-native plant species and their adverse impacts on wildlife and habitat. While there may be some concern regarding the impacts of herbicides on wildlife, such impacts are considered negligible as long as the herbicides are used in compliance with the manufacturer's and the EPA's guidelines and limits. Physical and mechanical treatments supplemented by herbicide use would increase the infected area that could be treated, and possibly reduce the disturbance of wildlife caused by mechanical removal. The combination of these actions would result in a long-term moderate beneficial impact on wildlife by more effectively removing the non-native plant species that adversely impact wildlife and habitat.

Cumulative Impacts

Cumulative impacts on wildlife are based on analysis of past, present, and reasonably foreseeable future actions in California and the Yosemite region in conjunction with the potential impacts of these alternatives. Past and present factors affecting wildlife include fire suppression, deposition of chemical compounds from outside the park, the invasion of non-native species (including pathogens), and land management practices outside Yosemite. In the foreseeable future, climate change has the potential to cause large-scale major adverse impacts on wildlife. Climate change could accelerate the arrival and spread of non-native plant species by making higher elevations of the park more suitable for these species through warming. These past, present, and foreseeable future impacts are long-term, adverse, and major.

Local past and present actions would have both beneficial and adverse impacts on wildlife. Parkwide planning efforts, such as the Merced and Tuolumne Wild and Scenic comprehensive management plans, would provide large-scale watershed protection to plant communities. Prescribed fire and managed wildland fire activities would greatly reduce the threat of large high-severity catastrophic fires, and would reduce the potential for habitat conversion. Present and future actions would restore wildlife habitat.

Past impacts on wildlife have been adverse, long-term, and major. Local present actions would contribute to reversing the major adverse impacts of past actions on wildlife, and would produce long-term moderate beneficial effects. In the context of the multiple, spatially massive, and potentially catastrophic past and present effects, the impacts of these alternatives are negligible. The past, present, and future effects, along with the local long-term minor adverse impacts of these alternatives, would result in long-term moderate adverse impacts on wildlife.

Conclusion

Long-term impacts on wildlife associated with Alternative 1 would be minor and adverse, and continued spread of invasive plants into the natural areas of the park would potentially affect large tracts of wildlife habitat, although not enough to result in impairment of the park's wildlife resources for future generations. Under Alternatives 2 and 3, the action alternatives, less time would be dedicated to detecting infestations, because existing non-native populations would be effectively eradicated and new invasions could be managed. The combination of these factors would result in a long-term moderate beneficial impact on wildlife by restoring natural plant communities quickly and effectively. Because long-term impacts on wildlife associated with the action alternatives would be moderate and beneficial, the action alternatives would not result in impairment of the park's wildlife resources for future generations.

7. SPECIAL STATUS WILDLIFE

Affected Environment

This section focuses on special status wildlife species that have declined to the point where further declines could result in their extinction. As such, these species are sensitive to small population fluctuations where even loss of individuals could have substantial repercussions for the species. This

situation requires a separate evaluation of possible adverse effects under the context of this plan's alternatives. This analysis considers special status wildlife species at the state and federal listing level, as shown in Table III-3. Section 7 (a) (2) of the federal Endangered Species Act of 1973, as amended, requires all federal agencies to consult with the United States Fish and Wildlife Service to ensure that actions taken by the agencies do not jeopardize the continued existence of federally listed or proposed threatened or endangered species, or result in the destruction of adverse modification of designated critical or proposed critical habitat. Where invasive plant control actions have the potential to adversely impact special status species populations, management planning and actions would also be carried out in coordination with Yosemite National Park wildlife biologists.

Environmental Consequences

Invasive species are considered by some to be the second leading cause of species extinctions after human development (Pimentel 2007). Invasive plants can displace the native plant communities that populations or individuals of special status species depend upon for habitat.

Management actions can also adversely affect special status species. The most effective management tool would be chosen that has the least potential to adversely affect special status species populations. Control of invasive plants could affect certain special status wildlife by removing non-native plants that may be providing food and cover in place of native plants. Control activities would also result in the collateral removal or disturbance of native plants. Direct effects on wildlife are also possible if physical, mechanical, or chemical controls disturbed reproducing wildlife, such as ground- or shrub-nesting birds. Some herbicides are toxic to some special status wildlife species (a well-known example includes the effects of DDT on eggshells of bald eagles and peregrine falcons, among other raptors).

The duration of impact is the time required for special status wildlife to recover after treatment. Short-term impacts are defined here as those that would last up to five years following implementation of an alternative. Long-term impacts would last longer than five years after implementation of an alternative.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible.

1) Park biologists would weigh the costs and benefits of invasive plant management actions for individuals or individual species populations in a particular area against the costs and benefits of protecting habitats and populations on larger spatial scales. The tools and methods that best protect park natural and cultural resources would be used. An herbicide could be the proper tool, even where it may result in a short-term localized adverse impact on a special status individual or population, if it protected the habitat of a special status species from being displaced across large spatial scales by a particular invasive species.
2) Priority invasive plants are not currently found in either Yosemite toad or Sierra Nevada yellow-legged frog habitat. Biologists would determine whether special status amphibians are present before any type of invasive plant control measure would take place in likely habitat. Under Alternative 1, herbicides would not be used in special status wildlife habitat. While this decision

could protect individual animals or species populations from localized short-term minor adverse impacts resulting from herbicides, it could also result in long-term moderate adverse impacts on larger spatial scales.

3) Since herbicides were reintroduced, they were used on only 41.7 acres in 2009, and 81.9 acres in 2010, or 0.01% of the park's 761,266 total acres. Treatment areas are in locations that previously have been disturbed by roads, campgrounds, buildings, landscaping, and other development. The effects of glyphosate and aminopyralid are considered negligible for amphibians and other wildlife species as long as the herbicides are used according to the guidelines and limits of the manufacturer and the EPA (see Appendices E, F, G, and H).

4) Some invasive species, particularly rhizomatous perennials, are difficult to control without the use of herbicides. Under Alternative 1, herbicide use is not allowed near water, within the beds and banks of Wild and Scenic rivers, or in tribal gathering areas, and is severely limited in designated Wilderness. Therefore, the control of some invasive species, such as Himalayan blackberry or velvet grass, may not be possible under Alternative 1 in some areas of the park, especially wetlands, lakeshores, and riparian areas. This is problematic, as these habitats are some of the most productive in the park and provide habitat for many wildlife species. Thus, Alternative 1 could result in moderate long-term adverse impacts on these habitats and the special status species dependent upon these habitats. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on park special status vegetation.

5) Effects on the bald eagle and peregrine falcon would be present only if invasive plant control resulted in a radical change in the vegetation type and structure where these birds forage. Such changes are not anticipated under the action alternatives. The estimated effects on the peregrine falcon and bald eagle under all three alternatives would be long-term negligible.

6) Current locations of invasive plants overlap very little with active great gray owl breeding habitat, but may adversely affect the species on its lower-elevation wintering grounds. Removal of invasive meadow plant species by physical and mechanical techniques where great gray owls are present could disturb feeding activity. To ensure that impacts are minimized, the park would schedule plant removal during periods when the birds are least susceptible to disturbance. Over the long term, restoration of a natural assemblage of meadow plants could improve prey forage. Meadows that provide foraging ground for great gray owls would be treated in segments (e.g., one-third of the meadow at a time) to provide continuous foraging habitat for owls. There would be a short-term minor adverse impact and a long-term minor beneficial impact on the great gray owl under all three alternatives.

7) Increased suppression of non-native plants through the use of a full range of tools would have a positive effect on the willow flycatcher by returning native plants to willow flycatcher nesting and foraging habitat. The benefit, however, would be minor, because the disappearance of the willow flycatcher from Yosemite likely has a more regional cause (other than habitat degradation in Yosemite) (Pyle et al. 2006). There would be a long-term minor beneficial impact on willow flycatcher habitat.

8) Early accounts of the Sierra Nevada red fox indicate that it was restricted to high elevations of the park (Grinnell and Irwin 1924). The vast majority of invasive plants would be controlled at lower elevations of Yosemite. There would be no effect on the Sierra Nevada red fox.

Table III-3. Yosemite Special Status Wildlife Species

Special Status Wildlife Species	Federal Status	State Status	Habitat
Invertebrates			
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	FT		-Occurs at elevations below 3,000 feet -Critical habitat has been designated, although not in park. -Elderberry plants with probable beetle exit holes have been found in El Portal -Entire life cycle revolves around elderberry plants (*Sambucus* spp.)
Amphibians			
Yosemite toad (*Bufo canorus*)	FC	CSC	-Found at elevations above ~6,400 feet -Breeds in shallow ponds and wet meadows -After breeding, adults disperse into the surrounding landscape. Most often found in meadows
Sierra Nevada yellow-legged frog (*Rana sierrae*)	FC	CSC	-High elevation distribution above 5,500 feet -Occurs in streams, lakes, and ponds in a variety of vegetation types
Birds			
Bald eagle (*Haliaeetus leucocephalus*)		SE	-Usually found near rivers and large lakes -One active nest at Lake Eleanor -More abundant on the Merced River, and on large water bodies in winter -Found in very low density in the park
American peregrine falcon (*Falco peregrinus anatum*)		SE	-Nests on high cliffs in eight locations in Yosemite -Preys primarily on birds that inhabit the cliffs or the habitats below
Great gray owl (*Strix nebulosa*)		SE	-Nests in forest and forages in big meadows -Lives at 4,000 to 8,000 feet in elevation -Moves to lower elevation meadows (as low as 2,000 feet) in winter
Willow flycatcher (*Empidonax traillii*)		SE	-No longer breeds in Yosemite (Pyle, Sielel, Paschube, et al. 2006) -Lives mostly at 4,000 to 5,000 feet -Nests in wet meadow and willow habitats that were once common in the park -Willow habitat and willow flycatcher populations in decline across the Sierras
Mammals			
Sierra Nevada red fox (*Vulpes vulpes necator*)		ST	-Possibly restricted to high elevations of the park (Grinnell and Irwin 1924) -Confused with introduced eastern red fox -Difficult to confirm existence and distribution in Sierra Nevada
California wolverine (*Gulo gulo*)		ST	-Historical documentation indicates that it lived at high elevations in the park -Uncertain if this species is still present in Yosemite (Garcelon, Rall, Hudgens, et al. 2006)

Special Status Wildlife Species	Federal Status	State Status	Habitat
Pacific fisher (*Martes pennanti*)	FC	CSC	-Lives in mature forest with dense canopy closure and complex understory structure, in oak and mixed confer habitats
American badger (*Taxidea taxus*)		CSC	-Wide elevations and habitat range -Distribution dependent on prey—burrowing rodents such as California ground squirrel (Spermophilus beecheyi), Belding's ground squirrel (S. beldingi), and yellow-bellied marmot (Marmota flaviventris) -Prey species occur in open meadow habitats (squirrels) and rocky areas (marmot)
Sierra bighorn sheep (*Ovis canadensis californiana*)	FE	CE	-Found in very small numbers in high-elevation alpine habitat
Western red bat (*Lasiurus blossevillii*)		CSC	-Winter range in lowlands and coast west of the park -Summer range up into coniferous forest -Roosts primarily in trees
Spotted bat (*Euderma maculatum*)		CSC	-Wide distribution, but limited by need for large, nearby cliffs for roosting -Lives in scrub to montane forests
Townsend's big-eared bat (*Corynorhinus townsendii*)		CSC	-Roosts in caves, large crevices, and sometimes hollow trees -Lives in many habitats from scrub up to coniferous forests
Pallid bat (*Antrozous pallidus*)		CSC	-Roosts in caves, crevices, and sometimes hollow trees -Forages in grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests
Western mastiff bat (*Eumops perotis*)		CSC	-Roosts in cliffs -Is active during the warmer months -Lives in chaparral to oak woodland and into the ponderosa pine belt and meadows of mixed conifer forests

FE – Federal Endangered FT – Federal Threatened FC – Federal Candidate
SE – State Endangered ST – State Threatened CSC – California Species of Concern

9) It is uncertain whether the California wolverine still lives in Yosemite (Garcelon et al. 2006). Historical documentation of this species indicates that it occurred at high elevations of the park, where non-native plant control would be unlikely to take place. There would be no effect on the California wolverine.

10) The Pacific fisher is very rare in Yosemite. It occurs at lower elevations than formerly believed and extends into oak, mixed-conifer habitats. Crucial habitat attributes of this species include dense canopy closure and complex understory structure. All the alternatives are unlikely to affect these crucial habitat attributes. There would be no effect on the Pacific fisher.

11) The American badger can inhabit a wide range of elevations and habitat types. Its distribution is dependent upon its prey, which includes burrowing rodents and yellow-bellied marmot. These prey species live in open meadow habitats (squirrels) and rocky areas (marmot). At low elevations, invasive plants may affect habitat quality by altering food availability for prey species. Aggressive suppression of invasive plants under the action alternatives would have a better

chance of restoring natural plant assemblages in badger habitat. Under the action alternatives, there would be a long-term minor beneficial effect on the American badger.

12) Herbicide use may result in negligible adverse impacts upon insects, the main food source of Yosemite bats. Therefore, as bioaccumulators, bats may have negligible adverse impacts.

13) Invasive plant management efforts are not expected to have an appreciable impact on Sierra bighorn sheep, either beneficial or adverse, because non-native species cover is currently very low in bighorn sheep habitat.

14) Invasive plant management efforts are not expected to have more than a negligible adverse impact on Valley elderberry longhorn beetles, because the herbicide application buffer will ensure that elderberry plants are not killed by herbicide application. Invasive plant management efforts will have a minor positive effect on the beetles where management efforts keep invasive plants from displacing elderberry populations.

Impairment

Because the proposed actions would not result in more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 1 will not result in impairment of the park's special status wildlife for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species, protecting and enhancing wildlife habitat.

Alternative 2 introduces four herbicides that would be used under threat conditions that the current plan cannot efficiently treat. The additional herbicides are U.S. and CAL EPA approved, and are recommended by university researchers, toxicologists, and wildland resource management specialists. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals. Impacts could include the following:

1) The use of herbicides near water and the addition of four more herbicides use may have localized short-term negligible adverse effects on special status wildlife species. As herbicides become a regular part of the park's invasive plant management toolbox, the acreage treated each year could increase. The emphasis of the Invasive Plant Management Program is expected to shift to early detection and eradication, as the populations of existing priority species, and the backlog of species like Himalayan blackberry that were not effectively managed using physical methods, are now effectively controlled. This could result in smaller acreages treated each year. Additionally, the use of more effective herbicides might result in smaller amounts being needed to treat invasive plant populations.

2) The use of herbicides near water may allow for the treatment of species such as Himalayan blackberry that would otherwise not be controlled using physical methods. This strategy could result in long-term moderate benefits to wildlife where invasive plants are not allowed to displace special status wildlife habitat.

The area of invasive plants treated near elderberry plants would increase slightly. In consultation with the United States Fish and Wildlife Service (personal communication, Jeremiah Karuzas, 2010), the "no spray" buffer around elderberry plants to protect federally threatened valley elderberry longhorn beetles would be reduced from 100 feet to spraying up to 30 feet from the drip line, followed by hand application up to 10' from the drip line. Within the 30-100' zone, herbicides that pose a risk to active adult beetles (March-June) would not be used. This strategy would protect the beetles while allowing for management of invasive species that could otherwise displace elderberry plants. The beetles occur in riparian areas below 3000 feet. Their entire life cycle takes place in, on, and directly around their host plant. They lay eggs on the bark of stems over 1 inch in diameter. Larvae burrow into the stem, where they may live for up to two years before exiting the plant. Oblong exit holes can indicate their presence, but are not always evident. There may be a short-term adverse effect (for a few individuals), but overall, a long-term negligible beneficial impact on the valley elderberry longhorn beetle population as habitat is protected or restored.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 2 would not result in impairment of the park's special status wildlife for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and show no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., against aquatic threats such as hydrilla). Impacts could include the following:

1) Impacts are similar to those under Alternatives 1 and 2.
2) The potential for impacts on wildlife species of concern would be considered prior to using aquatic herbicide formulations directly in water.

Impairment

Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 3 would not result in impairment of the park's special status wildlife for future generations.

Cumulative Impacts

Cumulative impacts on special-status wildlife are based on analysis of past, present, and reasonably foreseeable future actions in California and the Yosemite region in conjunction with the potential effects of these alternatives. Past and present factors affecting special status wildlife include fire suppression, deposition of chemical compounds from outside the park, the invasion of non-native species (including pathogens), and land management practices outside Yosemite. In the foreseeable future, climate change has the potential for large-scale major adverse impacts on wildlife. Climate change could accelerate the arrival and spread of non-native plant species by making higher elevations

of the park more suitable for these species through warming. These past, present, and foreseeable future impacts are long-term, adverse, and major.

Local past and present actions would have both beneficial and adverse impacts on special status wildlife. Parkwide planning efforts such as the Merced and Tuolumne Wild and Scenic comprehensive management plans would provide large-scale watershed protection to plant communities. Prescribed fire and managed wildland fire activities would greatly reduce the threat of large high-severity catastrophic fires, and would reduce the potential for habitat conversion. Other present and future actions would restore wildlife habitat.

Past impacts on special status wildlife have been adverse, long-term, and major. Local present actions would contribute to reversing the major adverse impacts of past actions on special status wildlife and would produce long-term moderate beneficial effects. In the context of the multiple, spatially massive, and potentially catastrophic past and present effects, the impacts of these alternatives would be negligible. The past, present, and future effects, along with impacts of all three alternatives would result in long-term adverse moderate impacts on special status wildlife.

Conclusion

Any potential impacts to special status wildlife in Yosemite National Park are similar across all alternatives. The primary differences are that herbicide use would be allowed to the waterline under Alternative 2, and herbicide use could be considered in water under Alternative 3. Potential impacts would range from beneficial to short-term, negligible, and therefore would not result in impairment of special status wildlife for future generations.

8. DESIGNATED WILDERNESS

Affected Environment

Aside from road corridors, developed areas, and the southwestern edge of the park, 95% of Yosemite is designated Wilderness. The California Wilderness Act designated 704,368 acres as Wilderness in 1984. An additional 927 acres is designated as potential Wilderness.

The Wilderness Act of 1964 mandates the preservation of Wilderness character, wildness, and naturalness. Wilderness is defined as "an area where the earth and its community of life are untrammeled by man," that is, protected and managed so as to preserve its natural conditions…with the imprint of man's work substantially unnoticeable" (Public Law 88-577 [16 USC 1131-1136]). Wilderness also has outstanding opportunities for solitude or a primitive and unconfined type of recreation. The Wilderness Act prohibits certain activities, such as the use of: motorized equipment; mechanical transport, structures or installations; and aircraft landing, unless such activities are considered the minimum requirement to administer the area for the purpose of preserving Wilderness character. In addition, the NPS *Management Policies* (2006b) mandate that decisions affecting wilderness be consistent with the minimum requirement concept (Appendix J).

The introduction of non-native invasive plants is recognized as being generated from outside the park and anthropogenic (resulting from human action) in origin. Treatment in Wilderness is justified where a

species has the potential for seriously degrading ecosystem processes and the natural environment, and where there is a reasonable chance that a species can actually be eradicated from Wilderness. Although non-native plants are present in Wilderness areas, they do not currently affect vast expanses of Yosemite's Wilderness to the extent that they do in the foothill woodland and low and middle elevation wetland habitats within the park. However, this is not a reason for complacency, as recent research has shown that even high elevation habitats within the park are susceptible to invasion (see "Purpose and Need" for further discussion). Prevention, and early detection and eradication are the keys to protecting Wilderness from degradation by invasive species. The challenge comes from the limited staffing and funding available for surveying such a vast area that is often difficult to access.

A total of 33 non-native plant species have been documented in the park's Wilderness, including 22 that are high- and medium-high priority species (NPS 2006c). Invasive plants enter the Wilderness in many ways, from attachment to shoes and socks to excretion by birds. Stock operations in Wilderness areas can also introduce non-native plants into the park through feed. The NPS and the park concessioner account for 59%of overnight stock use and 90% of day stock use in the park. These entities voluntarily use only certified weed-free feed, although this does not mean that the feed does not contain invasive plant seeds that could harm Yosemite National Park plant communities (see "Weed Free Hay" under "Alternatives Considered but Dismissed" in Chapter II).

In Yosemite, invasive plants are generally found in the immediate footprints of developed sites such as trails, corrals, and cabins, and at elevations of 7,000 feet or lower. Non-native plant species found outside developments are most often associated with areas that sustained large fires in proximity to trails. Wet areas, as well as sites where trails and streams intersect, are also especially likely to contain non-native species. The areas with the greatest density and diversity of invasive species include the Merced River corridor from Little Yosemite Valley to Merced Lake; the trail from Hetch Hetchy Reservoir to Beehive Spring, Pate, Tiltill, and Poopenaut valleys; Miguel Meadows; and Rancheria Falls. Currently, most invasive plants in Wilderness are hand pulled, although shovels and trowels are occasionally used for control.

Environmental Consequences

Wilderness character is considered to have four general components: untrammeled, natural, undeveloped, and experiential. *Untrammeled* is often defined as unmanipulated, or that which is not "subjected to human controls and manipulations that hamper the free play of natural forces" (Howard Zahniser, 1959, letter to C. Edward Graves). The *natural* quality refers to the natural quality of the environment. The *undeveloped* character typically refers to structures or other human constructions, although it could also refer to the use of powerful tools in wilderness such as machines and herbicides. The *experiential* quality refers to the primitive visitor experience.

When using any invasive plant control method or technology, there is a balance between the four components of wilderness character. For example, one technique may adversely impact the untrammeled component of wilderness character (by repeatedly manipulating ecological processes), but preserve or have a beneficial impact on the natural component of wilderness character (by protecting or improving the health of natural communities). Multiple annual visits to control an invasive plant over several years would have a greater impact on the untrammeled character than one or two visits with herbicides. Using adaptive management and recognizing this balance would allow resource managers to make the best decisions possible with the available information. Under the Wilderness Act, all manipulation is considered a permanent impact on the untrammeled quality of wilderness character.

In an effort to reduce soil and other disturbance in wilderness areas, invasive plant control methods typically involve hand pulling or using a shovel to slice below the root crown. Ground disturbance and the loss of vegetation are the most apparent impacts on wilderness character, which represents both

tangible and intangible components of the idea of wilderness. However, depending on the size and type of treatment, the effect on the untrammeled quality is arguably the greatest, most serious impact on wilderness character. Given the expansive size of the park's wilderness, backcountry trail crews and other individuals with responsibilities within Wilderness areas have negligible adverse impacts on wilderness character. Impacts on wilderness character were assessed in terms of duration, type, and intensity of impact.

Duration of Impact. The duration of an impact is the time required for wilderness character to recover after treatment. Impacts are considered short-term if evidence of human activity would last no more than five years following implementation of an alternative. Impacts are considered long-term if evidence of human activity would persist for more than five years following implementation of an alternative. Note that these criteria aren't necessarily a good fit with wilderness character. Some impacts on the untrammeled quality of Wilderness character are considered permanent and cumulative under the Wilderness Act. The effect upon wilderness's undeveloped or experiential character from having crews using herbicides in wilderness may be short-lived, besides which all forms of invasive plant removal would impact this quality to a comparable extent. The alteration of the untrammeled character of wilderness that would result from blocking invasive species from entering wilderness and permanently altering plant communities, even though it is positive, is also cumulative and permanent.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Actions considered under Alternative 1 would meet the *Wilderness Minimum Requirements Analysis.* Impacts are described below.

1) **Natural Quality:** Under Alternative 1, invasive plant management, especially early detection and prevention, would have a long-term minor beneficial impact on the natural quality of wilderness character. The positive impacts resulting from the prevention of invasive populations from becoming established could range from moderate to major. A caveat is that dedicating enough staff to the task of regularly surveying the 704,368 acres of the park that is wilderness for invasive species is not possible, especially in the current fiscal environment.

   Hand pulling or digging up the roots of large invasive plant populations could create temporary local ground disturbance, resulting in short-term negligible adverse impacts on the natural quality of wilderness character. Herbicide use is limited near water, in traditional gathering areas, within 100 feet of blue elderberry plants, and in wilderness. Because some invasive species, especially rhizomatous species, do not respond to physical controls, the establishment and spread of these species could result where herbicide use is restricted. This could result in moderate adverse impacts of the natural quality of wilderness in these areas. However, invasive plant management program actions taken to control invasive species, whether physical, cultural, chemical, or other, would not result in more than localized short-term negligible adverse impacts on park wilderness.

2) **Untrammeled Component:** Physical and herbicide invasive plant control efforts could both have a permanent negligible adverse impact on the untrammeled component of wilderness character. Herbicide application could reduce the need for additional human manipulation of

wilderness plant communities as compared to using physical controls. For example, Himalayan blackberry, a rhizomatous species, would require multiple physical retreatments each season over the course of many seasons.

3) **Experiential Component**: Invasive species management would result in a beneficial and an adverse impact on the experiential component of wilderness character. Visitors experience a more natural environment when invasive species are prevented from displacing or degrading native plant communities. However, herbicide application activities or warning signs result in a negligible adverse impact on the primitive wilderness experience. The Vegetation and Ecological Restoration Branch Prevention has one five-person restoration team working the full field season in wilderness, and two five-person teams working five weeks in wilderness. These crews spend approximately one-third of their time removing invasive species, using mostly physical methods such as hand pulling and shovel sheering. Encounters between park staff and visitors offer the opportunity for interaction with and education of the public about ecology, resource management, invasive species, and other issues. Some visitors would come away with a positive experience when they encounter park employees actively managing threats to a resource that they believe is important to protect. There is a chance that these encounters could be negative, should visitors opposed to herbicide use encounter a spray crew in wilderness.

4) **Undeveloped Component:** No permanent development is proposed in wilderness areas as part of this plan. Herbicide use is planned. Herbicides, like chainsaws and motorized weed whackers, are powerful tools, and would have a larger impact on the undeveloped quality than, for example, hand pulling. The use of such powerful tools, as well as temporary herbicide warning signs, could be construed as having an impact on the undeveloped quality of wilderness. In wilderness, there are few large established invasive plant populations outside of the foothills. The focus is on detection and eradication of small new patches. Approximately 120 acres, about .016% of the park's total acreage, were treated using herbicides in Yosemite during the 2009 and 2010 field seasons. While herbicides are planned for use in wilderness areas in the future, especially for control of Himalayan blackberry in the Poopenaut Valley, herbicides have not yet been sprayed in wilderness. Invasive plant management would result in short-term negligible adverse impacts on the undeveloped component of wilderness character.

5) **Overall,** when the impacts on various qualities of wilderness character are weighed against each other, Alternative 1 would have a long-term and moderate beneficial impact on wilderness character. Invasive species have displaced or otherwise degraded native plant communities throughout the world. These communities provide habitat for species ranging from fungi to large mammals. While there may be negligible or minor adverse impacts on the untrammeled, experiential, and undeveloped qualities of wilderness character, these would be outweighed by the positive impacts on the natural quality of wilderness character.

Impairment

Because the proposed actions would be expected to result in negligible adverse impacts, Alternative 1 would not result in impairment of the park's wilderness character for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, priority invasive plant species would be managed using a variety of physical, mechanical, chemical, and other control techniques. The use of four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be permitted. Using herbicides to control invasive species to spray to the water line would be of particular importance for protecting and enhancing wilderness character.

The park would likely use more herbicides as they become a regular part of the park's invasive plant management toolbox. This increase could be countered by the fact that the park could also likely use smaller amounts of more effective herbicides for treating invasive plant populations. The costs and benefits of using an herbicide that has been extensively tested, but that still might have unknown risks for non-target species, water quality, or human health, must be weighed against the benefits of more effective control. Impacts could include the following:

1) Impacts resulting from Alternative 2 would be, for the most part, similar to those under Alternative 1.
2) **Natural Component**: The ability to manage invasive species under Alternative 2, especially those populations located near water, would result in an improvement in the natural component over Alternative 1. The use of herbicides would result in improved control of rhizomatous perennials near water and less soil disturbance, and would allow work crews to spend less time controlling invasive plant populations. There could be short-term negligible adverse impacts on non-target plants, amphibians, and invertebrate species. However, the long-term moderate-to-major benefits derived from protecting native plant communities from displacement or degradation by non-native invasive species would balance out these impacts. Therefore, there would be a long-term minor to potentially major beneficial impact on the natural component of wilderness character as increasingly more infestations are controlled and replaced with natural communities. The range would be dependent upon available funding and staffing.
3) **Untrammeled Component**: Impacts would be similar to those under Alternative 1. Any human manipulation of wilderness is considered to have a permanent effect, whether it be hand pulling or using herbicides to control invasive plants. However, any adverse effects would be negligible.
4) **Experiential Component**: In the short term, the impacts of allowing additional herbicides and of actions that address limitations in the existing plan would be similar to those of Alternative 1. The primary difference between alternatives would relate to long-term impacts. Control of invasive species near water could be accomplished using fewer staff and fewer repeated site visits. Impacts on the experiential component of wilderness character would thus be minimized.
5) **Undeveloped Component**: Impacts would be similar to those under Alternative 1. More powerful tools and herbicides could carry greater risks to non-target species and the undeveloped component of wilderness character. However, the use of these tools would still be very limited. Invasive plant management would result in short-term negligible adverse impacts on the undeveloped component of wilderness character.
6) **Overall:** The impacts would be similar to those under Alternative 1. The benefits to the natural component of wilderness character would outweigh the negligible adverse impacts on the experiential, untrammeled, and undeveloped components of wilderness character.

Impairment

Because the proposed actions would be expected to result in negligible adverse impacts, Alternative 2 would not result in impairment of the park's wilderness character for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides, and Address Limitations in *2008 Plan*)

Alternative 3 would include a form of adaptive management that would provide the protocols for introducing additional tools, including herbicides, for protecting park natural and cultural resources. Criteria for introducing new herbicides include that the herbicides in question must: 1) be U.S. EPA and CAL EPA approved, 2) be tested in a wildland setting and show no adverse impacts, and 3) provide

functionality that the two currently used and four proposed herbicides do not provide (e.g., against aquatic threat such as hydrilla). Actions considered under impacts could include the following:

1) Impacts resulting from Alternative 2 would be, for the most part, similar to those under Alternative 1.
2) **Natural Component**: Impacts would be similar to those under Alternative 2.
3) **Untrammeled Component**: Impacts would be similar to those under Alternative 2.
4) **Experiential Component**: These would be the same as in Alternative 2. Impacts would be similar to those under Alternative 1.
5) **Undeveloped Component**: Impacts would be similar to those under Alternative 2. Using adaptive management, future impacts from herbicides and other invasive plant control technologies would probably be reduced as tools become more efficient.
6) **Overall:** Impacts would be similar to those under Alternative 2.

Structures in wilderness, such as trails, bridges, and campsites, diminish wilderness character. These facilities have the potential to diminish the wilderness quality from the perspective of some visitors, but most visitors depend on many of these features and tolerate their presence.

Local actions listed in Appendix I that could affect wilderness in Yosemite include the Merced and Tuolumne Wild and Scenic comprehensive management plans, the *Fire Management Plan*, and the *Comprehensive Transportation Plan.* Parkwide planning efforts would provide large-scale protection in wilderness.

Impairment

Because the proposed actions would be expected to result in negligible adverse impacts, Alternative 3 would not result in impairment of the park's wilderness character for future generations.

Minimum Requirement Analysis

The park consistently uses the same process for determining whether a proposed action is essential for managing a site in Wilderness (Appendix K). As noted in the "Purpose and Need" section, controlling invasive plants is required in order to preserve and restore Yosemite's Wilderness. Furthermore, as was discussed in the "Common to All Actions" section, herbicides are the minimum tool necessary for expediently controlling these species under all three alternatives. According to the park's wilderness policy, "When determining minimum requirements, the potential disruption of wilderness character and resources would be considered before, and given significantly more weight than, economic efficiency and convenience."

Cumulative Impacts

Cumulative impacts on wilderness are based on analysis of past, present, and reasonably foreseeable future actions in Yosemite's wilderness, combined with the potential effects of this alternative. Past impacts include prevention of Native American burning, 19th and 20th century grazing, fish stocking, and killing of predators and other large animals such as the California grizzly (*Ursus arctos horribilis*). Large areas of the western part of the park were logged in the early 20th century. Existing structures such as trails, bridges, and campsites already slightly diminish wilderness character for some visitors. However, most visitors depend on many of these features and tolerate their presence.

Physical, cultural, and chemical invasive plant management has been ongoing in Yosemite National Park since the 1930s. Some invasive plant management has occurred in designated Wilderness. The herbicide 2, 4-D was used in the park to control invasive plants in the park from the 1940s through the 1960s. Past chemical management has also included mosquito control, efforts to control white pine blister rust (*Cronartium ribicola*), and needle miner moth control (*Coleotechnites miller*). Cumulative effects from pesticides also include drift from herbicides, fungicides, and insecticides sprayed on agricultural crops in California's Central Valley. Other impacts on wilderness character include visitor use; firefighting activities, such as the use of aircraft and chemical retardants to fight fires; and the use of aircraft for search and rescue efforts. Management efforts also take place on National Forest, Bureau of Land Management, and private lands on the park's borders and throughout the United States and the world.

Outside of the park's foothill woodland habitat, invasive species are not yet widespread. Where physical controls (hand pulling, shovel shearing, etc.) are effective for protecting the natural and cultural resources found in wilderness areas of the park, these methods would still be an important part of a program of early detection and eradication. Herbicide use, as demonstrated over 2009 and 2010, would be limited to very small acreages in the park each year. Thus, the cumulative impacts of ongoing invasive plant management can be expected to be long-term but negligible.

Local actions listed in Appendix I that could affect wilderness in Yosemite include the Merced and Tuolumne Wild and Scenic comprehensive management plans, the *Fire Management Plan*, and the *Comprehensive Transportation Plan.* Parkwide planning efforts would provide large-scale protection in wilderness.

Cumulative impacts for Alternatives 2 and 3 would be similar to those under Alternative 1. The cumulative impacts of ongoing invasive plant management can be expected to be long-term but negligible.

Conclusion

Alternative 1 would provide a long-term moderate beneficial impact on wilderness values, as it prevents the invasion of non-native species into areas now largely free of invasive plants. Control actions would have a short-term localized negligible adverse impact and a long-term minor beneficial impact. Overall, Alternative 1 would have a long-term minor beneficial impact on wilderness character. Because long-term impacts on wilderness character associated with Alternative 1 would be minor and beneficial, Alternative 1 would not result in impairment of the park's wilderness resources for future generations.

Early detection and prevention actions would have a long-term moderate beneficial impact on wilderness values, because these actions would help prevent the invasion of non-native species into areas largely free of invasive plants. Hand pulling invasive plants could temporarily create noticeable ground disturbance, resulting in a short-term negligible adverse impact and a long-term minor beneficial impact on wilderness character. The action alternatives would allow for the use of additional herbicides, along with the use of physical and cultural means of control, in order to control invasive plants when the current herbicides are neither efficient nor effective. The introduction of these new herbicides is meant to help the park treat current invasive infestations, and to be prepared for potential infestations with the potential to spread quickly and invade large segments of wetland habitat in wilderness. Actions considered under Alternative 3 would meet the *Wilderness Minimum Tool Requirements Analysis* (Appendix K). Overall, Alternatives 2 and 3 would have a long-term moderate beneficial impact on wilderness character. Alternatives 2 and 3 would not result in impairment of the park's wilderness resources for future generations because the long-term impacts on wilderness character associated with Alternatives 2 and 3 would be moderate and beneficial.

9. ARCHEOLOGICAL RESOURCES

Affected Environment

Archeological sites are important because they provide information on prehistoric and historic lifestyles, as well as a tangible link with the past. Yosemite has a wide array of prehistoric and historic artifacts that provide a non-written source of information about the past. These artifacts are found in all vegetation zones and at all elevations in diverse habitats. They represent continuously inhabited areas within the park dating back many centuries. Park archaeologists must proceed cautiously due to the sensitivity of these resources and the potential to cause irreparable damage.

In many cases, archeological inventories are conducted in conjunction with park development projects, most in lower-elevation developed areas and road corridors. Therefore, the archeological database is not a representative sample of the park (Hull and Moratto 1999). It is not comprehensive because it is project-driven and is executed where the development is taking place (personal communication, Kevin McCardle, historical landscape architect, Yosemite National Park, 2010).

Environmental Consequences

Type, Duration and Intensity of Impacts

When the impact of an action results in an alteration to the characteristics or information contained in an archeological site that qualify it for inclusion in the National Register of Historic Places (NRHP), the action is considered to have an adverse effect under Section 106 of the National Historic Preservation Act. However, effects are not considered adverse under the 1999 Progammatic Agreement (PA), which stipulates that archeological investigations guided by the Yosemite Research Design and Archeological Synthesis be conducted in a manner that sufficiently minimizes the effect. The effect remains adverse if the 1999 PA cannot be implemented to avoid or minimize the effect, and the NPS, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation cannot agree on measures to avoid or minimize adverse impacts and are unable to negotiate and execute an alternate memorandum of understanding in accordance with 36 CFR 800.6(b). Because archeological resources are nonrenewable and irreplaceable resources, impacts on these resources are long-term.

Effects under the NHPA are described as having "no effect," "no adverse effect," or "adverse effect." These categories are stark because park resource managers cannot create more history. Rather, history is either retained or lost. An adverse type of effect and the intensity or degree of the effect on historic properties is measured by the Criteria of Adverse Effect in 36 CFR Part 800.5 (a) (1):

> *An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling or association. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.*

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified

criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts could include the following:

1) Under Alternative 1, the control of certain invasive plant species, rhizomatous species for example, may require treatment measures that involve ground-disturbing activities. Although ground disturbance has the potential to damage or unearth archeological resources, any impacts resulting from these treatment activities would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement.
2) The use of herbicides in areas where ground disturbance has the potential to damage or unearth archeological resources would allow the control of invasive plant populations that would not be controlled using mechanical or physical methods.

Impairment

Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 1 would not result in impairment of the park's archeological resources for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the park would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added under this alternative. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. The minimum amount of low-toxicity herbicides necessary to meet management goals would be used. Impacts could include the following:

1) Impacts of Alternative 2 are similar to those under Alternative 1.
2) Alternative 2 introduces four herbicides that expand the effectiveness and range of possible species that can be treated. Under Alternative 2, herbicide applications could also take place to the water's edge. This would lower the chance of impacts on archaeological resources by allowing for the chemical treatment in situations where physical or mechanical treatment would have been required previously, thereby minimizing ground disturbing activities and reducing the potential to damage or unearth archeological resources.

Impairment

Because any effects resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 2 would not result in impairment of the park's archeological resources for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

1) More effective treatment of invasive species resulting from implementing adaptive management would result in slightly smaller potential for impacts on archaeological resources than under Alternatives 1 or 2. This is because Alternative 3 would allow for the consideration of a wider range of management tools than either Alternative 1 or Alternative 2, which could reduce

potential for effects by further reducing the need for ground disturbance due to hand pulling and digging up of plant roots. Additionally, allowing more effective treatments would potentially reduce the number of treatments, and potential disturbance resulting from repeated visits by work crews.

Impairment

Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 3 would not result in impairment of the park's archeological resources for future generations.

Cumulative Impacts

In the past, archeological resources in the Yosemite region have been subject to damage from urbanization, vandalism, visitor access, and natural processes, including fire. Regional and local present and foreseeable future activities would have no effect and no adverse effect on archeological resources. Some actions listed in Appendix J, such as the Badger Pass Ski Area Redevelopment, involve soil and vegetation disturbance. While prescribed fire and managed wildland fire activities would greatly reduce the threat of large high-severity catastrophic fires, fire activities would also contribute to the damage and/or loss of some regional archeological resources through burning and post-burn landscape processes. In Yosemite, actions to control invasive plant species are approved by cultural resource specialists to ensure no adverse effect on archeological resources, and work plans would be adjusted if necessary. Overall, projects that could have an adverse cumulative impact on archeological resources could be minimized by implementing the 1999 Programmatic Agreement. These projects, when combined with any of the three individual alternatives, are expected to have no adverse effect on archeological resources.

Conclusion

Impacts related to invasive plant control activities would be minimized in accordance with the 1999 Programmatic Agreement. Where potential impacts could take place as a result of ground-disturbing activities related to invasive plant management, park archaeologists would be consulted prior to beginning work. The prevention and control activities under all three alternatives would not cause adverse impacts on archeological resources.

10. TRADITIONAL CULTURAL PROPERTIES AND ETHNOGRAPHIC RESOURCES

Affected Environment

Traditional cultural properties are historic properties that are eligible for inclusion in the NRHP because of their association with the cultural practices and/or beliefs of a living community that 1) are rooted in that community's history, and 2) are important in maintaining the continuing cultural identity of the community. Cultural use plants are often considered contributing elements, depending on the

associated cultural practices and/or beliefs that are linked to ongoing cultural identity. Ethnographic resources include any "site, structure, object, landscape, or natural resource feature assigned traditional, legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it" (NPS 1998a). Not all ethnographic resources are considered traditional cultural properties.

Management of biotic resources by American Indians in the Sierra Nevada took place over thousands of years, resulting in significant ecological and evolutionary consequences for regional ecosystems (Anderson and Moratto 1996). Through acquiring firewood, fish, game, plant foods, craft supplies, and building materials, American Indian peoples shaped the distribution, structure, composition, and extent of certain plant and animal communities. They did so using proto-agricultural techniques such as pruning, sowing, weeding, tilling, selective harvesting, and burning (Anderson 1993).

Two locations in Yosemite Valley are managed as traditional cultural properties. If a location has been determined to be eligible as a traditional cultural property and cultural use plants are a contributing element, then any associated impacts on cultural use plants—whether from invasive species management or visitor use and so forth—must be evaluated and, where possible, avoided and/or minimized.

Seven federally recognized and non-recognized tribal groups claim ancestral cultural association with park lands and resources, including the Tuolumne Band of Me-Wuk Indians, the Picayune Rancheria of Chukchansi Indians, the Mono Lake Kutzadika'a Tribe, the Bridgeport Paiute Indian Colony, the Bishop Paiute Tribe, the American Indian Council of Mariposa County, Inc. (Southern Sierra Miwuk Nation), and the North Fork Mono Rancheria.

Environmental Consequences

Non-native invasive species pose a significant threat to cultural use plants in Yosemite National Park. Invasive plant management can benefit traditionally gathered plant populations because it can prevent invasive plants from displacing these populations. However, traditionally used plants can be trampled or otherwise damaged during invasive plant control efforts. Some invasive plant species, especially rhizomatous perennials, cannot be controlled effectively using physical methods alone. However, the use of herbicides can be controversial for some people and in some locations.

Protecting traditionally used plants from invasive species would require ongoing consultation and dialogue between tribal councils, practitioners who gather plants, and Yosemite National Park resource managers. Maintaining an ongoing dialogue is especially important because areas where these plants are gathered change from year to year depending upon the preference of individual practitioners. Additionally, the locations where cultural use plant populations are gathered can shift from year to year.

Consultation between the associated tribes and groups and the Invasive Plant Management Program would take place prior to each field season. Consultation actions would include the publishing of a work plan each winter with the purpose of notifying the associated tribes and the general public regarding locations, methods, and approximate dates of proposed control actions. Additional consultation to notify the tribes about planned upcoming management actions could include notifications, meetings, and site visits. Consultation would be the same across all alternatives. Tribes and individual tribal members are encouraged to contact the Invasive Plant Management Program manager directly or through the tribal liaison with any concerns.

Type, Duration, and Intensity of Impact. A beneficial type of effect as measured in NEPA is folded into the "No Adverse Effect" finding under the NHPA. An adverse type of effect and the intensity or degree of effect on historic properties is measured by the Criteria of Adverse Effect in 36 CFR Part 800.5 (a) (1):

> *An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling or association. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.*

For potential effects on traditional cultural properties, Stipulation VII C. 2 f. of the *1999 Programmatic Agreement among the National Park Service at Yosemite, the California State Historic Preservation Officer and the Advisory Council on Historic Preservation Regarding Planning, Design, Construction, Operations and Maintenance, Yosemite National Park, California* stipulates that the NPS consult with appropriate Indian tribe(s) regarding possible effects to Native American archeological or traditional cultural properties in seeking measures to avoid adverse effects.

Because traditional cultural properties are nonrenewable and irreplaceable resources, any effects due to the implementation of an alternative are considered adverse and of permanent duration. Impacts on cultural use plants are considered short-term if implementation of an alternative would cause a temporary change in important vegetation or temporarily restrict access to, or cultural traditions associated with, an important resource. Impacts are considered long-term if implementation of an alternative would cause a change in culturally important vegetation or a cultural feature for a noticeable period; this period would vary by resource type and traditional practitioners. Long-term changes would disrupt cultural traditions associated with the affected resource, but the disruption would not alter traditional activities to the extent that the important cultural traditions associated with the resource would be lost. A permanent impact on traditional cultural properties would involve irreversible changes in important resources such that the ongoing cultural traditions associated with those resources would be lost.

Under the NHPA, the proposed action is considered to have no impact when no traditional cultural properties are present or when the action would not affect any traditional cultural properties. When an action would not alter the characteristics of a traditional cultural property that qualify it for inclusion in the NRHP, the action is considered to have no adverse effect. When an action would alter the characteristics of a traditional cultural property that qualify it for inclusion in the NRHP, the action is considered to have an adverse effect.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Under the no-action alternative, invasive species that do not respond well to physical controls would be likely to continue to spread and invade critical habitat and ecological zones that currently support traditional use plants, including contributing elements to proposed traditional cultural properties. Control activities under Alternative 1 would not cause adverse effects on traditional cultural properties given that the mitigating measures described below would be implemented.

Protecting cultural resources from invasive species would require cooperation, coordination, and input from park invasive plant and cultural staff, as well as tribal government and cultural use practitioners in the invasive plant management planning process. The most suitable control methods would be used to control invasive species while protecting traditional cultural properties, spiritual areas, and areas near cultural use plant populations. Control methods should also protect the people who gather the resource. A work plan is published every winter with the purpose of notifying the associated tribes and the general public regarding locations, methods, and dates of proposed control actions. Additional consultation to notify the tribes about planned upcoming management actions includes notifications, meetings, and site visits.

The intent of invasive plant management is to protect the park's natural and cultural resources. Potential impacts from invasive plant control activities on traditional cultural properties would be mitigated in accordance with guidelines found in 36 CFR 800, the implementing regulations for the NHPA, such that no direct adverse effects would result.

1) Management actions have short-term minor adverse impacts on the ability to gather traditional use plants. Management actions could be scheduled over several years so that management activities would take place in only a small portion of habitat for any particular cultural use plant, thus allowing for gathering of the resource.
2) Traditionally gathered plant populations can be displaced by the continued spread of invasive plants, and generally benefit from their removal.
3) Other traditional properties would not be affected under Alternative 1.

Impairment

Because the proposed actions would result in minor adverse impacts, Alternative 1 would not result in impairment of the park's traditional cultural properties or ethnographic resources for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the park would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added under this alternative. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. The minimum amount of low-toxicity herbicides necessary to meet management goals would be used.

1) Impacts would differ from those of Alternative 1 because herbicides potentially could be used to control non-native invasive plants in traditional gathering areas under Alternative 2. The use of herbicides may be the only effective tool for protecting cultural use plants from displacement by non-native invasive species.
2) Specific impacts of Alternative 2 would be addressed to the greatest extent possible through ongoing consultation with associated tribes pursuant to the 1999 Yosemite Programmatic Agreement. The creation of an informal invasive plant management working group would help facilitate cooperation and dialogue among the Yosemite National Park Invasive Plant Management Program and associated tribes and interested tribal members.

Impairment

Because the proposed actions would result in minor adverse impacts, Alternative 2 would not result in impairment of the park's traditional cultural properties or ethnographic resources for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

1) Possible impacts are similar to those under Alternatives 1 and 2.

Impairment

Because the proposed actions would result in minor adverse impacts, Alternative 3 would not result in impairment of the park's traditional cultural properties or ethnographic resources for future generations.

Cumulative Impacts

In the past, many traditional cultural properties in Yosemite have been lost or damaged through disruption of cultural traditions and through disenfranchisement due to government policies and actions, larger societal trends, past development, visitor use, and natural events such as fire. Nevertheless, Yosemite retains many sites and resources of importance to culturally associated American Indians. Regional and local present and foreseeable future activities may have both beneficial and adverse impacts on traditional cultural properties. For example, while hand pulling could reduce non-target impacts and promote native vegetation growth (beneficial), disturbed soils and the need for retreatment could also allow for different non-native plants to infest a treated area (adverse). Invasive plant control actions would take place only in traditional use areas, including those that are contributing elements to TCPs, after consultation with associated tribes and park cultural experts.

Conclusion

The purpose of actions proposed under these alternatives is to protect park natural and cultural resources from damage resulting from the introduction and spread of non-native invasive plants. The park would avoid or minimize direct impacts on traditional cultural properties through meaningful and ongoing consultation and collaboration between park resource managers and traditionally associated tribes. Planning and mitigation discussions would also involve collaboration to determine appropriate times, methods, and locations for various treatments. Therefore, the prevention and control efforts presented under the three alternatives would not impair traditional cultural properties and ethnographic resources for future generations.

11. CULTURAL LANDSCAPE

Affected Environment

Cultural landscapes are the result of the long interaction between humans and the land. They reflect human adaptation and use of natural resources, and the influence of beliefs, values, traditions, and actions over time upon the natural landscape. Cultural landscapes are shaped over time by historical land use and management practices, as well as by politics, property laws, levels of technology, and economic conditions. Cultural landscapes provide a living record of an area's past and act as a visual chronicle of its history. The National Park Service Cultural Landscapes Inventory database lists over 40 historic landscapes that have been inventoried, or found to be eligible, and 62 currently recognized cultural landscapes within Yosemite National Park (NPS 1998b), with more likely to be added in the future.

Cultural landscapes can be defined by their vegetation, which can be native or introduced. These landscapes have been cultivated or used by humans for practical or aesthetic purposes. Over thousands of years, American Indian modified the natural environment to suit their way of life and created the distinctive pattern of meadows and open woodland that is a hallmark of Yosemite Valley. European Americans continued to alter the environment during the 19th and 20th centuries while converting Yosemite into a national park. They deliberately and accidentally introduced many non-native species during the course of farming, grazing, construction, landscaping, and visitor use activities. Some non-native trees—in particular, the American elm (*Ulmus americana*), sugar maple (*Acer saccharum*), black locust (*Robinia pseudoacacia*), and domesticated apples (*Malus x domestica*)—are elements of the cultural landscape. Most of these non-native trees are represented by mature specimens that survived from the original plantings. Black locusts are reproducing in the park and spreading beyond their original locations. The plants beyond the original trees are thus considered invasive. The proliferation of non-native plants beyond established historical limits is changing the essential character of Yosemite's cultural landscape by displacing or otherwise altering native vegetation patterns.

American Indian traditional cultural properties. American Indian traditional cultural properties are discussed in the previous "Traditional Cultural Properties and Ethnographic Resources" section.

Environmental Consequences

Historic properties were analyzed qualitatively, in accordance with 36 CFR 800 criteria of effect, based on the modifications that would be made to character-defining features (features that qualify the property for inclusion in the NRHP).

Type, Duration, and Intensity of Impacts. Under the NHPA, impacts on cultural landscapes are characterized as having no effect, an adverse effect, or no adverse effect. A determination of adverse effect results when the proposed action directly or indirectly impacts any of the characteristics of the historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Unlike impact analyses performed under NEPA, NHPA analyses do not consider an impact to be beneficial. Any change in the physical attributes of a cultural landscape feature is considered adverse and of permanent duration.

The proposed action is considered to have no impact when no historic cultural landscapes are present or when the action would not affect historic cultural landscapes. When an action would not alter the

characteristics of a historic cultural landscape that qualify it for inclusion in the NRHP, the action is considered to have no adverse effect. When an action would alter the characteristics of a historic cultural landscape that qualify it for inclusion in the NRHP, the action is considered to have an adverse effect. However, effects on features and/or patterns of a cultural landscape are not considered adverse if standard mitigation measures identified in the 1999 Programmatic Agreement are implemented in consultation with the California State Historic Preservation Officer. If the NPS, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation cannot agree on implementation of standard mitigation measures to avoid or minimize adverse impacts and are unable to negotiate alternative measures in accordance with 36 CFR 800.6(b), the effect remains adverse.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible.

1) Invasive plant management could reduce the spread of existing invasive plants that have the potential to alter the cultural landscape, resulting in no adverse effect on cultural landscapes.
2) An effective early detection and prevention program would reduce the need for more intensive control efforts within cultural landscapes, thus reducing the risk to cultural landscapes.
3) The park would mitigate impacts related to invasive plant control activities in accordance with the 1999 Programmaatic Agreement such that no adverse effects on the cultural landscape would result. In some cases, this agreement could preclude the use of the control techniques proposed under these alternatives, or dictate the method of treatment. Where there would be the possibility of impacts on historical resources such as trees, this strategy could include not spraying within the drip line.

Impairment

Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 1 would not result in impairment of the park's cultural landscapes for future generations.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the NPS would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added to this plan. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species.

The additional herbicides are U.S. and CAL EPA approved, and are recommended by toxicologists and resource management specialists. Alternative 2 would meet integrated pest management goals because work crews would use the minimum amount of low-toxicity herbicides necessary to meet management goals.

1) Impacts of Alternative 2 would be similar to those under Alternative 1.

Impairment

Because any impacts resulting from the proposed actions would be mitigated in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 2 would not result in impairment of the park's cultural landscapes for future generations.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements a form of adaptive management that would provide the protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides in question must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting and show no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., against aquatic threat such as hydrilla).

1) Impacts are similar to those under Alternatives 1 and 2.

Impairment

Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 3 would not result in impairment of the park's cultural landscapes for future generations.

Cumulative Impacts

Cumulative impacts on the cultural landscape are based on analysis of past, present, and reasonably foreseeable future actions in the Yosemite region in conjunction with the potential effects of these alternatives. Past development, visitor use, and natural events have resulted in adverse cumulative impacts on historic resources and the cultural landscape, including structures and sites such as homestead cabins, barns, road and trail segments, bridges, mining complexes, railroad and logging facilities, historic tourist facilities, tree blazes, and campsites.

None of the three alternatives would result in impairment of the park's cultural landscapes for future generations. Overall, projects that could have an adverse cumulative impact on historic structures, buildings, and landscapes could be minimized by implementing the 1999 Programmatic Agreement (NPS 2003b). These projects, when combined with Alternative 1 or either of the action alternatives, are expected to have no adverse effects.

The impacts of cumulative projects in Yosemite would be minimized to have no adverse effect on the cultural landscape. These effects, along with the action alternatives, would result in no adverse impacts on the cultural landscape.

Conclusion

The invasive plant program described under the action alternatives could reduce the spread of existing invasive plants that have the potential to alter the cultural landscape. Treatment methods would not have a permanent adverse impact on the cultural landscape directly after work crews remove invasive plants. Impacts related to invasive plant control activities would be minimized in accordance with the 1999 Programmatic Agreement such that there would be no adverse effects on the cultural landscape.

12. VISITOR EXPERIENCE AND RECREATION

Affected Environment

Invasive plants have the potential to affect the recreational experience of park visitors by altering the character of the scenic landscape, limiting access through areas, or limiting the visibility of scenic views. The invasive plants with the highest risk of adversely impacting visitor access and views include Himalayan blackberry, yellow star-thistle, black locust, and tree-of-heaven. Figure III-5 shows the most recent visitor recreation and leisure activities (Littlejohn, Meldrum, and Hollenhorst 2006). Yosemite is one of the most highly visited national parks. Visitor use has been tracked by the NPS Public Use Statistics Office, as shown in Figure III-6. Yosemite visitation peaked in the mid-1990s at over 4 million annual recreation visits, and then declined to 3.4 million in 2005 (http://www.nps.gov/yose/parkmgmt/statistics.htm). Visitation is predicted to again top 4 million in 2010. The evaluation of impacts on visitor experience and recreation was based on scientific literature and/or expert judgment. Several basic assumptions guided these evaluations:

- Invasive plant management strategies may affect the quality of visitor experiences and the character of recreation opportunities in the park in different ways depending on the type and intensity of management action taken.
- The quality of a recreational experience may be measured to some degree by a person's participation in a particular activity (Driver and Knopf 1977).
- The quality of the visitor experience is determined prior to, during, and after participation in activities (Clawson and Knetsch 1966).

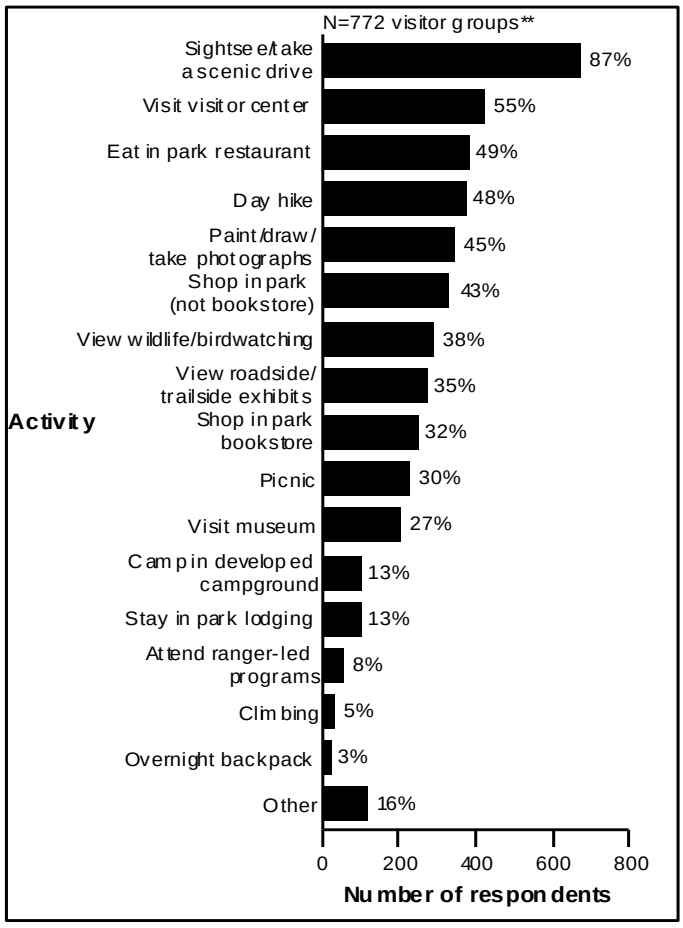


Figure III-5. Visitor Activities in Yosemite National Park

Impacts on the visitor experience can be short- or long-term and beneficial or adverse. Negligible impacts, as described by Yosemite Visitor Use and Social Sciences staff, are those that would result in little noticeable change in visitor experience. Minor impacts would result in changes in desired experiences, but would not appreciably limit or enhance critical experiential characteristics or activity participation.

Moderate impacts would appreciably alter critical experiential characteristics and/or activity participation. Major impacts would

eliminate or greatly enhance multiple critical characteristics or greatly reduce/increase activity participation.

Across all alternatives, treatment involving hand pulling or the use of tools for pulling would not result in more than a negligible impact on the recreational setting. The noise generated by mowing, brush-cutting, weed-eating, and other equipment can intrude upon the natural landscape, disrupting enjoyment of natural ambient sounds and affecting the ability of visitors to obtain a quality leisure experience that includes a sense of solitude and tranquility. This approach would result in localized short-term minor to moderate adverse impacts on the quality of the visitor experience.

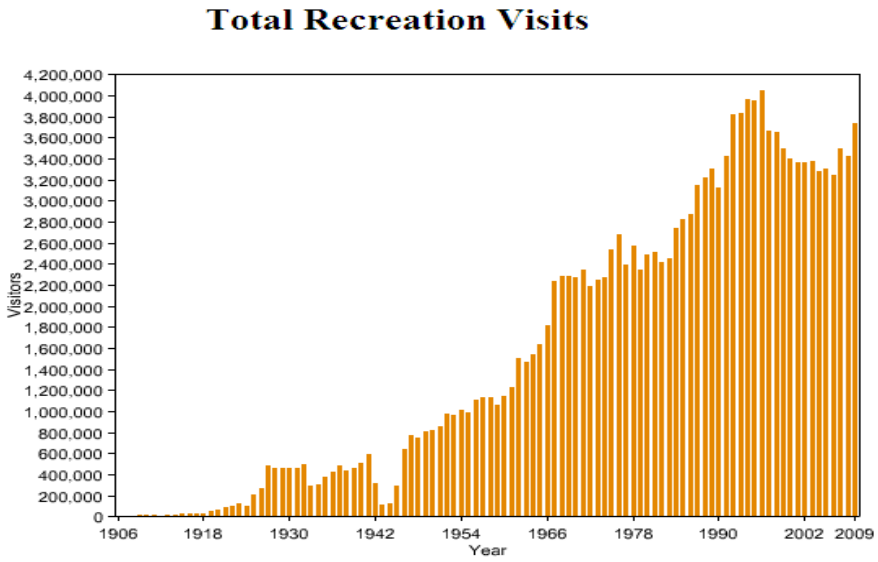


Figure III-6. Recreation Use in Yosemite National Park

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible.

1) Implementation of Alternative 1 would cause negligible short-term impacts on the quality of the visitor experience. These impacts could be either adverse or beneficial. For example, the presence of uniformed resource managers in wilderness could detract from their experience for those visitors who are seeking solitude.
2) The use of herbicides could have a minor adverse effect on the experience for some visitors due to real or perceived health risks associated with such chemicals. However, the experience of other visitors could be enhanced where encounters with park staff offer opportunities for learning about resource management issues, research, and other activities, and from seeing park staff actively addressing threats to park resources.

3) Long-term minor beneficial impacts would result for the visitor experience where invasive plants are prevented from altering the character of the scenic landscape and limiting access to natural areas.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Under Alternative 2, the park would meet management objectives for priority invasive plant species using a variety of physical, mechanical, chemical, and other control techniques. Four additional herbicides (rimsulfuron, chlorsulfuron, imazapyr, and triclopyr) would be added under this alternative. Introducing aquatic formulations and the ability to spray to the water line would be of particular importance in the control of certain non-native invasive species. The minimum amount of low-toxicity herbicides necessary to meet management goals would be used.

1) Impacts of Alternative 2 would, for the most part, be similar to those under Alternative 1.
2) By addressing limitations in the *2008 Plan* and allowing for the use of additional herbicides, Alternative 2 would better preserve park ecological diversity compared with Alternative 1. Thus, implementation of a comprehensive program would have a long-term minor beneficial impact on scenic aspect of visitor use in Yosemite.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements a form of adaptive management that would provide the protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Criteria for new herbicides to be implemented include that the herbicides must: 1) be U.S. and CAL EPA approved, 2) be tested in a wildland setting with no adverse impacts, and 3) provide functionality that the currently used and proposed herbicides do not provide (e.g., against aquatic threat such as hydrilla (*Hydrilla verticillata*)). Impacts could include the following:

1) Impacts are similar to those under Alternatives 1 and 2.
2) By allowing for the implementation of adaptive management, Alternative 3 would better protect the visitor experience from adverse impacts resulting from the establishment and spread of invasive species.

Cumulative Impacts

The major effects of the *2010 Update* upon the visitor experience would be localized effects on recreational experiences, including hiking, nature study, and scenic touring. The impacts of other invasive plant management efforts in the region, in conjunction with the impacts of the action alternatives, would result in long-term minor beneficial impacts on the visitor experience.

Conclusion

Implementation of a comprehensive invasive plant program would have a long-term minor beneficial impact on the visitor experience in Yosemite. Control activities under the proposed actions could have a short-term minor adverse impact on the visitor experience for some visitors and a short-term minor positive impact for other visitors, depending upon their reaction to meeting park personnel in wilderness and their views on herbicide use. There would be a long-term minor beneficial impact on the

visitor experience resulting from the prevention of invasive plants from altering the character of the scenic landscape, limiting access to natural areas in the park, or limiting the visibility of scenic views. Because long-term impacts on recreation under these alternatives would be minor and beneficial, they would not result in impairment of the park's visitor experience or recreational resources for future generations.

13. PARK OPERATIONS

Affected Environment

The park superintendent is responsible for the overall management, administration, and safety operations of the park. The NPS in Yosemite is organized operationally into eight divisions, each with a functional area of responsibility. Each division plays a part in invasive plant control. The Vegetation and Ecological Restoration Branch in the Division of Resources Management and Science manages the Invasive Plant Management Program and performs the majority of the functions related to invasive plant control. The Division of Planning oversees the general direction of planning in the park. The Division of Facilities Management maintains the park infrastructure, which includes buildings, grounds, roads, trails, and utilities. The Division of Project Management oversees all park construction projects, many of which are completed by private contractors. Project Management employees ensure that contractors are in compliance with park policies that reduce the risk of spreading invasive plants. The Division of Project Management also facilitated the environmental assessment and compliance requirements of this *Invasive Plant Management Plan.* The Division of Protection oversees law enforcement, fire, and wilderness management. Fire managers play an important role in the control of invasive plants, because recently burned ground is highly susceptible to plant invasion. The Division of Interpretation and Education conveys a variety of park issues to the public. Interpretation staff influences the public perception of NPS *Management Policies* (2006b), including those policies relevant to invasive plant management. The Division of Business and Revenue Management administers concessioner contracts, commercial use authorizations, special use permits, realty, the park's volunteer program, entrance fee collection, and campground operations. Many operational oversight functions of this division may be of assistance in the implementation of the *Invasive Plant Management Plan.* The Division of Administration performs fundamental services for the success of invasive planning efforts, such as administering staff, hiring, contracts, and housing needs. Additionally, personnel from each division, especially those with field staff, can be an asset in the early detection of invasive plant populations.

Environmental Consequences

Impacts were evaluated by assessing changes to park operations that would be needed to perform the actions described for each alternative. Alternatives that would necessitate changes in staffing levels would represent an impact on operations. Existing staffing levels were identified, and assessments of current operations were made. Knowledge about proposed activities was used to anticipate the operational changes that would be needed for each action alternative. An assessment of the labor required to implement these actions was compared with existing operations, staffing, and funding.

Type, Duration, and Intensity of Impacts. Impacts are considered adverse when the alternative would increase operating costs, and beneficial when implementing the alternative would decrease operating costs. The duration of an impact is the time required for park operations to return to current conditions after implementation of an alternative. In general, short-term impacts would be temporary transitional effects associated with implementation of an action (e.g., related to construction activities). In contrast, long-term impacts are generally those that would last ten years or more and have a permanent effect on park operations. The intensity of an impact on park operations is a measure of changes in costs required to continue existing operations. Negligible impacts would not result in costs measurably different from existing levels. Minor impacts are those that would cause measurable additions or reductions in cost of less than 15% of existing levels. Moderate impacts would result in additions or reductions in cost of 15%-30% of existing levels. Major impacts would result in additions or reductions exceeding 30% of existing levels.

Alternative 1 (No Action)

The NPS would continue to manage invasive plants through a comprehensive program that employs a variety of physical, mechanical, chemical, and other techniques. Only when invasive plant control objectives could not be met using these control techniques and invasive plant populations met specified criteria would work crews use herbicides to control up to 22 priority invasive plant species. Hand tools would continue to be the primary control tool used on sensitive soils. Treatments such as tilling would continue on resilient and other soils. Prevention, early detection, and prioritization practices would continue to distribute resources as effectively as possible. Impacts are described below.

1) Resource Management and Science employees could be needed in order to carry out the programmatic actions described for Alternative 1, including surveys of construction sites, burned areas, wilderness, and developed areas. The Divisions of Facilities Management and Project Management could experience increases in project/contract costs for construction site surveys. Invasive plant prevention measures related to fire management could also increase work demands. Additional staffing demands for inventory, prevention and early detection, and eradication activities would be far more cost-effective than controlling invasive species once they establish. These additional staffing needs would be small, so impacts on park operations would be minor over the long term.
2) Under Alternative 1, because no herbicide use is allowed within 10 feet of water, invasive species such as Himalayan blackberry would continue to spread along riparian areas and in wetlands. Park operations could experience minor long-term adverse impacts under Alternative 1 because maintaining power lines, roads, underground pipes, keeping riverside trails open, and so forth, would necessitate the clearing of invasive plants prior to beginning work, as well as the management of and monitoring for invasive species upon project completion.

Alternative 2 (Add Four Additional Herbicides and Address Limitations in *2008 Plan*)

Alternative 2 would enable Yosemite resource managers to more effectively meet management objectives for managing priority invasive plant species than Alternative 1. A variety of physical, mechanical, chemical, and other control techniques would be used, including four additional herbicides: rimsulfuron, chlorsulfuron, imazapyr, and triclopyr. Introducing herbicides that are more effective in certain situations than the herbicides approved under Alternative 1, and allowing the spray of certain herbicides to the water line, would improve the efficacy of control efforts, especially in disturbed and developed areas of the park such as road corridors, parking lots, and staging areas. Impacts could include the following:

1) Impacts of Alternative 2 would be similar to those under Alternative 1.
2) Invasive plant management efforts would result in a short-term minor adverse impact resulting from increased management efforts, and a long-term minor beneficial impact on park operations as invasive species are controlled.
3) The ability to use herbicides to control invasive plants up to the water's edge would result in minor long-term positive impacts on park operations. For example, controlling Himalayan blackberry would mitigate the effects of a species that has the potential to block access to riparian areas for park visitors and staff.

Alternative 3 (Preferred Alternative, Adaptive Management, Add Four Herbicides and Address Limitations in *2008 Plan*)

Alternative 3 is similar to Alternative 2; however, Alternative 3 implements a form of adaptive management that would provide protocols for the introduction of additional tools, including herbicides, should a threat arise that could not be treated with the currently available tools. Impacts could include the following:

1) Impacts would be similar to those under Alternatives 1 and 2.
2) The ability to consider the use of safer, more effective tools and to use adaptive management would result in minor long-term positive impacts on park operations.

Cumulative Impacts

Cumulative effects on park operations are based on an analysis of the potential effects of invasive plant management as it relates to past, present, and reasonably foreseeable future plans and projects in Yosemite National Park. The extent of possible cumulative effects is determined largely by whether such projects would affect park facilities or the demand for park operations, services, and facilities. Park operations and facilities have been affected by numerous past management decisions and projects. Some present projects—such as the Utilities Master Plan/East Yosemite Valley Utilities Improvement Plan, for example—would have overall net long-term minor to moderate beneficial impacts on park operations. These projects would improve and/or replace existing infrastructure with more modern and efficient materials, with the net effect of reducing maintenance and upkeep needs and thus reducing demands on overall park operations.

Cumulative impacts on park operations as they relate to invasive plant management would be similar for each of the three alternatives. The primary difference would be that Alternative 2 would allow for more efficient and effective treatment of invasive species and thus would create fewer cumulative impacts on park operations than Alternative 1. Alternative 3 would allow for more efficient and effective treatment of invasive species and thus create fewer cumulative impacts on park operations than Alternatives 1 or 2.

Conclusion

Herbicides are one of the tools being used for wildland, terrestrial, and aquatic invasive plant management by the NPS, as well as by the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, The Nature Conservancy, and other agencies and organizations. Targeted herbicide applications kill invasive plant populations without soil disturbance, and limiting impacts to surrounding native plants. For many species, herbicide treatments are more effective than other methods. All application rates and methods would be consistent with the product labels.

Herbicide application practices in Yosemite National Park are very different from those in agriculture and forestry. The potential impacts of using herbicides in Yosemite National Park are weighed against the potential benefits resulting from increased protection of park natural and cultural resources from displacement or other degradation by non-native invasive species. For many species, especially rhizomatous perennials, control using physical methods can take many visits per season over many years, or has proven impossible. The use of herbicides increases the likelihood of controlling invasive plant populations, and of preventing populations from going to seed and infesting new areas of the park.

Herbicides selected for use in Yosemite National Park have been approved for use by the U.S. Environmental Protection Agency, the California Department of Pesticide Registration, the NPS national or regional integrated pest management coordinator, and resource management staff at Yosemite National Park. U.S. Forest Service Human Health and Ecological Risk Assessments, or similar risk assessments, were also reviewed, and toxicologists, university invasive species researchers, NPS resource managers, and other federal, state, and conservation land managers were consulted. Herbicide information sheets summarizing each herbicide selected for use in the park, including human toxicity and environmental fate and toxicity, can be found in Appendix G.

IV WILD AND SCENIC RIVER ACT COMPLIANCE

Introduction

In the 1960s, the United States came to recognize that the nation's rivers were being dredged, dammed, diverted, and degraded at a rapid rate. In response, in October 1968, the U.S. Congress established the Wild and Scenic Rivers Act to protect and enhance rivers that possess distinctively unique or "outstandingly remarkable values" (ORV) that set them apart from all other rivers. Wild and Scenic rivers are designated to protect their free-flowing condition and to protect and enhance their unique values for the benefit and enjoyment of present and future generations (16 USC 1271).

Yosemite contains two Wild and Scenic rivers. In 1984, Congress designated 83 miles of the Tuolumne River, of which 54 are within Yosemite National Park, as part of the National Wild and Scenic River system. In 1987, Congress placed 122 miles of the main stem and South Fork of the Merced River—including the forks of Red Peak, Merced Peak, Triple Peak, and Lyell—into the Wild and Scenic River system. The NPS manages 81 miles of the Merced Wild and Scenic River, encompassing both the main stem and the South Fork in Yosemite National Park and the El Portal Administrative Site. This chapter evaluates the consistency of the proposed action in the *Invasive Plant Management Plan Update* with the Wild and Scenic Rivers Act.

Methodology

This analysis focuses on five elements of the Wild and Scenic Rivers Act: 1) the relationship of the proposed action to Wild and Scenic river boundaries; 2) the compatibility of the proposed action with Wild and Scenic river classifications; 3) the protection and enhancement of outstandingly remarkable values; 4) user capacity; and 5) the Section 7 requirements of the Wild and Scenic Rivers Act. This analysis compares the preferred alternative with the no-action alternative (see Chapter 2, "Alternatives"). The focus of the analysis is on long-term effects (e.g., effects that would last 10 years or more or would be permanent). Short-term effects are not addressed in this analysis unless they have a substantial, highly noticeable influence that warrants consideration.

Relationship of the Action to the Wild and Scenic River Boundary

The 1984 Tuolumne River Wild and Scenic River designation established a boundary extending 0.25 mile on either side of the river, the maximum allowed under the Wild and Scenic Rivers Act. In the designating language for the Merced River, the Wild and Scenic Rivers Act signals the intent of Congress to protect a minimum of 0.25 mile from both riverbanks until a comprehensive management plan formally defines the boundaries. The *Secretarial Guidelines* restate that, for designated rivers for which boundaries are yet to be formally defined, the boundary is "an area extending the length of the river segment authorized for study and extending in width one-quarter mile from each bank of the river." The proposed alternative in the *2010 Update* calls for actions within Wild and Scenic River boundaries in Yosemite, the main stem and South Fork of the Merced Wild and Scenic River, and the Dana and Lyell forks of the Tuolumne Wild and Scenic River.

Classification Consistency

The Merced and Tuolumne Wild and Scenic rivers are broken into segments that are classified as Wild, Scenic, or Recreational in accordance with criteria established in the Wild and Scenic Rivers Act at the time of designation. These classifications are derived at the time of designation from the status of impoundments, shoreline development, or road access along the river. The *2010 Update* would result in no inconsistencies with the existing classifications.

Outstandingly Remarkable Values

With regard to Wild and Scenic rivers, outstandingly remarkable values (ORV) are the river-related/river-dependent rare, unique, or exemplary values that make a river worthy of special protection. These values can include scenery, recreation, fish and wildlife, geology, history, culture, and other similar values. Section 10(a) of the Wild and Scenic Rivers Act requires that river managers protect and enhance ORV. Section 7 of the Wild and Scenic Rivers Act requires river managing agencies to determine whether water resources projects that take place in the bed and banks of the river or upstream tributaries would adversely affect free flow or directly and adversely impact ORV. Uses that are consistent with this provision and that do not substantially interfere with public use and enjoyment of these values should not be limited (16 USC 1281[a]). ORV located outside the Wild and Scenic river corridor boundary must also be protected (NPS 2005a).

The analysis of ORV is focused on segment-wide effects, rather than site-specific or localized effects. Actions that could have substantial effects on specific ORV, such as degradation of river-related habitat or a special status species endemic to that location, are also considered. Actions that could degrade ORV on a segment-wide basis include actions with effects that would be discernible throughout the majority of the river segment, or that would be of sufficient magnitude to affect adjacent segments. This analysis is based on the *Draft Outstandingly Remarkable Values Report for the Merced Wild and Scenic River* (February 2008) and the *Draft Outstandingly Remarkable Values Report for the Tuolumne Wild and Scenic River*. Final ORV for each river will be published in the Record of Decision for each plan. This analysis considers the following ORV:

- **Scientific:** The analysis considers whether the preferred alternative would affect the integrity of the Wild and Scenic River as a scientific resource, or would degrade the river's value for research.
- **Scenic:** The analysis considers scenic resources along the river from the perspective of a person situated on the riverbank or on the river.
- **Geologic Processes/Conditions:** The analysis gives primary consideration to designated processes, and the evidence of those processes (e.g., U-shaped valley, hanging valleys, evidence of glaciations, etc.), responsible for creating the river's geologic landscape.
- **Recreation:** The analysis considers whether opportunities to experience a spectrum of river-related recreational activities would be affected.
- **Biological:** The analysis focuses on effects to riparian areas, wetlands, low-elevation meadows, and other riverine areas that provide rich habitat for a diversity of river-related species, including special status species.
- **Cultural:** The analysis considers effects on river-related cultural resources, including archeological sites that provide evidence of thousands of years of human occupation and continuing traditional use today. The analysis also considers effects on nationally significant

historic resources, such as designed landscapes and developed areas, historic buildings, and circulation systems (trails, roads, and bridges) that provide visitor access to the sublime views of natural features that are culturally valuable.

- **Hydrologic Processes:** Consideration is primarily given to designated processes such as river meandering, world-renowned waterfalls, active flood regimes, oxbows, and fluvial processes.

Merced River Outstandingly Remarkable Values. The ORV for the Wild and Scenic Merced River corridor are currently being refined for the "Draft New Merced River Plan/Draft Environmental Impact Statement." When the ORV are finalized, and the New Merced River Plan Record of Decision is signed, this plan will be reviewed by the NPS to ensure consistency with the final plan, and that the proposed action protects and enhances the Merced River ORV.

Tuolumne River Outstandingly Remarkable Values. The Congressional declaration of policy from 16 USC 1271 to protect the Tuolumne Wild and Scenic River and the immediate environment states that all "remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations" (16 USC 1271). Primary emphasis is placed on protecting a river's "esthetic, scenic, historic, archaeological, and scientific features" (16 USC 1281). The park has established Draft Outstandingly Remarkable Values for the Tuolumne Wild and Scenic River. The current analysis uses the following ORV to define the river values in the corridor: scenic, recreational, geologic, fish and wildlife, historic, archaeological, scientific, cultural, or other similar values.

ORV Analysis. The preferred alternative in the *2010 Update* would not adversely impact the ORV for which the rivers have been designated. Rather, the proposed action would protect and enhance the ORV of the Merced and Tuolumne Wild and Scenic rivers by restoring and protecting the overall integrity of park ecosystems and biological, recreational, wildlife, and scientific values. The preferred alternative would provide for the benefit and enjoyment of the Wild and Scenic rivers for present and future generations. In addition, through adherence to mitigation measures and best management practices developed to protect water and soil quality, and biotic and human health, the NPS will ensure protection of ORV. No adverse effects on ORV are expected to result from implementation of the proposed action. Full environmental impacts analysis is provided in Chapter 3.

User Capacity

The proposed action is not expected to result in any changes in the types or levels of visitor use in the Tuolumne River or Merced River Wild and Scenic river corridors; nor would it change existing vehicular or pedestrian circulation patterns.

Wild and Scenic Rivers Act, Section 7

Pursuant to the Wild and Scenic Rivers Act, the NPS must develop a Section 7 determination for any proposed water resource projects that may affect the beds and banks of Wild and Scenic rivers, that is the Tuolumne or Merced rivers in Yosemite National Park. This determination ensures that actions do not affect free flow, and do not directly and adversely impact the ORV for which the rivers were designated. A water resources project is any dam, water conduit, powerhouse, transmission line, or other works project under the Federal Power Act, or other developments, that would affect the free-flowing character of a wild and scenic river. In addition to projects licensed by the Federal Energy

Regulatory Commission, water resources projects may include dams, water diversions, fisheries habitat and watershed restoration, bridges and other roadway construction, reconstruction projects, bank stabilization projects, channelization projects, levee construction, boat ramps, and fishing piers. It also includes activities that require a Section 404 permit from the U.S. Army Corps of Engineers (IWSRCC 1999). Because the proposed action does not qualify as a water resource project as defined above, the NPS concludes that a formal Section 7 determination is not applicable. The NPS anticipates that there will be no effects to the beds and banks of the Wild and Scenic rivers, or to their free flow; nor will it directly or adversely affect the ORV for which the rivers were designated.

V CONSULTATION AND COORDINATION

Internal and Public Scoping

A formal public scoping period was held for the *2010 Update* from April 14 through May 15, 2010. The park announced the opening of public scoping with a press release and announcement in the *Yosemite National Park Daily Report* and in the *Mariposa Gazette* (newspaper of record), as well as electronically through the Yosemite National Park website, and the NPS's Planning Environment and Public Comment (PEPC) database system. The park invited interested parties to attend two public meetings (open houses) and an interpretive site visit during the public scoping period. Professional staff members were available at the open houses to introduce the project, answer questions, and accept comments. Open houses continued monthly from the initiation of the scoping period through the conclusion of the planning process. The open houses included exhibits about existing conditions, the proposed plan and alternatives, methods and techniques, and environmental considerations. The park received comment letters during the public scoping process, including 29 from individuals and 17 from organizations. Public comments were accepted at open houses, by mail, by e-mail, and through the PEPC database system.

During the 30-day comment period, five public comment letters were received. These comments were thoroughly reviewed and analyzed to identify substantive concerns, and each distinct comment was summarized in a public scoping report. These comments were considered by the project team during the development of alternatives for this environmental assessment update. Also, the planning team reviewed public comments received on the *2008 Invasive Plant Management Plan* Environmental Assessment, published in the *2008 Finding of No Significant Impact* (FONSI) and available on the PEPC database, for relevancy and applicability to the new environmental assessment.

Agency Consultation

U.S. Fish & Wildlife Service (Sacramento Fish and Wildlife Office)

The United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service work collaboratively to provide guidance to other federal agencies for fulfilling the requirements of the federal Endangered Species Act of 1973, as amended. Section 7 of the federal Endangered Species Act (16 USC 1531 et seq.) outlines the procedures for federal interagency cooperation to conserve federally listed species and designated critical habitats.

Section 7(a) (1) requires federal agencies to use their authorities to further the conservation of listed species. Section 7(a) (2) requires federal agencies to consult with the USFWS and the National Marine Fisheries Service to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species, or to destroy or adversely modify designated critical habitat. Other paragraphs of this section establish the requirement to conduct conferences on proposed species, allow applicants to initiate early consultation, and require the USFWS and National Marine Fisheries Service to prepare Biological Opinions and issue Incidental Take statements.

Yosemite National Park is located within the jurisdiction of the Sacramento Fish and Wildlife Office, and consults with this office to obtain lists of federally listed endangered and threatened species that may be present in the project area. The park generated a Species List from the USFWS website on September 14, 2010. The park used the Species List (and updates) as the basis for analyzing the effects of this project on federally protected species. Based on this list, park data, and park staff's professional knowledge and judgment, it was determined that the project would have "no effect" on any federally protected species or their critical habitat. During the public review period for this environmental assessment, additional consultation will take place to confirm determinations of effect (if needed) with the USFWS. Notice of concurrence with the determinations of effect will be documented in the FONSI, if prepared, for this environmental assessment.

Other Federal Land Management Agencies

Yosemite National Park invasive plant managers work closely with neighboring land management agencies to address invasive plant issues and concerns that cross agency borders. Yosemite managers work with the Sierra National Forest, Stanislaus National Forest, and the Bureau of Land Management to map invasive plant populations, prioritize and treat infested areas, and exchange information on invasive plant control.

Yosemite National Park is a member of the Sierra-San Joaquin Noxious Weed Alliance, a local organization that brings together county, state, federal, and private landowners from Fresno, Mariposa, and Madera Counties to coordinate and combine action and expertise in control of common invasive plants. This group functions under the authority of a mutually developed memorandum of understanding, and is subject to statutory and regulatory invasive plant control requirements. The Sierra National Forest botanist chairs this group. Botanists from the Sierra National Forest and the Stanislaus National Forest (Groveland and Miwuk Ranger Districts) aided in the review and development of this *Invasive Plant Management Plan Update.*

California State Office of Historic Preservation/ Advisory Council on Historic Preservation

In 1999, the NPS, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation developed a Programmatic Agreement (PA) (NPS 1999) in consultation with American Indian tribes and the public. The PA stipulates procedures for Yosemite National Park to carry out its responsibilities under Section 106 of the NHPA. In accordance with the 1999 PA, public involvement was coordinated as part of the NEPA public involvement and scoping process for the *2010 Update.* Pursuant to the 1999 PA, the park is responsible for reviewing projects of this nature and magnitude in-house with no additional consultation with the State Historic Preservation Office or the Advisory Council on Historic Preservation. The NHPA Section 106 review process is documented in this environmental assessment. If the subsequent decision is a Finding of No Significant Impact, the park will report to the State Historic Preservation Office, the Advisory Council on Historic Preservation, American Indian tribes, and other consulting parties in its annual report.

American Indian Consultation

The project scope includes areas with known traditional cultural properties and other traditional cultural resource use areas to which American Indians attach religious or cultural significance. Yosemite National Park is consulting with American Indian tribes that have a cultural association with Yosemite Valley—including the American Indian Council of Mariposa County (also known as Southern Sierra Miwuk), the Tuolumne Band of Me-Wuk Indians, the North Fork Rancheria of Mono Indians, the

Picayune Rancheria of Chukchansi Indians, the Bishop Paiute Tribe, the Bridgeport Paiute Indian Colony, and the Mono Lake Kutzadika'a Paiute Tribe—to ensure no adverse effect on traditional cultural properties or traditional cultural use areas. Information sharing and project planning will continue in consultation with the American Indian tribes throughout the planning and implementation of the proposed project to ensure that concerns are properly addressed and that management recommendations are fully considered. Information sharing will include notifications, meeting and field visits, and an annual work plan that will outline locations, approximate dates, and methods for invasive plant management activities proposed for the following season.

Commenting on this Environmental Assessment

This environmental assessment is available for a 30-day public review and comment period from December 15, 2010 through January 15, 2011. The availability of the environmental assessment was announced in the *Mariposa Gazette*, and the environmental assessment is being mailed or e-mailed to the persons and agencies that have expressed interest in Yosemite National Park's proposed actions and events. The environmental assessment will also be available at local libraries, including Mariposa, El Portal, Wawona, Oakhurst, and Groveland. An electronic copy of the environmental assessment is available online at: http://www.nps.gov/yose/parkmgmt/invasive_docs.htm.

Comments on the environmental assessment, or requests for additional copies of this environmental assessment (CD or printed copy), should be directed to:

Superintendent, Yosemite National Park
ATTN: Invasive Plant Management Plan Update
P.O. Box 577
Yosemite, CA 95389

Fax: 209-379-1294

Email: yose_planning@nps.gov

For a copy of this document, please call Yosemite National Park at (209) 379-1365.

This environmental assessment is available for a 45 day pubic review and comment period from December 15, 2010 through January 30, 2011. To receive full consideration in the agency decision, comments must be submitted in writing by the close of the 45-day public review and comment period. Park management will consider all substantive comments in making a final decision, which will be documented in a Finding of No Significant Impact if appropriate, and sent to the NPS Pacific West regional director for review and approval.

During the public review period, if necessary, additional consultation will take place to confirm determinations of effect with the California State Historic Preservation Office, the USFWS, and the U.S. Army Corps of Engineers. Notice of concurrence with the determinations of effect or any agency-recommended mitigations would be included in the Finding of No Significant Impact, as appropriate.

For more information concerning this environmental assessment, please contact the park office of Environmental Planning and Compliance at (209) 379-1365.

List of Agencies, Organizations, and Businesses that Received the 2010 Invasive Plant Management Plan Update Environmental Assessment for Yosemite National Park

American Alpine Club
American Indian Council of Mariposa County
California Air Resources Board
California Department of Fish and Game
California Department of Transportation (Caltrans)
California Invasive Plant Council (Cal-IPC)
California Regional Water Quality Control Board
California State Library
Californians for Alternatives to Toxics
Caltrans Central Regional Environmental Analysis Office
Central Sierra Environmental Resource Center
Central Sierra Partnership Against Weeds
Columbia College Library
Delaware North Corporation
El Portal Town Planning Advisory Committee
Friends of the River/American Rivers
Friends of Yosemite Valley
George Radanovich, Representative
Government Information Shields Library
Groveland Community Services District
Groveland Ranger District
Hayward Area Recreation and Park District
Inyo National Forest
Mammoth Mountain Ski Area
Mariposa County Board of Supervisors
Mariposa County Chamber of Commerce
Mariposa County Commissioner
Mariposa County Department of Public Works
Mariposa County Fire Department
Mariposa County Planning Department
Mariposa County School District
Mariposa County Visitors Bureau
Mariposa Public Utility District
Mariposans for Environmentally Responsible Growth
Merced County Association of Governments
Merced Sun Star
Mono County Board of Supervisors
National Parks and Conservation Association, National Office
National Parks Conservation Association
National Park Service - Water Resources Division
National Park Service - Columbia Cascades Seattle Office
National Park Service - Denver Service Center

National Park Service - Denver Service Center, Planning
National Park Service - Denver Service Center, Technical Information Center
National Park Service - Pacific West Region
Oakhurst Public Library
Office of Assemblyman Dave Cogdill
Sacramento County Public Library
San Francisco City Public Library
San Francisco Planning Department
San Francisco Public Utilities Commission, Hetch Hetchy Water and Power
San Joaquin Valley Air Pollution Control District
Senator Barbara Boxer
Senator Dianne Feinstein
Sierra and San Joaquin Weed Management Areas
Sierra Club
Sierra Club Yosemite Committee
Sonoma County Library
Sonoma State University, Salazar Library
Stanford University Green Library
Stanislaus Council of Government
The Access Fund
Tuolumne County Board of Supervisors
Tuolumne County Visitor Bureau
Tuolumne Me-Wuk Tribal Council
Tuolumne River Preservation Trust
U.S. Army Corp of Engineers
U.S. Department of Agriculture, Forest Service, Sierra and Stanislaus National Forests
U.S. Department of the Interior, Bureau of Land Management
U.S. Department of the Interior, Fish and Wildlife Service
U.S. Department of the Interior, National Park Service, Sequoia and Kings Canyon National Parks
U.S. Department of the Interior, Office of Environmental Policy & Compliance
U.S. Environmental Protection Agency, Region IX
U.S. Federal Highway Administration
U.S. House of Representatives, Subcommittee on National Parks & Public Lands
U.S. Attorney's Office
University of California Bancroft Library
University of California Santa Barbara, Bioscience and Natural Resources Library
University of Minnesota
Upper Merced River Watershed Council
Virginia Lakes Pack Outfit
Wawona Area Property Owners Association
Wawona Town Plan Advisory Committee
Wilderness Watch
Yosemite Area Audubon

Table V-1. List of Preparers and Reviewers

Name	Responsibility	Education	Years Experience
National Park Service, Yosemite National Park			
Don Neubaucher	Superintendent	M.S. Natural Resource Management B.S. Planning and Management	28 NPS
Niki Nicholas	Division Chief, Resources Management and Science	Ph.D. Forestry M.S. Ecology B.A. Biology	7 Yosemite 22 other
Judi Weaser	Branch Chief, Vegetation and Ecological Restoration	M.S. Community Development B.S. Zoology	7 Yosemite 20 Public
Elexis Mayer	Environmental Planning and Compliance Manager	B.S. Natural Resource Planning	7 NPS 2 other
Report Authors			
Charles Repath	Project Manager/ Lead Author	M.S. B.A. History	1 Yosemite 3 Public 13 other
David Jaffe	Project Assistant/Author	M.S. Ecology B.S. Environmental Science	1 Yosemite 14 other
Brenda Ostrom	Private Contractor/Author	M.S. Aeronautical Technology B.S. Geography	4.5 Federal 10.5 Other
Henrietta DeGroot	Community Planner	M.A. Public Policy B.A. Political Science	14 NPS 9 other
Reviewers and Technical Experts, Yosemite National Park			
Martin Hutten	Manager, Invasive Plant Management Program	M.S. Land Resources and Environmental Sciences	3 Yosemite 7 NPS
Ann Roberts	NEPA Compliance Specialist/U.S. Fish and Wildlife Agency Coordination	M.S. Forestry-Ecosystem Restoration B.S. Wildlife Management	5 Yosemite 8 Public 5 other
Billy Bryan	Concessions Management Specialist	B.A. History and English	1 NPS 15 other
Mark Fincher	Wilderness Specialist	B.A. Geography and Environmental Studies	22 NPS
Jana Friesen-McCabe	Visual Information Specialist	M.A. Romance Language B.A. Latin American Studies	10 NPS 1 Yosemite
Jennifer Hardin	Cultural Anthropologist	Ph.D. candidate M.A. Applied Cultural Anthropology M.A. Cultural Anthropology B.S. Cultural Anthropology	6 NPS 13 other
Laura Jones	Biologist	M.S. Biology B.A. Biology	2 Yosemite

Name	Responsibility	Education	Years Experience
Kevin McCardle	Historical Landscape Architect Vista Project Manager	M.L.A. B.S. Microbiology B.S. Science Education	1 NPS 11 Other
Todd Newburger	Visitor Use and Impact Monitoring Program Manager	M.S. Geography, Resource Management and Conservation	3 NPS 13 Other
Steve Thompson	Branch Chief, Wildlife Management	M.S. Ecology – Wildlife B.S. Biology	21 NPS 5 Other
Helli Tucker	Biological Science Technician	B.S. Physical Geography	5 NPS
Lusetta Nelson	Biologist	B.S. Environmental Science M.S. Environmental Education and Botany	4 NPS 4 Other
Jim Roche	Park Hydrologist	M.S. Geology B.S. Chemistry	8 NPS 3 Other
Heather Smith	Invasive Plant Crew Lead	B.S. Biology	3 NPS
John Leonard	El Portal Crew Supervisor and Crew Leader	B.S. Forestry	8 Yosemite 7 other
Laisa Leao	Visual Information Specialist	B.A. Publicity and Advertising	1 NPS 5 Private
Rachel Frantz	Restoration Worker	B.A. Anthropology and Sociology	1 NPS 1 Other
Reviewers and Technical Experts Outside of Yosemite National Park			
Joel Trumbo	Staff Environmental Scientist Wildlife Branch of CA Dept. Fish and Game	B.S. Plant Science	27 DFG
Joe DiTomaso	Cooperative Extension Specialist	Ph.D. Botany/Weed Science M.S. Biological Sciences B.S. Wildlife and Fisheries Sciences	23 University
Erv Gasser	NPS Pacific West IPM Coordinator	B.S. Natural Resource Management B.A. History/Philosophy M.S. Environmental Science	30 Federal 8 Other

VI GLOSSARY

Glossary of Terms

Affected environment: Existing natural, cultural, and social conditions of an area that are subject to change, both directly and indirectly, as a result of a proposed human action.

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

Alternatives: Sets of management elements that represent a range of options for how or whether to proceed with a proposed project. An Environmental Assessment analyzes the potential environmental and social impacts of the range of alternatives presented, as required under NEPA.

Aquatic: Growing or living in or frequenting water; taking place in or on water.

Biological diversity (biodiversity): The number and abundance of species found within a common environment. This includes the variety of genes, species, ecosystems, and ecological processes that connect everything in a common environment.

Biomass: The total weight of all living organisms in a biological community.

Bioregion: A biological subdivision of the earth's surface delineated by the flora and fauna of the region.

Council on Environmental Quality: The Council on Environmental Quality was established by NEPA, and was given the responsibility for developing federal environmental policy and overseeing the implementation of NEPA by federal agencies.

Chemical control: A method of controlling invasive plants by employing herbicides.

Community: Any grouping of populations of different organisms that live together in a particular environment.

Control: A desired goal of invasive plant management in which only follow-up maintenance treatments are required to meet management objectives for that specific invasive plant population (see "Physical Control").

Critical habitat areas: Areas designated for the survival and recovery of State or federally listed threatened or endangered species.

Cultivar: A variety of a plant produced by horticultural techniques and not normally found in nature.

Designated Wilderness: An area of land designated by Congress to be managed according to the Wilderness Act of 1964. Wilderness is capitalized in text where it refers to Designated Wilderness, and not capitalized otherwise.

Disturbance: An event or change in the environment that alters the composition and successional status of a biological community and may deflect succession onto a new trajectory, such as a forest fire or hurricane, glaciation, agriculture, or urbanization.

EC50: The concentration of a chemical that will invoke physiological or behavioral effects, not death, to fifty percent of the study animals

Ecosystem restoration: The study of renewing a degraded, damaged, or destroyed ecosystem through active human intervention.

Ecology: The interrelationships of living things to one another and to their environment, or the study of these interrelationships.

Ecosystem: An arrangement of living and non-living things and the forces that move them. Living things include plants and animals. Non-living parts of ecosystems include rocks and minerals. Weather and wildland fire are two of the forces that act within ecosystems.

Endangered species: Plant and animal species that are in danger of extinction throughout all or a significant portion of their range. Endangered species are identified by the Secretary of the Interior in accordance with the Endangered Species Act of 1973.

Endemic: Exclusively known to a place or a biota.

Environmental Assessment: A public document required under the National Environmental Policy Act (NEPA) that 1) helps determine whether the impact of a proposed action or its alternatives could be significant; 2) aids NEPA compliance by evaluating a proposal that will have no significant impacts, but may have measureable adverse impacts; or 3) evaluates a proposal that either is not described on the list of categorically excluded actions, or is on the list, but exceptional circumstances apply.

Eradicate: To pull up from the roots, or to do away with as completely as if by pulling up from the roots.

Ethnobotany: The study of the relationship between people and plants.

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.

Fauna: The animal life of a region or geological period.

Finding of No Significant Impact: The public document describing the decision made on selecting the "preferred alternative" in an Environmental Assessment (see Environmental Assessment).

Fire management activities: Include fire planning; management strategies, tactics, and alternatives; prevention; preparedness; and education that addresses the role of mitigation, post-fire rehabilitation, fuels reduction, and restoration activities in fire management.

Fire Management Plan: A strategic plan that defines a program to manage wildland fires based on an area's approved land management plan. Fire Management Plans must address a full range of fire management activities that support ecosystem sustainability, values to be protected, protection of firefighters and public safety, public health, and environmental issues, and must be consistent with resource management objectives and activities of the area.

Fire regime: The combination of fire frequency, predictability, intensity, seasonality, and extent characteristic of fire in an ecosystem.

Flora: Plant or bacterial life forms of a region or geological period.

Foreign species: A species introduced to a new area or country. Similar terms include alien species, exotic species, introduced species, non-indigenous species, and non-native species.

Fuels management: The planned manipulation and/or reduction of living and dead forest fuels for forest management and other land use objectives.

Fuels treatment: The treatment of fuels that, left untreated, would otherwise interfere with effective fire management or control. For example, prescribed fire can reduce the amount of fuels that accumulate on the forest floor.

Gross infestation: Gross infestation size is the area over which the weed is distributed and the area that must be surveyed in return trips following control treatments.

Habitat: The place, including physical and biotic conditions, where a plant or an animal usually lives.

Herbicide: Pesticide that specifically targets vegetation.

Indigenous: A species that exists naturally in an area; a synonym for native species (see Endemic).

Initial attack: The aggressive response to a wildland fire based on values to be protected, benefits of response, and reasonable cost of response.

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

Interagency: Coordination, collaboration, and communication among cooperating agencies.

Introduced species: Species that have been transported by human activities, either intentionally or unintentionally, into a region in which they did not historically exist and are now reproducing in the wild.

Invasion: The expansion of a non-native species into an area occupied by native species.

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.

Inventory & Monitoring Program: A National Park Service initiative to acquire the information and expertise needed by park managers in their efforts to maintain ecosystem integrity in the approximately 270 National Park System units that contain significant natural resources.

Landscape: A large land area composed of interacting ecosystems that are repeated due to factors such as geology, soils, climate, and human impacts.

LC50 (lethal concentration): The concentration of chemical in air or water that will kill fifty percent of the study animals. LC50 usually has a time associated with the test.

LD 50: Toxic concentrations are most commonly reported as LD50 (lethal dose). LD50s represent a volume chemical/body weight of test animal fed to (oral LD50) or applied topically (dermal LD50) all at once that will kill fifty percent of the study animals.

Management action: Actions taken to protect river values and return conditions to established standards based on information gathered by the Visitor Experience & Resource Protection monitoring program.

Mechanical control: Invasive plant removal method that uses hand-held motorized equipment such as brush-cutters (with strings or blades) and hedge trimmers.

Method: A technique or procedure for carrying out invasive species management.

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 Range: The ecosystem that a species inhabits.

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

National Environmental Policy Act: An act of Congress, passed in 1969, declaring a national policy to encourage productive and enjoyable harmony between people and the environment, to promote efforts to prevent or eliminate damage to the environment and the biosphere and to stimulate the health and welfare of people, and to enrich the understanding of the ecological systems and natural resources important to the nation, among other purposes.

National Park Service Organic Act: In 1916, the National Park Service Organic Act established the National Park Service to "promote and regulate use of parks" and defined the purpose of the national parks as being "to conserve the scenery and natural and historic objects and wild life therein and to provide for the enjoyment of the same in a manner and by such means as will leave them unimpaired for the enjoyment of future generations." This law provides overall guidance for the management of Yosemite.

National Park Service Management Policies: Guiding principles and procedures that set the framework and provides direction for National Park Service management decisions. National Park Service policies are guided by and consistent with the U.S. Constitution, public laws, Executive proclamations and orders, and regulations and directives from higher authorities. Policies translate these sources of guidance into cohesive directions. National Park Service *Management Policies 2006* are applicable National Park Service-wide. Director's Orders supplement and may amend Management Policies.

Net Infestation: The area to which treatment of invasive plants is actually applied.

No Action Alternative: The most likely condition expected to exist in the future if current management continues unchanged.

Non-ionic surfactant: A surface-active substance without electromagnetically charged compounds.

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 lives. 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.

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. Examples of noxious weeds in Yosemite include yellow star-thistle, spotted knapweed, and Himalayan Blackberry.

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.

Physical control: Invasive plant removal that uses hand-pulling, lopping, or cutting with non-motorized equipment such as shovels, axes, rakes, grubbing hoes, and hand clippers to expose, cut, and remove flowers, fruits, stems, leaves, and/or roots from target plants.

Population: Potentially interbreeding individuals of a species found in the same place and time.

Preferred alternative: The alternative within the range of alternatives presented in an environmental assessment that the agency believes would best fulfill the purpose and need of the proposed action. While the preferred alternative is a different concept from the environmentally preferable alternative, they may be the same for some environmental assessments.

Prescribed fire: Any fire ignited by resource managers to meet specific objectives.

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

Restoration: Holistic actions taken to modify an ecosystem to achieve desired healthy and functioning conditions and processes.

Riparian area: The area along a watercourse or around a lake or pond.

Riparian ecosystem: The ecosystem around or next to water areas that support unique vegetation and animal communities as a result of the influence of water.

Record of Decision: An official document in which a deciding official states the alternative that will be implemented from a prepared Environmental Impact Statement.

Rosettes: A circular cluster of leaves that radiate from a center or close to the ground.

Sensitive species: Plant or animal species that is susceptible to habitat changes or impacts from management activities.

Seed bank: Seeds that become incorporated into the soil.

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.

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 other infrastructure. Often, surplus project-generated materials such as rock and soil will remain at such areas for future park uses.

Stewardship: Responsibility of federal agencies to manage natural resources on public land.

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

Threatened species: Plant or animal species likely to become endangered throughout all or a specific portion of their range within the foreseeable future, as designated by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973.

Tilling: Turning over of soil with heavy equipment such as a Bobcat; would be used for invasive plant control only in heavily disturbed sites.

Traditional cultural properties: A resource to which American Indian tribes attach cultural and religious significance that is eligible for listing or is listed in the National Register of Historic Places, and includes structures, objects, districts, geological and geographical features, and archaeology. *National Register Bulletin 38* provides guidance for identifying and evaluating such properties for eligibility.

Treatment area: The site-specific location of a resource improvement activity.

Tool: An instrument or herbicide used to manage invasive species.

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.

Watershed: The entire region drained by a waterway, lake, or reservoir. More specifically, a watershed is an area of land above a given point on a stream that contributes water to the stream flow at that point.

Wildland: An area in which development is essentially non-existent, except for roads, railroads, power lines, and other transportation facilities.

Wildland fire: Any non-structural fire that occurs on wildlands that is not a prescribed fire.

Wildland urban interface: The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

Acronyms and Abbreviations

BLM	Bureau of Land Management
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CDFA	California Department of Food and Agriculture
CDPC	California Invasive Plant Council
CDPR	California Department of Pesticide Regulation
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
dB	decibel(s)
dBA	decibels on the A-weighted scale
EC50	effect concentration of fifty percent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
IPM	Integrated Pest Management
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
LC50	lethal concentration to fifty percent
LD50	lethal dose to fifty percent
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NO_x	nitrogen oxides
NP	nonylphenol
NPE	nonylphenol polyethoxylate
NPS	National Park Service
NP9E	nonylethoxylate
NRHP	National Register of Historic Places
ORV	Outstandingly Remarkable Values
OSHA	Occupational Safety and Health Administration
PM	particulate matter
PM_{10}	particulate matter less than ten microns in diameter
POEA	polyethoxylated tallowamine
PPE	personal protective equipment
TCP	traditional cultural property
USC	United States Code
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
96-H LC50	96-hour lethal concentration fifty percent dose

Special Status Wildlife Designations

FE	Federal Endangered
FT	Federal Threatened
FC	Federal Candidate
SE	State Endangered
ST	State Threatened
CSC	California Species of Concern

VII SELECTED BIBLIOGRAPHY

Acquavella, J. F., Alexander, B. H., Mandel, J. S., Gustin, C., Baker, B., Chapman, P., & Bleeke, M. (2004). Glyphosate biomonitoring for farmers and their families: Results from the farm family exposure study. *Environmental Health Perspectives, 112*(3), 321-326.

Alford, R. A., & Richards, S. J. (1999). Global amphibian declines: A problem in applied ecology. *Annual Review of Ecology and Systematics, 30,* 133-165.

Anderson, M. (1993). *Indian fire-based management in the Sequoia-mixed conifer forests of the central and southern Sierra Nevada.* Final contract report submitted to Yosemite Research Center, Yosemite National Park, CA. Cooperative Agreement Order No. 8027-2-002.

Anderson, M. K., & Moratto, M. J. (1996). Native American land-use practices and ecological impacts. Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, *Assessments and scientific basis for management options* (pp. 187-205). Davis: University of California, Centers for Water and Wildland Resources.

Antunes-Kenyon, S.E., & Kenney, G. A. (2004, November 12). *A review of the toxicity and environmental fate of triclopyr*. Massachusetts Department of Agricultural Resources. http://www.mass.gov/agr/pesticides/aquatic/docs/triclopyr.pdf

BASF. (2004). *Specimen: Stalker herbicide*. Retrieved from http://www.cdms.net/LDat/ld01R002.pdf

Baumann, P. A., Dotray, P. A., & Prostko, E. P. (1999). *Herbicides: How they work and the symptoms that they cause*. Agricultural Communications, the Texas A&M System. Retrieved from http://repository.tamu.edu/bitstream/handle/1969.1/86804/pdf_1063.pdf?sequence=1

Bautista, S. L., & Bulkin, S. P. (2006, April). *Herbicide information summary and project design criteria crosswalk*. Portland, OR: USDA Forest Service.

Belmonte, R. V. (2006). *Victims of glyphosate*. Inter Press Service News Agency. Retrieved from http://ipsnews.net/news.asp?idnews=32528

Belnap, J., & Phillips, S. L. (2001). Soil biota in an ungrazed grassland: Response to annual grass (Bromus tectorum) invasion. *Ecological Applications, 11*(5), 1261-1275.

Bibby, B. (1994). *An ethnographic evaluation of Yosemite Valley: The Native American cultural landscape*. Yosemite, CA: Yosemite National Park.

Blaustein, A. R., Romansic, J. M., Kiesecker, J. M., & Hatch, A. C. (2003). Ultraviolet radiation, toxic chemicals, and amphibian population declines. *Diversity and Distributions, 9*, 123-140.

Bossard, C. C., Randall, J. M., & Hoshovsky, M. C. (2000). *Invasive plants of California's wildlands*. Berkeley: University of California Press.

Botti, S. J. (2001). *An illustrated flora of Yosemite National Park*. El Portal, CA: Yosemite Association.

Bradford, D. F., Graber, D.M., & Tabatabai, F. (1993). Isolation of remaining populations of the native frog, *Rana muscosa*, by introduced fishes in Sequoia and Kings Canyon National Parks, California. *Conservation Biology, 7*(4), 882-888.

Brausch, J., & Smith, P. (2007). Toxicity of three polyethoxylated tallowamine surfactant formulations to laboratory and field collected fairy shrimp (*Thamnocephalus platyurus*). *Archives of Environmental Contamination and Toxicology, 52*(2), 7-221. doi: 10.1007/s00244-006-0151-y

Brown, M., Duncan, C. A., & Halstvedt, M. B. (1999). Spotted knapweed management with integrated methods. *Proceedings Western Society of Weed Science, 52,* 68-70.

Brunner, R. D., & Clark, T. W. (1997). A practice-based approach to ecosystem management. *Conservation Biology, 48,* 11.

Buchwalter, D., Jenkins, J., Kerkvliet, N., & Thompson, P. (1996, updated 2002). *Imazapyr pesticide fact sheet: Forestry use.* National Institute of Environmental Health Service, Oregon State University.

Busse, M. D., Ratcliff, A. W., Shestak, C. J., & Powers, R. F. (2001). Glyphosate toxicity and the effects of long-term vegetation control on soil microbial communities. *Soil Biology & Biochemistry, 33,* 1777-1789.

California Regional Water Quality Control Board Central Valley Region. (1998, September). *The water quality control plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region* (4th ed.). Retrieved from http://lrdp.ucmerced.edu/docs/ADMIN%20RECORD/HYDRO_Ref%20Docs/CVRWQCB%202007_Basin%20Plan%20rev%202007.pdf

Carmichael, N. G., Nolan, R. J., Perkins, J. M., Davies, R., & Warrington, S. J. (1989). Oral and dermal pharmacokinetics of triclopyr in human volunteers. *Human Toxicology, 8*(6), 431-7.

CDFA (California Department of Food and Agriculture). (2007). *California State-listed noxious weeds.* California Department of Food and Agriculture. Retrieved from http://plants.usda.gov/java/noxious?rptType=State&statefips=06

CDFG (California Department of Fish and Game). (2003). *Atlas of the biodiversity of California.* M. Pitcairn, E. Begley, et al. Sacramento, CA: Author.

CDPR (California Department of Pesticide Regulation). (1997). *Standard operating procedure - Conducting surface water monitoring for pesticides.* Retrieved from http://www.cdpr.ca.gov/docs/emon/pubs/sops/fswa002.pdf

CDPR (California Department of Pesticide Regulation). (1999). *Standard operating procedure - Transporting, packaging and shipping samples from the field to the warehouse or laboratory.* Retrieved from http://www.cdpr.ca.gov/docs/emon/pubs/sops/qaqc0401.pdf

CDPR (California Department of Pesticide Regulation). (2007). *Assessment of the tolerances for Section 3 registration of Shadeout J (Rimsulfuron) on tomatoes.* California Environmental Protection Agency. Retrieved from http://www.cdpr.ca.gov/docs/risk/rcd/rimsulfur.pdf

Centers for Water and Wildland Resources. (1996). *Sierra Nevada Ecosystem Project report.* Davis: University of California. Retrieved from http://ceres.ca.gov/snep

Clawson, M., & Knetsch, J. L. (1966). *Economics of outdoor recreation.* Baltimore, MD: Resources for the Future by John Hopkins Press.

Clow, D. W., Mast, M. A., & Campbell, D. H. (1996). Controls on surface water chemistry in the Upper Merced River Basin, Yosemite National Park. *Hydrological Processes, 10,* 727-746.

CNPS (California Native Plant Society). (2001). *Inventory of rare and endangered plants of California* (sixth ed.). Sacramento, CA: Author.

Collins, J. P., & Storfer, A. (2003). Global amphibian declines: Sorting the hypotheses. *Diversity and Distributions, 9,* 89-98.

Council on Environmental Quality. (1997). *Considering cumulative effects under the National Environmental Policy Act*. Retrieved from http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm

Cousens, R., & Mortimer, M. (1995). *Dynamics of weed populations*. New York, NY: Cambridge University Press.

Cowardin, L. M., Carter, V., Golet, F. C., & LaRoe, E. T. (1979). Classification of wetlands and deepwater habitats of the United States. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service. Retrieved from http://www.charttiff.com/pub/WetlandMaps/Cowardin.pdf

Cox, C. (1998). Clopyralid – Herbicide fact sheet. *Journal of Pesticide Reform, 18*(4), 15-19.

Cox, C. (2004). Glyphosate herbicide factsheet. *Journal of Pesticide Reform, 24*, 10-15.

Critical Habitat Project, Center for Ethics and Toxics (CETOS). (n.d.). *Imazapyr factsheet*. Retrieved from http://environmentalcommons.org/cetos/criticalhabitat/imazapyr.pdf

D'Antonio, C., & Mahall, B. (1991). Root profiles and competition between the invasive, exotic perennial, Carpobrotus edulis, and two native shrub species in California coastal scrub. *American Journal of Botany, 78*, 885-894.

D'Antonio, C. M., Dudley, T. L., & Mack, M. (1999). Disturbance and biological invasions: Direct effects and feedbacks. In L. R. Walker, *Ecosystems of disturbed ground* (pp. 429-468). Amsterdam: Elsevier.

D'Antonio, C. M., Berlow, E. L., & Haubensak, K. L. (2004). *Invasive exotic plant species in Sierra Nevada ecoystems*. USDA Forest Service Gen. Tech. Rep. PSW-GTR-193. Retrieved from http://www.fs.fed.us/psw/publications/documents/psw_gtr193/psw_gtr193_5_2_DAntonio.pdf

Dow. (Dow AgroSciences LLC). (1999). *Specimen label: Transline specialty herbicide*. Indianapolis, IN: Author.

Dow. (Dow AgroSciences LLC). (2005a). *Pesticide fact sheet: Aminopyralid*. Indianapolis, IN: US Office of Prevention, Pesticides, Environmental Protection and Toxic Substances Agency.

Dow. (Dow AgroSciences LLC). (2005b). *Aminopyralid technical bulletin*. Indianapolis, IN: Author. Retrieved from http://www.dowagro.com/PublishedLiterature/dh_0052/0901b80380052fe6.pdf?filepath=usag/pdfs/noreg/010-50433.pdf&fromPage=GetDoc

Dow. (Dow AgroSciences LLC). (2005c). *Specimen label: Milestone® specialty herbicide*. Indianapolis, IN: Author.

Dow. (Dow Agrosciences LLC). (2006a). *Label for Rodeo® herbicide*. Indianapolis, IN: Author.

Dow. (Dow AgroSciences LLC). (2006b). *Specimen label: Garlon 3A specialty herbicide*. Indianapolis, IN: Author.

Dow. (Dow AgroSciences LLC). (2007). *Specimen label: Garlon 4 specialty herbicide*. Indianapolis, IN: Author.

Dow. (Dow AgroSciences LLC). (2008). *Specimen label: Triclopyr 4*. Indianapolis, IN: Author.

Driver, B. L., & Knopf, R. C. (1977). Personality, outdoor recreation and expected consequences. *Environment and Behavior, 9*(2), 169-193.

Drost, C. A., & Fellers, G. M. (1996). Collapse of a regional frog fauna in the Yosemite area of the California Sierra Nevada, USA. *Conservation Biology, 10*(2), 414-425.

Dubbin, W. E., Sposito, G., & Zavarin, M. (2000). X-ray absorption spectroscopic study of Cu-glyphosate adsorbed by microcrystalline gibbsite. *Soil Science, 165*(9), 699-707.

DuPont. (2007). Identity of active substance of matrix (rimsulfuron). *Technical Bulletin*. Retrieved from http://www2.dupont.com/Production_Agriculture/en_US/assets/downloads/pdfs/K-14710.pdf

DuPont. (2007). Telar XP herbicide. *Technical Bulletin*. Retrieved from http://www2.dupont.com/Land_Management/en_US/assets/downloads/pdfs/IWM/K-14605.pdf

Edginton, A. N., Sheridan, P. M., Stephenson, G. R., Thompson, D. G., & Boermans, H. J. (2004). Comparative effects of pH and Vision® herbicide on two life stages of four anuran amphibian species. *Environmental Toxicology and Chemistry, 23*(4), 815-822.

Ehrenfeld, J. G. (2003). Effect of exotic plant invasions on soil nutrient cycling processes. *Ecosystems,* 6, 503-523.

Enloe, S. F., DiTomaso, J. M., Orloff, S. B., & Drake, D. J. (2004). Soil water dynamics differ among rangeland plant communities dominated by yellow starthistle (Centaurea solstitialis), annual grasses, or perennial grasses. *Weed Science, 52*(6), 929-935.

EPA (Environmental Protection Agency). (1993a, May 27). Environmental Fate and Effects Division's chapter for the reregistration eligibility document (RED) for glyphosate, case #0178.

EPA (Environmental Protection Agency). (1993b, October). *Reregistration eligibility decision document: Triclopyr* (EPA-738-R-98-011) (pp. 3-58). Washington, D.C.: U.S. Government Printing Office. http://www.epa.gov/oppsrrd1/REDs/2710red.pdf

EPA (Environmental Protection Agency). (1997, August). *Pesticide industry sales and usage 1994 and 1995 market estimates.* Washington, D.C.: U.S. Government Printing Office.

EPA (Environmental Protection Agency). (2002, November). Reregistration eligibility decision for Endosulfan. (7508C). (EPA 738-R-02-013). Washington, D.C.: U.S. Government Printing Office. Retrieved from http://www.epa.cov/oppsrrd1/REDs/endosulfan red.pdf

EPA (Environmental Protection Agency). (2005a).Pesticide fact sheet: Aminopyralid. Retrieved from http://www.epa.gov/opprd001/factsheets/aminopyralid.pdf

EPA (Environmental Protection Agency). (2005b). *Environmental fate and ecological risk assessment for the registration of aminopyralid.* Washington, D.C.: U.S. Government Printing Office. Retrieved from http://www.epa.gov/opprd001/factsheets/aminopyralidEFEDRA.pdf

EPA (Environmental Protection Agency). (2005c). *Reregistration eligibility decision document: Chlorsulfuron* (EPA 738-F-05-002). Washington, D.C.: U.S. Government Printing Office. Retrieved from http://www.epa.gov/oppsrrd1/REDs/factsheets/chlorsulfuron_factsheet.pdf

EPA (Environmental Protection Agency). (2006). *Reregistration eligibility decision document: Imazapyr* (7508C). (EPA 738-R-06-007). Washington, D.C.: U.S. Government Printing Office.

European Commission DG ENV. (2000, June 21). *Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption.* Retrieved from http://ec.europa.eu/environment/docum/01262_en.htm#bkh

European Commission Health and Consumer Protection Directorate-General (2005). *Final review report for the active substance rimsulfuron.* Retrieved from http://ec.europa.eu/food/plant/protection/evaluation/existactive/list-rimsulfuron_en.pdf.

Evans, R. D., Rimer, R., Sperry, L., & Belnap, J. (2001). Exotic plant invasion alters nitrogen dynamics in an arid grassland. *Ecological Applications, 11*(5), 1301-1310.

Feng, J. C., & Thompson, D. G. (1990). Fate of glyphosate in a Canadian forest watershed: Persistence in foliage and soils. *Journal of Agriculture and Food Chemistry, 38,* 1118-1125.

Feng, J. C., Thompson, D. G., & Reynolds, P. E. (1990). Fate of glyphosate in a Canadian forest watershed: Aquatic residues and off-target deposit assessment. *Journal of Agricultural and Food Chemistry,* 38, 1110-1118.

Fischman, R., & Ruhl, J. B. (2010). *Adaptive management in the courts* (Draft). Florida State University College of Law, Public Law Research Paper No. 411.

Franz, J. E., Mao, M. K., & Sikorski, J. A. (1997). *Glyphosate: A unique global herbicide.* Washington, DC: American Chemical Society.

Ganapathy, C. (1997, January 2). *Environmental fate of triclopyr*. Sacramento, CA: Environmental Monitoring and Pest Management Branch, Department of Pesticide Regulation.

Garcelon, D. K., Rall, R., Hudgens, B., Brown, R., & Kohlman, S. (2006). *Feasibility assessment and implementation plan for reintroducing wolverines to California.* Arcata, CA: Proposal to Yosemite National Park from the Institute for Wildlife Studies: 74.

Gerlach, J. D., Jr., Moore, P. E., Johnson, B., Roy, G., Whitmarsh, P., Lubin, D. M. . . . Keely, J. E. (2003). Alien plant species threat assessment and management prioritization for Sequoia and Kings Canyon and Yosemite National Parks. Carson City, NV: U.S. Geological Survey Open-File Report 02-170.

Ghassemi, M., Fargo, L., Painter, P., Quinlivan, S., Scofield, R., & Takata, A. (1981). *Environmental fates and impacts of major forest use pesticides*. Washington, D.C.: U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances

Gordon, D. R. (1998). Effects of invasive, non-indigenous plant species on ecosystem processes: Lessons from Florida. *Ecological Applications, 8*(4), 975-989.

Grinnell, J., & Irwin, T. (1924). *Animal life in Yosemite: An account of the mammals, bird, reptiles and amphibians in a cross-section of the Sierra Nevada.* Berkeley: University of California Press.

Groves, R. H. (1986). Invasion of Mediterranean ecosystems by weeds. In B. Dell, A. J. M. Hopkins, & B. B. Lamont, *Resilience in Mediterranean-type ecosystems* (pp. 129-146). Dordrecht: Junk.

Haney, R. L., Senseman, S. A., & Hons, F. M. (2002). Bioremediation and biodegradation. *Journal of Environmental Quality, 31*, 730-735.

Health Canada. (2008). *Re-evaluation decision document: Rimsulfuron.* Retrieved from http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_decisions/rvd2008-29/index-eng.php

Hendry, G. W. (1934). The source literature of early plant introduction into Spanish America. *Agricultural History, 8,* 64-71.

Hickman, J. C. (Ed.). (1993). *The Jepson manual: Higher plants of California*. Berkeley: University of California Press.

Hobbs, R. J., & Huenneke, L. F. (1992). Disturbance, diversity, and invasion: Implications for conservation. *Conservation Biology, 6*(3), 324-337.

Hollaway, K. (2007). Sustainable use of sulfonylurea herbicides on alkaline soils. *Australian Grain, April-May*, 11-14.

Holling, C.S. (Ed.). (1978). *Adaptive environmental assessment and management.* Chichester, UK: Wiley.

Howe, C. M., Berrill, M., Pauli, B. D., Helbing, C. C., Werry, K., & Veldhoen, N. (2004). Toxicity of glyphosate-based pesticides to four North American frog species. *Environmental Toxicology and Chemistry, 23*(8), 1928-1938.

Hughes, J. W. (2007). Environmental problem solving: A how-to guide. Burlington: University of Vermont Press.

Hull, K. L., & Moratto, M. J. (1999). Archeological synthesis and research design, Yosemite National Park, California. Yosemite Research Center Publications in *Anthropology, No. 21*. El Portal, CA: Yosemite National Park.

Heissenbuttel, A. E. (1996). Ecosystem management–Principles for practical application. *Ecological Applications, 6,* 730-732.

IWSRCC (Interagency Wild and Scenic Rivers Coordinating Council). (1999). *Wild and Scenic rivers reference guide*. Interagency Wild and Scenic Rivers Coordinating Council BLM, NPS, U.S. Fish and Wildlife Service and U.S. Forest Service. Retrieved from www.rivers.gov/publications.html

Jonkers, N., Knepper, T. P., & de Voogt, P. (2001). Aerobic biodegradation studies of nonylphenol ethoxylates in river water using liquid chromatography-electrospray tandem mass spectrometry. *Environmental Science and Technology, 35*(2), 335-340.

Kane, J. M., Heath, S., & Kuhn, B. (2006). *Non-native vascular plant inventory of riparian areas in Yosemite National Park, California, Point Reyes Bird Observatory.* Final report submitted to Yosemite National Park and Sierra Nevada Inventory & Monitoring Network. PRBO Conservation Science Contribution #1335.

King, W. B. (1985). Island birds: Will the future repeat the past? In P. J. Moor, *Conservation of island birds* (pp. 3-15). Cambridge, UK: International Council for Bird Preservation.

Knapp, R. A., & Matthews, K. R. (2000). Non-native fish introductions and the decline of the mountain yellow-legged frog from within protected areas. *Conservation Biology, 14*(2), 428-438.

Knapp, R. A. (2005). Effects of nonnative fish and habitat characteristics on lentic herpetofauna in Yosemite National Park, USA. *Biological Conservation, 121,* 265-279.

Knapp, R. A., Boiano, D. M., & Vredenburg, V. T. (2007). Removal of nonnative fish results in population expansion of a declining amphibian (mountain yellow-legged frog, *Rana muscosa*). *Biological Conservation, 135,* 11-20.

Lee, H.-L., Chen, K.-W., Chi, C.-H., Huang, J.-J., & Tsai, L.-M. (2000). Clinical presentations and prognostic factors of a glyphosate – Surfactant herbicide intoxication: A review of 131 cases. *Academic Emergency Medicine, 7*(8), 906-910.

Littlejohn, M., Meldrum, B., & Hollenhorst, (2006). *Yosemite National Park visitors study. Spring 2005.* Visitor Services Project Report #168. Moscow, ID: National Park Service and University of Idaho, Cooperative Park Studies Unit.

Liu, Z. (2004). Effects of surfactants on foliar uptake of herbicides – A complex scenario. *Colloids and Surfaces B: Biointerfaces, 35*(3-4), 149-153.

Lovich, J. E., Egan, T. B., & DeGouvenion, R. C. (1994). Tamarix control on public lands in the desert of Southern California: Two case studies. *Proceedings of the 46th Annual California Weed Conference, California Weed Science Society,* pp. 166-177.

Mack, R.N., & Lonsdale, W. M. (2001). Humans as global plant dispersers: Getting more than we bargained for. *BioScience, 51*(2), 95-102

Mack, R. N., Simberloff, D., Lonsdale, W. M., Evans, H., Clout, M., & Bazzaz, F. A. (2000). Biotic invasions: Causes, epidemiology, global consequences, and control. *Ecological Applications, 10*(3), 689-710.

Mann, R. M., & Bidwell, J. R. (1999). The toxicity of glyphosate and several glyphosate formulations to four species of southwestern Australian frogs. *Archives of Environmental Contamination and Technology, 36*, 193-199.

Martins, J., Chevre, N., Spack, L., Tarrradellas, J., & Mermoud, A. (2001). Degradation in soil and water and ecotoxicity of rimsulfuron and its metabolites. *Chemosphere, 45*, 515-522.

Miller, P., & Westra, P. (2006). *Herbicide surfactants and adjuvants, no. 0.559.* [Crop series fact sheet]. Colorado State University Cooperative Extension.

Monsanto (Monsanto Company). (2001). *RODEO® emerged aquatic weed and brush herbicide, version 1.2.* [Material safety data sheet]. Effective date: January 30, 2001.

Monsanto (Monsanto Company). (2005, February 3). *Aquamaster® herbicide.* [Material Safety Data Sheet]. St. Louis, MO: Author. Retrieved from http://www.sccd.org/water/documents/aqua_master_msds.pdf

Monsanto (Monsanto Company). (2005). *Roundup® PRO® Herbicide Material, version 1.2.* [Material safety data sheet]. Effective date: April 21, 2005.

Murray, C., & Marmorek, D. (2004). Adaptive management: A science-based approach to managing ecosystems in the face of uncertainty. In N. W. P. Munro, T. B. Herman, K. Beazley, & P. Dearden (Eds.), *Making ecosystem-based management work* (Chapter 8, Paper #9). Proceedings of the Fifth International Conference on Science and Management of Protected Areas, Victoria, BC, May 11-16, 2003. Wolfville, Nova Scotia: Science and Management of Protected Areas Association. Retrieved from www.sampaa.org/proceedings.htm

Mutch, L. S., Goldin Rose, M., Heard, A., Cook, R. R., & Entsminger, G. L. (2007). *Sierra Nevada network: Vital signs monitoring plan.* Natural Resource Report NPS/SIEN/NRR-2008/072. Fort Collins, CO: U.S. National Park Service.

Newton, M., Horner, L. M., Cowell, J. E., White, D. E., & Cole, E. C. (1994). Dissipation of glyphosate and aminomethylphosphonic acid in North American forests. *Journal of Agricultural and Food Chemistry, 42*(8), 1795-1802.

NISC (National Invasive Species Council). (2001, October). *Meeting the invasive species challenge: National invasive species management plan.* Retrieved from http://www.invasivespeciesinfo.gov/docs/council/mpfinal.pdf

NISC (National Invasive Species Council).(2008). *2008-2012 national invasive species management plan.* Retrieved from http://www.anstaskforce.gov/Meetings/2008_October/NISC_Plan_09_29_08%20fact%20sheet.pdf

NPS (National Park Service)/Department of the Interior. (1980). *General management plan/Visitor use/Park operations/Development.* El Portal, CA: Yosemite National Park.

NPS (National Park Service). (1996). *Preserving our natural heritage: A strategic plan for managing invasive nonnative plants on our national park system lands.* Washington, D.C.: Government Printing Office.

NPS (National Park Service). (1998a). *Directors Order (DO) 28: Cultural resource management guidelines.* Retrieved from http://www.nps.gov/policy/DOrders/DOrder28.html

NPS (National Park Service). (1998b, revised 2005). National Park Service ultural landscapes inventory. Retrieved from http://www.nps.gov/whsa/parkmgmt/upload/White%20Sands%20Cultural%20Landscapes%20Inventory.pdf

NPS (National Park Service)/Department of the Interior. (1999). *Programmatic agreement among the National Park Service at Yosemite, the California State Preservation Officer, and the Advisory Council on Historic Preservation regarding planning, design, construction, operations and maintenance, Yosemite National Park.* El Portal, CA: Yosemite National Park.

NPS (National Park Service). (2000). *Final Yosemite Valley plan/Supplemental environmental impact statement.* Retrieved from http://www.nps.gov/archive/yose/planning/yvp/seis/index.html

NPS (National Park Service)/Department of the Interior. (2004, March). *Final Yosemite fire management plan.* [Environmental Impact Statement]. Retrieved from http://www.nps.gov/archive/yose/planning/fire/frames/index.htm

NPS (National Park Service)/Department of the Interior. (2005a). *Merced Wild and Scenic River revised comprehensive management lan and supplemental environmental impact statement.* Retrieved from http://www.nps.gov/yose/parkmgmt/mrp_archive.htm

NPS (National Park Service). (2006a). *Blackberry monitoring report.* M. Oliver. [Internal report]. Yosemite National Park.

NPS (National Park Service)/Department of the Interior. (2006b). *National Park Service management policies*. Retrieved from http://www.nps.gov/policy/mp2006.pdf

NPS (National Park Service).(2006c). *Protecting wilderness character: Wilderness restoration program final report.* V. Hartman & K. Vaughn. El Portal, CA: National Park Service Vegetation and Restoration.

NPS (National Park Service). (2006d). *Yosemite National Park invasive plant program annual report.* [Internal report]. Yosemite National Park.

NPS (National Park Service). (2007). *Yosemite National Park plant observation database.* [Internal report]. Yosemite National Park.

NPS (National Park Service). (2010). *Integrated pest management manual.* Retrieved from: http://www.nature.nps.gov/biology/ipm/manual/ipmmanual.cfm

NYSDEC (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). Retrieved from http://pmep.cce.cornell.edu/profiles/herb-growthreg/naa-rimsulfuron/rimsulfuron/matrix_mcl_0509.pdf

Olmstead, F. L. (1865). *Yosemite and the Mariposa Grove: A preliminary report.* National Park Service. Retrieved from http://www.yosemite.ca.us/library/ol msted/report.html

Oregon Department of Forestry). (1992). *Forest herbicide application: Water quality sampling study.* Forest Practices section.

Oregon Department of Forestry. (2002). Oregon Department of Forestry's Best Management Practices Compliance Audit Project, version 3.0: Final report. L. Dent & J. Robben. Salem: Oregon Department of Forestry.

Oregon State University & Interox, Inc. (2006, February). *Chlorsulfuron: Roadside vegetation management herbicide fact sheet.* Washington State Department of Transportation. Retrieved from http://www.wsdot.wa.gov/NR/rdonlyres/BA59FA46-057D-4526-9BC3-F7B3831E453D/0/chlorsulfuron.pdf

Parsons, D. J., & Stohlgren, T. J. (1989). Effects of varying fire regimes on annual grasslands in the southern Sierra Nevada of California. *Madrono, 36*(3), 154-168.

Pauchard, A., Kueffer, C., Dietz, H., Daehler, C. C., Alexander, J., Edwards, P. J., . . . Seipel, T. (2009). Ain't no mountain high enough: Plant invasions reaching new elevations. *Frontiers in Ecology and the Environment, 7,* 479-486. doi:10.1890/080072

PMRA (Pest Management Regulatory Agency of Canada). (2007, January 17). *Regulatory note: Aminopyralid*. Ottawa, Ontario: PMRA, Alternative Strategies and Regulatory Affairs Division. Retrieved from http://dsp-psd.pwgsc.gc.ca/Collection/H113-7-2007-1E.pdf

Pimentel, D. (2007). Environmental consequences and economic costs of alien species. In Inderjit (Ed.), *Invasive plants: Ecological and agricultural aspects* (pp. 269-276). Basel, Switzerland: Birkhauser Verlag.

Pimm, S. L. (1984). The complexity and stability of ecosystems. *Nature, 307,* 321-326.

Pless, P. (2005, May 4). *Use of Imazapyr herbicide to control invasive cordgrass (Spartina spp.) in the San Francisco estuary*. Prepared for San Francisco Estuary Invasive Spartina Project c/o Coastal Conservancy. Retrieved from http://www.spartina.org/referencemtrl/SF-Imazapyr-EA.pdf

Powell, H. A., Kerby, N. W., & Rowell, P. (1991). Natural tolerance of cyanobacteria to the herbicide glyphosate. *New Phytologist, 119*(3), 421-426.

Prato, T. (2006). Adaptive management of national park ecosystems. *George Wright Society, 23*, 72-86.

Pyle, P., Kaschube, D. R., Siegel, R. B., & DeSante, D. F. (2006, March 29). *The 2005 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) Program in Yosemitie National Park*. Point Reyes Station, CA: The Institute for Bird Populations. Retrieved from http://www.birdpop.org/DownloadDocuments/yosrep05.pdf

Rachowicz, L., Knapp, R. A., Morgan, J. A. T., Stice, M. J.,Vredenburg, V. T., Parker, J. M., & Briggs, C. J. (2006). Emerging infectious disease as a proximate cause of amphibian mass mortality. *Ecology, 87*(7), 1671-1683.

Randall, J. M., Rejmanek, M., & Hunter, J. C. (1998). Characteristics of the exotic flora of California. *Freemontia, 26*(4), 3-12.

Rashin, E., & Graber, C. (1993, October). *Effectiveness of best management practices for aerial application of forest pesticides*. Washington State Deparment of Ecology, TFW-WQ1-93-001. Retrieved from http://www.dnr.wa.gov/Publications/fp_tfw_wq1_93_001.pdf

Ratcliff, A. W., Busse, M.D., & Shestak, C. J. (2006). Changes in microbial community structure following herbicide (glyposate) additions to forest soils. *Applied Soil Ecology, 34,* 114-124.

Rejmanek, M., & Pitcairn, M. J. (2002). When is eradication of exotic pest plants a realistic goal? In C. R. Veitch & M. N. Clout (Eds.), *Turning the tide: The eradication of invasive species* (pp. 249-253). Auckland, New Zealand: Invasive Species Specialist Group of the World Conservation Union (IUCN).

Relyea, R. A. (2004). The growth and survival of five amphibian species exposed to a combination of pesticides. *Environmental Toxicology and Chemistry, 23,* 1737-1742.

Relyea, R. A. (2005a). The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. *Ecological Applications, 15*(2), 618-627.

Relyea, R. A. (2005b). The lethal impact of Roundup on aquatic and terrestrial amphibians. *Ecological Applications, 15*(4), 1118-1124.

Relyea, R. A. (2005c). *Roundup is highly lethal: Dr. Relyea responds to Monsanto's concerns regarding recent published study*. Retrieved from http://www.mindfully.org/GE/2005/Relyea-Monsanto-Roundup1apr05.htm

Relyea, R. A. (2006). Response. To The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. *Ecological Applications, 15*(2), 2027-2034.

Richard, S., Moslemi, S., Sipahutar, H., Benachour, N., & Seralini, G. (2005). Differential effects of glyphosate and Roundup® on human placental cells and aromatase. *Environmental Health Perspectives*. Retrieved from http://www.ehponline.org/docs/2005/7728/abstract.html

Richardson, D. M., Pyšek, P., Rejmánek, R., Barbour, M. G., Panetta, F. D., & West, C. J. (2000). Naturalization and invasion of alien plants: Concepts and definitions. *Diversity and Distributions, 6,* 93-107.

Ringold, P. L., Alegria, J., Czaplewski, R. L., Mulder, B. S., Tolle, T., & Burnett, K. (1996). Adaptive management design for ecosystem management. *Ecological Applications, 6,* 745.

Rozenfelds, A., Cave, L., Morris, D., & Buchanan, A. (1999). The weed invasion in Tasmania since 1970. *Australian Journal of Botany, 47,* 23-48.

Ruhl, J. B., & Fishman, R. (2010). Adaptive management in the courts. *Minnesota Law Review, 95*(2). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1542632##

Schuette, J. (1998, November). *Environmental fate of glyphosate*. Sacramento: California Department of Pesticide Regulation. Retrieved from http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/glyphos.pdf

Schneiders, G., Koeppe, M., Naidu, M., Horne, P., Brown, A., & Mucha, C. (1993). Fate of rimsulfuron in the environment. *Journal of Agriculture and Food Chemistry, 41,* 2404-2410.

Science Lab. (2005a, updated on October 11). [Material Data Safety Sheet]. Caffeine. *Sciencelab.com*. Retrieved from http://www.sciencelab.com/xMSDS-Caffeine-9927475

Science Lab. (2005b, updated on October 11). [Material Data Safety Sheet]. Sodium chloride. *Sciencelab.com*. Retrieved from http://www.sciencelab.com/xMSDS-Sodium_chloride-9927593

Senseman, S. A. (Ed.). (2007). *Herbicide handbook* (9th ed.). Lawrence, KS: Weed Science Society of America.

SERA (Syracuse Environmental Research Associates). (1997, February 6). *Effects of surfactants on the toxicity of glyphosate, with specific reference to RODEO*. Prepared for USDA, Animal and Plant Health Inspection Service. SERA TR 97-206-1b. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/pdfs/Surfactants.pdf

SERA (Syracuse Environmental Research Associates). (2003, March 1). *Glyphosate – Human health and ecological risk assessment final report.* Prepared for the U.S. Forest Service, Forest Health Protection. SERA TR 02-03-49-04a. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/pdfs/04a03_glyphosate.pdf

SERA (Syracuse Environmental Research Associates). (2003). *Triclopyr – Human health and ecological risk assessment final report.* Prepared for the U.S. Forest Service, Forest Health Protection. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA (Syracuse Environmental Research Associates). (2004a). *Clopyralid – Human health and ecological risk assessment final report.* Prepared for the U.S. Forest Service, Forest Health Protection. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA (Syracuse Environmental Research Associates). (2004b). *Imazapyr – Human health and ecological risk assessment – Final report.* Prepared for the U.S. Forest Service, Forest Health Protection. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA (Syracuse Environmental Research Associates). (2007). *Aminopyralid — Human health and ecological risk assessment final report.* Prepared for the U.S. Forest Service and the National Park Service. Fayetteville, NY. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Shaner, D. (2006). An overview of glyphosate mode of action: Why is it such a great herbicide? *2006 North Central Weed Society Proceedings, 61*, 94. Retrieved from http://www.weeds.iastate.edu/ncwss2006/abstracts/94.pdf

SNEP (Sierra Nevada Ecosystem Project). (1996). *Status of the Sierra Nevada: Summary of The Sierra Nevada Ecosystem Project Final Report to Congress.* Davis: Centers for Water and Wildlife Resources, University of California Press.

Staples, C. A., Weeks, J., Hall, J. F., & Naylor, C. G. (1998). Evaluation of aquatic toxicity and bioaccumulation of C8- and C9-alkylphenol ethoxylates. *Environmental Toxicology and Chemistry, 17*(12), 2470-2480.

Smith, G. R. (2001). Effects of acute exposure to a commercial formulation of glyphosate on the tadpoles of two species of anurans. *Bulletin of Environmental Contamination and Toxicology, 67,* 483-488.

Smith, H. A., Johnson, W. S., Shonkweiler, J. S., & Swanson, S. R. (1999). The implications of variable or constant expansion rates in invasive weed infestations. *Weed Science, 47*(1), 62-66.

State Water Resources Control Board. (2005). *Regulation of aquatic pesticides following the Ninth Circuit decision in Fairhurst v. Hagener*. Sacramento, CA. Retrieved from http://www.swrcb.ca.gov/aquatic/docs/memo_fairhurstvhagener.pdf

Tatum, V. L. (2004). Toxicity, transport, and fate of forest herbicides. *Wildlife Society Bulletin, 32*(4), 1042-1048.

Thompson, D. G., Solomon, K. R., Wojtaaszek, B. F., Edginton, A.N., & Stephenson, G. R. (2006). The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. *Ecological Applications, 16*(5), 2022-2027.

Tilman, D. (1999). The ecological consequences of changes in biodiversity: A search for general principles. *Ecology (Washington D.C.), 80*(5), 1455-1474.

Timmins, S. M., & Braithwaite, H. (2001). Early detection of invasive weeds on islands. In C. R. Veitch & M. N. Clout (Eds.), *Turning the tide: The eradication of invasive species* (pp. 311-318). IUCN SSC Invasive Specialist Group. Gland, Switzerland and Cambridge, UK: IUCN.

Trumbo, J. (2005). An assessment of the hazard of a mixture of the herbicide Rodeo and the non-ionic surfactant R-11 to aquatic invertebrates and larval amphibians. *California Fish and Game, 91*, 38-46.

Tsui, M. T., & Chu, L. M. (2003). Aquatic toxicity of glyphosate-based formulations: Comparison between different organisms and the effects of environmental factors. *Chemosphere, 52*(7), 1189-1197.

Tu, M., Hurd, C., & Randall, J. M. (2001, April). Weed control methods handbook: Tools and techniques for use in natural areas. *The Nature Conservancy*. Retrieved from http://tncweeds.ucdavis.edu/handbook.html

USDA (Natural Resource Conservation Service/Departmentof Agriculture). (2006). *Soil survey of Yosemite National Park, California*. Retrieved from http://soildatamart.nrcs.usda.gov/Manuscripts/CA790/0/Yosemite_CA.pdf

USFS (U.S. Forest Service). (n.d.). *Human health and ecological risk assessments*. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

USFS (U.S. Forest Service). (1984). Pesticide background statements. In The Nature Conservancy, *Agriculture handbook no. 633* (Vol. 1). Herbicides. Part 2. Use in Natural Areas (Version date: April 2001) (pp. T1-T61). Retrieved from http://tncweeds.ucdavis.edu/handbook.html

USFS (U.S. Forest Service). (1996). *Triclopyr herbicide information profile*. Retrieved from http://www.fs.fed.us/r6/nr/fid/pubsweb/tri.pdf

USFS (U.S. Forest Service)/Department of Agriculture, Pacific Northwest Region. (1997, February). *Glyphosate herbicide information profile*. Portland, OR: U.S. Forest Service, Pacific Northwest Region.

USFS (U.S. Forest Service). (2003a). *Glyphosate – Human health and ecological risk assessment final report*. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

USFS (U.S. Forest Service). (2003b). *Human and ecological risk assessment of ponylphenol polyethoxylate-based (NPE) surfactants in Forest Service herbicide applications*. U.S. Department of Agriculture Forest Service Pacific Southwest Region (Region 5).

USFS (U.S. Forest Service). (2004). *Chlorsulfuron– Human health and ecological risk assessment final report*. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

USFS (U.S. Forest Service). (2006). *2,4-D – Human health and ecological risk assessment final report*. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

USFS (U.S. Forest Service). (2007). *Aminopyralid– Human health and ecological risk assessment final report*. Retrieved from http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

USFWS (U.S. Fish and Wildlife Service)/Department of the Interior. (1995). *Draft national wetland inventory maps: Yosemite National Park.*

USFWS (U.S. Fish and Wildlife Service). (1997, March 3). *U.S. Fish and Wildlife Service national list of vascular plant species that occur in wetlands: 1996 national summary*. Ecology Section, National Wetlands Inventory. Retrieved from http://library.fws.gov/Pubs9/wetlands_plantlist96.pdf

USGS (U.S. Geological Survey). (2000). Alien plants ranking system version 5.1. National Park Service, Ripon College, University of Minnesota, & USGS. Retrieved from http://www.npwrc.usgs.gov/resource/literatr/aprs/index.htm

USGS (U.S. Geological Survey). (2005). (2005). "Special status vascular plant surveys and habitat modeling in Yosemite National Park." Unpublished final report. P. E. Moore, A. E. L. Colwell, & C. L. Coulter. USGS Western Ecological Research Center, Yosemite Field Station.

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.

Vitousek, P. M., & Walker, L. (1989). Biological invasion by *Myrica faya* in Hawaii: Plant demography, nitrogen fixation, ecosystem effects. *Ecological Monographs, 59*(3), 247-265.

Vredenburg, V. T. (2004). Reversing introduced species effects: Experimental removal of introduced fish leads to rapid recovery of a declining frog. *Proceedings of the National Academy of Sciences, 101,* 7646-7650.

Wang, N., Besser, J. M., Buckler, D. R., Honegger, J. L., Ingersoll, C. G., Johnson, B. T., . . . McKee, M. J. (2005). Influence of sediment on the fate and toxicity of a polyethoxylated tallowamine surfactant system (MON 0818) in aquatic microcosms. *Chemosphere, 59*(4), 545-551.

Weiss, S. B. (1999). Cars, cows, and checkerspot butterflies: Nitrogen deposition and management of nutrient-poor grasslands for a threatened species. *Conservation Biology, 13*(6), 1476-1486.

Wester, R. C., Melendres, J., Sarason, R., McMaster, J., & Maibach, H. I. (1991). Glyphosate skin binding, absorption, residual tissue distribution, and skin decontamination. *Toxicological Sciences, 16*(4), 725-732.

Wester, R. C., Quan, D., &Maibach, H. I. (1996). In vitro percutaneous absorption of model compounds glyphosate and malathion from cotton fabric into and through human skin. *Food and Chemical Toxicology, 34*(8), 731-735.

WHO (World Health Organization). (1994). *Glyphosate, environmental health criteria* (EHC 159). H. Mensink & P. Janssen. International Programme on Chemical Safety. Geneva, Switzerland: United Nations Environment Programme, the International Labour Organisation, and the World Health Organization.

Williams, B. K. (2007). Adaptive management technical guidance. US Department of the Interior. Retrieved from http://www.doi.gov/initiatives/AdaptiveManagement/index.html

Williams, B. K., Szaro, R. C., and Shapiro, C. D. (2007). *Adaptive management: The U.S. Department of the Interior technical guide*. U.S. Department of the Interior. Retrieved from http://www.doi.gov/initiatives/AdaptiveManagement/index.html

Williams, G. M., Kroes, R., & Munro, I. C. (2000, April). Safety evaluation and risk assessment of the herbicide Roundup® and its active ingredient, glyphosate, for humans. *Regulatory Toxicology and Pharmacology, 31*(2), 117-165.

Wilson, C. (2006). *Aquatic toxicology notes: Predicting the fate and effects of aquatic and ditchbank herbicides*. Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Wood, W. (2006). *Aminopyralid fact sheet*. Retrieved from http://www.alanwood.net/pesticides/aminopyralid.html

Zabinski, C. A., Quinn, L., & Callaway, R. (2002). Phosphorous uptake, not carbon transfer, explains arbuscular mycorrhizal enhancement of Centaurea maculosa in the presence of native grassland species. *Functional Ecology, 16,* 758-765.

Zedler, J. B., & Kercher, S. (2004). Causes and consequences of invasive plants in wetlantd: opportunities, opportunists, and outcomes. *Plant Science, 23*(43), 1-52.

Ziska, L. H. (2006). *Climate change impacts on weeds*. Retrieved from http://www.climateandfarming.org/pdfs/FactSheets/III.1Weeds.pdf

Ziska, L. H., & George, K. (2004). Rising carbon dioxide and invasive, noxious plants: Potential threats and consequences. *World Resource Review, 16,* 427-447.

Appendix A: Invasive Plant Species-Specific Management Objectives

Invasive plant program managers developed the following objectives for the highest priority invasive plants in Yosemite National Park. This list is based on the likely threat of each invasive species to park resources, the current locations of the invasive plant, and the knowledge of the effectiveness of invasive plant control actions for the species in Yosemite National Park. Effective control of a species is considered to be achieved when follow-up maintenance is the only treatment required to meet management objectives. The difficulty of control is considered in the context of Yosemite National Park and the size and location of existing populations.

High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Cheatgrass (*Bromus tectorum*)		
Impact: High Threat: High Difficulty of Control: High	Document abundance and distribution throughout the park. Survey in areas that have recently been burned (El Portal, Yosemite Valley, and Wawona). Develop management objectives once parkwide abundance and distribution are better understood.	Work with Fire Management for effective use of fire to enhance native plant competition and limit extent of spread.
Italian thistle (*Carduus pycnocephalus*)		
Impact: Low Threat: High Difficulty of Control: Low	Emphasize immediate detection of new populations parkwide. Survey every two years for new populations in the foothill woodland zone. Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Document the location of each individual encountered throughout the park. Prevent all populations from establishment in the park throughout all vegetation zones.	There are no known persistent populations in the park at this time. Practice parkwide early detection and immediate control or eradication of new populations.
Spotted knapweed (*Centaurea maculosa*)		
Impact: Medium Threat: High Difficulty of Control: Low	Emphasize immediate detection of new populations parkwide. Survey annually for new populations in Foresta. Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Document the location of each individual encountered throughout the park. Census location and life stage data. Prevent all populations from establishment in the park throughout all vegetation zones.	Eradicate existing populations from Foresta and Yosemite Valley. Practice parkwide early detection and immediate control or eradication of new populations.

High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Yellow star-thistle (*Centaurea solstitialis*)		
Impact: High Threat: High Difficulty of Control: Medium	Emphasize immediate detection of new populations. Do directed surveys for new populations along all roads within the foothill woodland zone and the lower montane forest. Update abundance and distribution maps every three years. Monitor effectiveness of control techniques. Monitor plant community response to control techniques. Prevent the transport of seed from infested areas of the park. Refrain from transferring fill material from infested areas within and outside the park to non-infested areas. Prevent all new populations outside the foothill woodland zone from becoming established.	Reduce current populations to 30% of the current extent and 25% of the current abundance. Eradicate all populations found outside the foothill woodland zone.
Bull thistle (*Cirsium vulgare*)		
Impact: Medium Threat: High Difficulty of Control: Medium	Make yearly assessment of abundance in meadows, recent burn areas, and other high-priority areas. Document abundance and distribution in Wilderness areas.	Control populations in developed areas in the lower montane vegetation zone. Eradicate populations in Yosemite Valley meadows populations found within the upper montane vegetation zone. Eradicate in high-use Wilderness areas (Pate Valley and Little Yosemite Valley).
French broom (*Genista monspessulana*)		
Impact: Low Threat: High Difficulty of Control: Low	Emphasize immediate detection of new populations parkwide. Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Document parkwide distribution and abundance. Keep areas of the Tuolumne and South Fork of the Merced free of infestation. Eliminate ornamental planting in residential areas with community outreach and education.	Eradicate from El Portal. Practice parkwide early detection and immediate control or eradication of new populations.
Common velvet grass (*Holcus lanatus*)		
Impact: Medium Threat: High Difficulty of Control: Medium	Update abundance and distribution maps every three years. Monitor effectiveness of control techniques. Monitor plant community response to control techniques.	Eradicate from restoration sites. Control populations in priority wetland areas and Wilderness areas (Pate Valley and Tiltill Valley) to maintenance levels, where regular follow-up is the only treatment necessary.

High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Perennial pepperweed (*Lepidium latifolium*)		
Impact: Medium Threat: High Difficulty of Control: Low	Parkwide emphasis on immediate detection of new populations. Survey annually for new populations in Foresta. Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Document the location of each individual encountered throughout the park. Prevent all populations from establishment in the park throughout all vegetation zones.	Eradicate known population in Foresta. Practice parkwide early detection and immediate control or eradication of new populations.
Himalayan blackberry (*Rubus armeniacus)*		
Impact: High Threat: High Difficulty of Control: High	Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Update abundance and distribution maps every three years. Monitor effectiveness of control techniques. Monitor plant community response to control techniques. Prevent spread into Wilderness, meadow, riparian, and wetland areas parkwide.	Control populations within high-priority sites throughout the park (high visitor-use sites, wetlands, meadows, riparian areas, Wilderness, Tenaya Canyon, Pate Valley, and Poopenaut Valley).
Common St. John's wort *(Hypericum perforatum)*		
Impact: Medium Threat: Medium Difficulty of Control: High	Document abundance and distribution in Wilderness areas.	Maintain populations to control levels in developed areas and road corridors throughout all vegetation zones.
Oxeye daisy *(Leucanthemum vulgare)*		
Impact: Medium Threat: High Difficulty of Control: High	Document parkwide distribution and abundance. Monitor effectiveness of control techniques. Monitor plant community response to control techniques. Prevent spread into Wilderness, meadow, riparian, and wetland areas parkwide.	Contain currently known populations within all vegetation zones. Begin control after abundance and distribution have been established.

Medium-High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Prostrate pigweed (*Amaranthus albus*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Survey for populations in recently disturbed sites within or above the upper montane forest zone. Document occurrences of this plant that occur when observed within or above the upper montane forest zone. Prevent establishment in recent restoration sites, construction sites, staging areas, Wilderness areas, and undisturbed areas.	Eradicate existing population at Snow Creek Quarry.
Giant reed (*Arundo donax*)		
Impact: Low Threat: High Difficulty of Control: Medium	Emphasize immediate detection of new populations parkwide. Document the location of each individual encountered throughout the park.	Eradicate from El Portal. Practice parkwide early detection and immediate control or eradication of new populations.
Black mustard (Brassica nigra)		
Impact: Low Threat: Medium Difficulty of Control: Low	Prevent species from invading developed areas above 4,000 feet.	Reduce existing populations along El Portal Road and El Portal Administrative Site.
Field mustard (*Brassica rapa*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Prevent species from invading developed areas above 4,000 feet.	Reduce existing populations within the El Portal Maintenance Complex.
Tocolote (*Centaurea melitensis*)		
Impact: Medium Threat: Low Difficulty of Control: Medium	Do directed surveys along the El Portal Road every other year. Document changes in abundance and distribution of this plant in El Portal. Document changes in relationship with fire. Prevent from spreading to areas outside of the Foothill Woodland Zone.	Eradicate all occurrences found above the Foothill Woodland Zone.
Bermuda grass (*Cynodon dactylon*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Emphasize immediate detection of new populations parkwide. Document abundance and distribution throughout the park. Prevent all new populations from becoming established in the park throughout all vegetation zones.	Eradicate populations in Yosemite Valley. Eradicate populations within and adjacent to riparian areas. Practice parkwide early detection and immediate control or eradication of new populations.

Medium-High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Foxglove (*Digitalis purpurea*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Prevent from spreading into areas above 5,000 feet.	Control throughout developed areas in the park. Eradicate from Wilderness.
English ivy (*Hedera helix*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution throughout the park. Prevent spread into meadow, riparian, and wetland areas throughout the park. Do not allow plant for landscaping in the park. Eradicate from construction sites.	Eradicate populations found in riparian areas and wetlands throughout the park to preserve Tompkin's sedge habitat.
Shortpod mustard (*Hirschfeldia incana*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document abundance and distribution in Wilderness areas.	Control populations within the El Portal Maintenance Complex.
Hops (*Humulus lupulus*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution throughout the park.	Eradicate known populations from Yosemite Valley, Carlon and Wawona.
Perennial sweet pea (*Lathyrus latifolius*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document park-wide distribution and abundance.	Reduce population in developed areas (Wawona, Foresta, and El Portal). Eradicate all populations that occur in riparian areas throughout the park.
Rose campion (*Lychnis coronaria*)		
Impact: Medium Threat: Medium Difficulty of Control: Medium	Document distribution in Yosemite Valley, Wawona, and other developed areas. Prevent spread into Wilderness areas.	Control populations that occur away from developed areas within all vegetation zones.

Medium-High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
White sweetclover (*Melilotus alba*) yellow sweetclover (*Melilotus officinalis*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document abundance and distribution with a high priority in areas away from developed areas. Monitor populations in disturbed sites to determine ability to spread into adjacent undisturbed areas. Control in road maintenance areas.	Control populations along roadsides, in developed areas, and in construction sites.
Spearmint (*Mentha spicata* var. *spicata*)		
Impact: Medium Threat: Medium Difficulty of Control: Medium	Prevent from becoming established in restoration and construction sites.	Control populations in restoration sites.
Sourclover (*Melilotus indica*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Prevent species from invading developed areas above 4,000 feet.	Control populations along roadsides, in developed areas, and in construction sites.
Manyflower tobacco (*Nicotiana acuminata* var.)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document abundance and distribution in Wilderness areas.	Control populations in restoration sites that persist for more than four years.
Woodbine, Virginia creeper (*Parthenocissus vitacea*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Prevent species from invading developed areas above 4,000 feet.	Control populations along roadsides, in developed areas, and in construction sites.
Black locust (*Robinia pseudoacacia*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution throughout the park.	Eradicate all individuals in Yosemite Valley that are not historically significant. Eradicate from El Portal.

Medium-High-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Cutleaf blackberry (*Rubus laciniatus*)		
Impact: Medium Threat: High Difficulty of Control: High	Survey annually in areas with ground disturbance for a minimum of three years after disturbance. Update abundance and distribution maps every three years. Monitor effectiveness of control techniques. Monitor plant community response to control techniques. Prevent spread into Wilderness, meadow, riparian, and wetland areas.	Control populations within high-priority sites throughout the park (high visitor use sites, wetlands, meadows, riparian areas, Wilderness, Tenaya Canyon, Pate Valley, and Poopenaut Valley).
London rocket (*Sisymbrium irio*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document distribution in Yosemite Valley and other developed areas.	Control populations within the El Portal Maintenance Complex.
Rose clover (*Trifolium hirtum*)		
Impact: Medium Threat: Medium Difficulty of Control: Medium	Prevent population from El Portal Road from moving higher in elevation to Yosemite Valley and elsewhere into the park.	Reduce populations along the El Portal Road Corridor and Administrative Site. Eradicate all populations within the El Portal Maintenance Complex.
Purple vetch (*Vicia benghalensis*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Monitor for expansion into undisturbed areas. Prevent the spread of vetch away from roads and developed areas in El Portal.	Control populations along El Portal Road and within the El Portal Administrative Site.
Common mullein (*Verbascum Thapsus*)		
Impact: Low Threat: Medium Difficulty of Control: Low	Document abundance and distribution in Wilderness areas.	Control to maintenance levels in developed areas throughout the park, where regular follow-up is the only treatment necessary.

Medium-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Tree-of-heaven (*Ailanthus altissima*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document parkwide abundance and distribution.	Eradicate from El Portal and Yosemite Valley.
Foxtail chess (*Bromus madritensis* ssp. *rubens*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in Wilderness areas and frontcountry sites above 6,000 feet.	Control populations in Wilderness areas that occur above 6,000 feet.
Bachelor's button (*Centaurea cyanus*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in Wilderness areas. Prevent species from invading developed areas above 4,000 feet.	Eradicate all populations that occur within and above the lower montane vegetation zone. Eradicate populations within the El Portal Maintenance Complex.
Jerusalem oak (*Chenopodium botrys*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in Wilderness areas.	Control populations that remain in restoration sites for greater than four years.
Gypsyflower (*Cynoglossum officinale*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in all vegetation zones of the park.	More information is needed to develop management objectives. Objectives will be developed once the significance of the threat has been determined.
Lanceleaf tickseed (*Coreopsis lanceolata*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in all vegetation zones of the park.	More information is needed to develop management objectives. Objectives will be developed once the significance of the threat has been determined.
Tall fescue (*Festuca arundinacea*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in developed areas and Wilderness sites throughout the park.	More information is needed to develop management objectives. Objectives will be developed once the significance of the threat has been determined.

Medium-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Black bindweed (*Polygonum convolvulus*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in park areas above 5,000 feet.	Control populations in restoration and construction sites. Eradicate from Wilderness areas if found.
Radish (*Raphanus sativus*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in Wilderness areas.	Control populations in Yosemite Valley.
Blackeyed Susan (*Rudbeckia hirta* var. *pulcherrima*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution throughout the park.	Eradicate all populations found in wetlands throughout the park.
Bouncingbet (*Saponaria officinalis*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in Wilderness areas.	Eradicate populations within all vegetation zones that are greater than 1 square meter and have a density of greater than 10 individuals per square meter.
Charlock mustard (*Sinapis arvensis*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in all vegetation zones of the park.	More information is needed to develop management objectives. Objectives will be developed once the significance of the threat has been determined.
Dandelion (*Taraxacum officinale*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in Wilderness areas.	Control populations in Wilderness.
Yellow salsify (*Tragopogon dubius*)		
Impact: Low Threat: Low Difficulty of Control: Low	Document abundance and distribution in Wilderness areas.	Control populations in Wilderness and developed areas within and above the lower montane vegetation zone. Control populations to maintenance levels in meadows and roadsides throughout the park.

Medium-Priority Species		
Priority of Control	**Early Detection, Monitoring, and Prevention Management Objective**	**Control Management Objective**
Puncture vine (*Tribulus terrestris*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution in Wilderness areas.	Control populations in Wilderness and developed areas.
Greater periwinkle (*Vinca major*)		
Impact: Low Threat: Medium Difficulty of Control: Medium	Document abundance and distribution throughout the park. Prevent spread into meadow, riparian, and wetland areas throughout the park. Do not allow plant for landscaping in the park.	Eradicate populations found in riparian areas and wetlands throughout the park to preserve Tompkin's sedge habitat. Eradicate from construction sites.

Appendix B: Non-native Plant Species in Yosemite

*Agrostis capillaris**	colonial bentgrass
*Agrostis gigantea**	redtop
*Agrostis stolonifera**	creeping bentgrass
*Ailanthus altissima**	tree-of-heaven
Aira caryophyllea	European hairgrass
*Amaranthus albus**	prostrate pigweed
Anagallis arvensis	scarlet pimpernel
Anthemis cotula	stinkweed
Anthriscus caucalis	burr chervil
Arabidopsis thaliana	mouse-ear cress
*Arundo donax**	giant reed
Avena barbata	slender wild oat
Avena fatua	wild oat
Bidens tripartita	threelobe beggarticks
Brassica nigra	black mustard
Brassica rapa	field mustard
Briza minor	little quaking grass
Bromus arenarius	Australian brome
Bromus catharticus	rescue grass
Bromus diandrus	ripgut brome
*Bromus hordeaceus**	soft brome
Bromus inermis ssp. *inermis**	smooth brome
Bromus japonicus	field brome
Bromus madritensis ssp. *rubens*	foxtail chess
Bromus secalinus	rye brome
Bromus sterilis	poverty brome
Bromus tectorum	cheatgrass
Capsella bursa-pastoris	shepherd's purse
Carduus pycnocephalus	Italian thistle
Centaurea cyanus	bachelor's button
Centaurea maculosa	spotted knapweed
Centaurea melitensis	tocolote
Centaurea solstitialis	yellow star-thistle
Cerastium fontanum ssp. *vulgare*	big chickweed
Cerastium glomeratum	sticky chickweed
Chamomilla suaveolens	pineapple weed
*Chenopodium album**	lambsquarters
*Chenopodium botrys**	Jerusalem oak
*Cirsium vulgare**	bull thistle
Cnicus benedictus	blessed thistle
Convolvulus arvensis	field bindweed
*Coreopsis lanceolata**	lance-leaf tickseed
Crepis capillaris	smooth hawksbeard
Cynodon dactylon	Bermuda grass
*Cynoglossum officinale**	hound's tongue
Cynosurus echinatus	hedgehog dogtail
*Dactylis glomerata**	orchard grass
Dianthus barbatus ssp. *barbatus*	sweet William
*Digitalis purpurea**	foxglove
Digitaria ischaemum	smooth crabgrass
Digitaria sanguinalis	hairy crabgrass
*Echinochloa crus-galli**	barnyard grass
Epipactis helleborine	broadleaf helleborine
Eragrostis cilianensis	lovegrass
Erigeron annuus	eastern daisy fleabane
Erigeron strigosus	prairie fleabane
Erodium botrys	long-beaked stork's bill
Erodium brachycarpum	short fruit stork's bill
Erodium cicutarium	red-stem stork's bill
*Festuca arundinacea**	tall fescue
*Festuca pratensis**	meadow fescue
Filago gallica	narrow-leaved herba impia

Gaillardia pulchella	fire wheel
Galium parisiense	wall bedstraw
Genista monspessulana	French broom
Geranium dissectum	cutleaf geranium
Geranium robertianum	Robert's geranium
Glechoma hederacea	ground ivy
Hedera helix	English ivy
Herniaria hirsuta ssp. *cinerea*	rupture wort
Herniaria hirsuta ssp. *hirsuta*	hairy rupture wort
Hirschfeldia incana	short-pod mustard
*Holcus lanatus**	common velvet grass
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley
Hordeum murinum ssp. *glaucum*	smooth barley
Hordeum murinum ssp. *leporinum*	leporinum barley
Hordeum murinum ssp. *murinum*	wall barley
Humulus lupulus	hops
Hypericum perforatum	common St. John's wort
*Hypochaeris glabra**	smooth cat's ear
*Hypochaeris radicata**	hairy cat's ear
*Lactuca serriola**	prickly lettuce
Lamium amplexicaule	henbit dead nettle
Lathyrus latifolius	perennial sweet pea
*Lepidium latifolium**	perennial pepperweed
Lepidium virginicum var. *virginicum*	Virginia pepperweed
*Leucanthemum vulgare**	ox-eye daisy
Lolium multiflorum	Italian ryegrass
*Lolium perenne**	perennial ryegrass
Lolium temulentum	darnel
Lunaria annua	annual honesty
Lychnis coronaria	rose campion
Malva nicaeensis	bull mallow
Malva parviflora	cheeseweed
*Marrubium vulgare**	horehound
Medicago lupulina	black medic
*Medicago polymorpha**	California burclover
Medicago sativa	alfalfa
Melilotus alba	white sweetclover
*Melilotus indicus**	sour clover
*Melilotus officinalis**	yellow sweetclover
Mentha spicata var. *Spicata**	spearmint
Mollugo verticillata	carpetweed, Indian chickweed
*Muhlenbergia schreberi**	nimblewell
Nicotiana acuminata var. *multiflora*	manyflower tobacco
*Nicotiana glauca**	tree tobacco
Oxalis corniculata	creeping woodsorrel
Panicum miliaceum	broomcorn millet
Parapholis incurva	curved sicklegrass
*Parthenocissus vitacea**	woodbine, Virginia creeper
*Phleum pratense**	cultivated timothy
Plantago lanceolata	English plantain
*Plantago major**	common plantain
Poa annua	annual bluegrass
Poa bulbosa	bulbous bluegrass
*Poa compressa**	Canada bluegrass
Poa nemoralis	wood bluegrass
*Poa palustris**	fowl bluegrass
Poa pratensis ssp. *pratensis**	Kentucky bluegrass
Polycarpon tetraphyllum	four-leaved allseed
Polygonum arenastrum	common knotweed
*Polygonum convolvulus**	black bindweed
Polygonum persicaria	spotted lady's thumb
Polygonum ramosissimum	bushy knotweed
Polypogon maritimus	Mediterranean beard grass
*Polypogon monspeliensis**	annual beard grass

Portulaca oleracea	little hogweed
Ranunculus muricatus	spinyfruit buttercup
Raphanus raphanistrum	jointed charlock
*Raphanus sativus**	radish
*Robinia pseudoacacia**	black locust
*Rubus armeniacus**	Himalayan blackberry
*Rubus laciniatus**	cut-leaved blackberry
Rudbeckia hirta var. *pulcherrima**	black-eyed Susan
*Rumex acetosella**	sheep sorrel
Rumex conglomeratus	dock
*Rumex crispus**	curly dock
*Saponaria officinalis**	bouncingbet
Scirpus cyperinus	woolgrass
Secale cereale	cereal rye
Senecio vulgaris	common groundsel
Setaria pumila	yellow foxtail
Setaria viridis	green bristlegrass
Silene gallica	common catchfly
Silene latifolia ssp. *alba*	bladder campion
Sinapis arvensis	charlock mustard
*Sisymbrium altissimum**	tall tumble mustard
Sisymbrium irio	London rocket
Sisymbrium officinale	hedge mustard
Soliva sessilis	field burrweed
Sonchus asper ssp. *asper**	prickly sow thistle
Sonchus oleraceus	common sow thistle
Spergularia rubra	red sandspurry
Stellaria media	common chickweed
*Tanacetum parthenium**	feverfew
Taraxacum officinale	dandelion
*Torilis arvensis**	spreading hedge parsley/miner's lice
Tragopogon dubius	yellow salsify
Tribulus terrestris	puncture vine
Trifolium dubium	little hop clover
Trifolium hirtum	rose clover
Trifolium pratense	red clover
*Trifolium repens**	white clover
Triticum aestivum	common wheat
Urtica urens	dwarf nettle
Verbascum blattaria	moth mullein
*Verbascum Thapsus**	common mullein
Veronica anagallis-aquatica	water speedwell
Veronica arvensis	corn speedwell
Veronica persica	Persian speedwell
Vicia benghalensis	purple vetch
Vicia cracca	bird vetch
Vinca major	greater periwinkle
Viola arvensis	European field pansy
*Vitis vinifera**	wine grape
Vulpia bromoides	brome fescue
Vulpia myuros var. *myuros*	foxtail fescue

* Potential to occur in wetlands —
Obligate wetland species almost always occur in wetlands.
Facultative wetland species usually occur in wetlands (estimated probability 67 to 99%).
Facultative species are equally likely to occur in wetlands or non-wetlands (estimated probability 34 to 66%).

Appendix C: Watchlist for Invasive Plant Species Not Yet Found in Yosemite National Park

The purpose of Table C-1 is to prioritize the invasive plant species that have not yet reached Yosemite, and to use this list in early detection surveys. Drucker and Bradshaw (2007) prioritized these invasive plants into four broad groups according to the threat they pose to natural habitat in Yosemite and their proximity to the park. The list is limited to plant species previously documented in California and plant species with a history of wildland invasion.

Table C-1: Yosemite National Park Invasive Plant Watch List

Invasive Plant Species	Habitat
Priority Group 1 – California Invasive Plant Council status of "High," "Moderate," or "Limited"; found within 62 miles of park boundary; found within the elevation range of the park; previously documented in California	
Acroptilon repens	Scrub, grasslands, riparian, pinyon-juniper woodland, forest
Aegilops triuncialis	Grassland, oak woodland
Bromus japonicus	Great Basin grassland, valley and foothill grassland, pinyon and juniper woodland, lower montane coniferous forest
Cardaria chalepensis	Central Valley wetlands; limited distribution in California; may not be as invasive as Cardaria draba
Cardaria draba	Riparian areas, marshes of central coast
Cardaria pubescens	Grasslands and meadows
Carduus tenuiflorus	Valley and foothill grasslands
Centaurea calcitrapa	Grasslands
Centaurea diffusa	Fields and roadsides
Chondrilla juncea	Grasslands
Cirsium arvense	Grasslands, riparian areas, forests
Conium maculatum	Riparian woodland, grasslands
Cytisus scoparius	Coastal scrub, oak woodland
Descurainia Sophia	Scrub, grasslands, woodland
Ficus carica	Riparian woodlands
Halogeton glomeratus	Scrub, grasslands, pinyon-juniper woodland
Hordeum marinum	Grasslands, drier habitats
Hordeum murinum	Grasslands and wetlands
Iris pseudacorus	Riparian, wetland areas, especially southern California
Isatis tinctoria	Great Basin scrub and grasslands, coniferous forest
Linaria genistifolia ssp. dalmatica	Grasslands, forest clearings
Lythrum hyssopifolium	Grasslands, wetlands, vernal pools
Lythrum salicaria	Wetlands, marshes, riparian areas

Table C-1: Yosemite National Park Invasive Plant Watch List	
Invasive Plant Species	**Habitat**
Medicago polymorpha	Grasslands; widespread weed of agriculture and disturbed areas
Mentha pulegium	Vernal pools, wetlands
Myriophyllum aquaticum	Freshwater aquatic systems
Schismus arabicus	Scrub, thorn woodland
Silybum marianum	Grasslands, riparian; widespread, primarily in disturbed areas
Spartium junceum	Coastal scrub, grasslands, wetlands, oak woodland, forests
Taeniatherum caput-medusae	Grasslands, scrub, woodland
Tamarix parviflora	Riparian areas, desert washes, coastal scrub
Tamarix ramosissima	Desert washes, riparian areas, seeps and springs
Torilis arvensis	Disturbed areas
Priority Group 2 – California Invasive Plant Council status of "High," "Moderate," or "Limited"; found from 124 to 186 miles of the park boundary; found within the elevation range of the park; previously documented in California or California Invasive Plant Council status of "High," "Moderate," or "Limited"; found within 62 miles of the park boundary; found within the elevation range of the park; not previously documented in California	
Anthoxanthum odoratum	Coastal prairie, coniferous forest
Carduus acanthoides	Valley and foothill grasslands
Carduus nutans	Grasslands
Cordyline australis	Coniferous forest
Cotoneaster franchetii	Coniferous forest
Crataegus monogyna	Riparian habitats, woodland
Dipsacus fullonum	Grasslands, seep, riparian scrub
Dipsacus sativus	Grasslands, seep, bogs
Egeria densa	Streams, ponds, sloughs, lakes
Elaeagnus angustifolia	Riparian areas
Glyceria declinata	Vernal pools, moist grasslands
Kochia scoparia	Scrub, chaparral, grasslands
Linaria vulgaris	Valley and foothill grasslands, Great Basin grassland, riparian woodland, lower montane coniferous forest, upper montane coniferous forest
Nicotiana glauca	Coastal scrub, grasslands, riparian woodland
Onopordum acanthium	Wet meadows, sage brush, riparian areas
Polygonum cuspidatum	Riparian areas, wetlands, forest edges
Polygonum sachalinense	Riparian areas
Potamogeton crispus	Freshwater aquatic systems
Rubus armeniacus	Riparian areas, marshes, oak woodlands
Schinus molle	Riparian areas; limited distribution
Senecio jacobaea	Grasslands, riparian
Tanacetum vulgare	Riparian areas, forest

Table C-1: Yosemite National Park Invasive Plant Watch List	
Invasive Plant Species	**Habitat**
Priority Group 3 – California Invasive Plant Council status of "High," "Moderate," or "Limited"; found more than 186 miles from the park boundary; found within the elevation range of the park; previously documented in California OR California Invasive Plant Council status of "Evaluated Not Listed"; found more than 186 miles from the park boundary; found within the elevation range of the park; and not previously documented in California	
Brachypodium sylvaticum	Forests in Santa Cruz mountains; spreading rapidly
Centaurea virgata	Scrub, grasslands, pinyon-juniper woodland
Chorispora tenella	Dry disturbed sites, winter annual crops (especially winter wheat), roadsides, waste places
Daucus carota	Disturbed sites, particularly roadsides
Erigeron karvinskianus	Shaded rock walls, moist disturbed habitats
Erodium botrys	Present in wildlands, but impacts are unknown
Erodium brachycarpum	Present in wildlands, but impacts are unknown
Euphorbia esula	Forests, woodlands, juniper forest
Geranium molle	Present in wildlands, but impacts are unknown
Geranium retrorsum	Present in wildlands, but impacts are unknown
Phytolacca americana	Riparian forest, riparian woodland
Salvia aethiopis	Sagebrush, juniper, bunchgrass; limited distribution
Schismus barbatus	Scrub, thorn woodland
Ulmus pumila	Waste places, roadsides, washes
Priority Group 4 – Previously documented in California and not found within the elevation range of the park	
Acacia melanoxylon	Coniferous forest, chaparral, woodland, riparian
Aegilops cylindrica	Disturbed sites, fields, and roadsides
Anagallis arvensis	Disturbed sites
Anthriscus caucalis	Disturbed sites
Apium graveolens	Wetlands, moist disturbed sites
Arenaria serpyllifolia	Disturbed, sandy, rocky soil
Arrhenatherum elatius	Meadows, fields, open ground, waste places, and roadsides
Asparagus asparagoides	Riparian woodlands
Asparagus officinalis	Fields, woods, fencerows, roadsides
Barbarea verna	Disturbed areas
Bellardia trixago	Grasslands
Bellis perennis	Present along trails, not known to spread into undisturbed areas
Briza minor	Swamp margins, seasonal wetlands and around vernal pools, open woodlands, sandhills, roadsides, and pastures
Bromus arenarius	Can invade many plant communities
Bromus catharticus	Disturbed areas
Bromus sterilis	Disturbed areas
Bromus trinii	Dry plains, rocky or wooded slopes
Capsella bursa-pastoris	Pastures, orchards, and disturbed areas
Carthamus tinctorius	Disturbed areas and roadsides

Table C-1: Yosemite National Park Invasive Plant Watch List	
Invasive Plant Species	**Habitat**
Catalpa bignonioides	Escaped cultivar found in wildlands; native to United States, but not to California
Cerastium fontanum ssp. vulgare	Disturbed areas, grassy slopes, damp woods, marshy ground
Cerastium glomeratum	Dry hillsides, grasslands, chaparral, disturbed areas
Chamaesyce maculata	Waste places, gardens
Chamomilla suaveolens	Disturbed sites, sandbars, riverbanks, footpaths, roadsides, grazed land
Cistus ladanifer	Uncommon in disturbed areas
Cnicus benedictus	Disturbed areas
Coronopus didymus	Disturbed areas, gardens, fields
Cortaderia selloana	Coastal dunes, coastal scrub, Monterey pine, riparian, grasslands, wetlands, serpentine soils
Crassula tillaea	Open, gravelly sites
Crupina vulgaris	Forest, woodland, and grasslands
Digitaria sanguinalis	Disturbed places, fields, roadsides
Dittrichia graveolens	Spreading rapidly in grasslands and riparian scrub
Ehrharta erecta	Scrub, grasslands, woodlands, and forests
Eichhornia crassipes	Aquatic systems in Sacramento-San Joaquin Delta
Elymus repens	Open areas with moderate to high nutrient levels such as agricultural fields, lightly grazed pastures, and waste places
Elytrigia elongata	Disturbed areas, slopes
Eragrostis cilianensis	Disturbed areas
Euphorbia oblongata	Meadows and woodlands
Euphorbia peplus	Waste places, gardens
Filago gallica	Common, weedy; bare or grassy places*
Foeniculum vulgare	Grasslands and scrub
Fraxinus uhdei	Riparian, escaped cultivar
Fumaria officinalis	Disturbed areas
Galium murale	Damp, mossy places, undergrowth on grassy hillsides
Galium parisiense	Warm, dry, generally rocky soil
Gastridium ventricosum	Open, generally dry, disturbed sites
Gnaphalium luteo-album	Fields, waste places
Gypsophila paniculata	Disturbed sites, especially on sandy soils and in open, grassy places
Herniaria hirsuta	Disturbed, sandy or clay soils
Hydrilla verticillata	Freshwater aquatic systems; the most important submerged aquatic invasive in southern states
Juglans regia	Persisting near abandoned habitations
Lamarckia aurea	Open ground, moist seeps, rocky hillsides, sandy soil
Lamium amplexicaule	Disturbed sites, cultivated or abandoned fields
Ligustrum lucidum	Riparian possible
Lolium temulentum	Open, disturbed sites

Table C-1: Yosemite National Park Invasive Plant Watch List	
Invasive Plant Species	**Habitat**
Malus sylvestris	Disturbed areas
Malva neglecta	Disturbed areas
Malva parviflora	Disturbed areas
Mollugo verticillata	Common. Moist, exposed, disturbed wetland margins, roadsides, fields
Morus alba	Disturbed areas, moist soil, stream banks
Myosotis latifolia	Coniferous forest, riparian
Ononis alopecuroides	Grasslands, oak woodland
Paspalum dilatatum	Moist places, ditches, roadsides
Pennisetum clandestinum	Present at low levels in numerous wildland habitats; also a turf weed
Petrorhagia dubia	Disturbed areas, woodland savanna
Phalaris minor	Disturbed areas
Phalaris paradoxa	Disturbed areas
Physalis philadelphica	Waste places, cultivated fields, roadsides
Plantago major	Disturbed areas
Poa annua	Abundant in disturbed moist ground, lawns, etc.
Poa palustris	Disturbed ground in moist forests or sagebrush scrub, meadows, along streams
Polycarpon tetraphyllum	Disturbed areas, roadsides, shaded waste areas
Polygonum arenastrum	Common in disturbed areas
Polygonum argyrocoleon	Fields, disturbed places
Polypogon australis	Edges of streams, ditches
Polypogon interruptus	Common; stream banks, ditches
Polypogon maritimus	Riparian, moist areas
Polypogon viridis	Moist places, ditches, roadsides
Prunus cerasifera	Riparian habitats, chaparral, woodland
Ranunculus repens	Riparian areas and coniferous forest
Ranunculus parviflorus	Waste areas, wet fields
Ranunculus testiculatus	Waste areas, overgrazed pastures, scrub
Raphanus raphanistrum	Disturbed areas, fields, roadsides
Rosmarinus officinalis	Widespread, can invade wildland areas
Rumex conglomeratus	Common in moist areas
Rumex dentatus	Common in moist areas
Sapium sebiferum	Spreading rapidly in riparian areas along the American River
Schinus terebinthifolius	Riparian areas
Scleranthus annuus ssp. annuus	Meadows, stream margins, serpentine areas, disturbed areas
Senecio vulgaris	Abundant in gardens, farmlands, and other disturbed sites
Sesbania punicea	Riparian areas
Setaria pumila	Riparian areas
Setaria viridis	Waste places, fields, roadsides

Table C-1: Yosemite National Park Invasive Plant Watch List	
Invasive Plant Species	**Habitat**
Silene gallica	Fields, disturbed areas
Sisymbrium officinale	Disturbed areas, gardens, roadsides
Sisymbrium orientale	Disturbed areas, fields
Soliva sessilis	Disturbed areas, especially hard-packed paths, roadsides, and lawns
Sonchus oleraceus	Abundant weed in waste places, gardens, etc.
Sorghum bicolor	Disturbed areas, roadsides, fallow fields
Sorghum halepense	Disturbed areas, ditch banks, roadsides
Spergularia rubra	Open forests, gravelly glades, meadows, mud flats, disturbed areas
Stellaria media	Oak woodlands, meadows, disturbed areas
Tamarix chinensis	Canyons, riverbanks, roadsides
Torilis nodosa	Disturbed areas
Trifolium campestre	Disturbed areas, roadsides, lawns
Vicia sativa	Disturbed areas, fields
Vitis vinifera	Abandoned fields, roadsides

References

Drucker, B., & Bradshaw, G. L. (2007). "Early detection priority for watchlist species of Devil's Postpile National Monument and Sequoia, Kings Canyon and Yosemite National Parks." Unpublished report prepared for the National Park Service Inventory and Monitoring Program.

Appendix D: Best Management Practices to Prevent the Spread of Invasive Plants

Prevention can be the most efficient and cost-effective way to limit the effects of invasive plants. Prevention practices would be incorporated at the planning, implementation, and follow-up of park projects and routine maintenance operations. This prevention plan addresses three primary activities within the park: 1) projects and maintenance programs that require ground disturbance, 2) wilderness activities, and 3) fire management activities.

Ground-disturbing Projects and Maintenance Programs

- Incorporate weed prevention and control into project layout, design, evaluation, and redevelopment when activities that disturb ground or vegetation are a necessary component of a project or routine maintenance operations.
- Include assessments to 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.
- Conduct invasive plant surveys within the project site and access routes during the planning process. Develop treatment plans for existing invasive plant populations.
- A staging area standard operating procedure would 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. Identify staging areas that are free of invasive plants during the project planning stages, and use when possible.
- Take measures to minimize the extent of ground and vegetation disturbance during routine maintenance operations by limiting project boundaries to the minimum necessary to complete the project.
- Inspect park vehicles, machinery, and equipment; make sure they are clear of soil and debris before moving to another site in the park, especially those that have been used in areas contaminated by invasive plants.
- Inspect materials that are imported from outside the park, such as sand, gravel, and fill materials at the source, to ensure that they are free of invasive plants before transport and use. If sources of sand, gravel, and fill are contaminated with invasive plants, use alternative sources.
- Before entering the park, clean mud, dirt, and plant parts from heavy equipment and vehicles, including contractor equipment and equipment rented by the park. This includes equipment bound for park inholdings.
- Keep stockpiled, non-infested materials free of invasive plants by preventing weed seed contamination with physical barriers, and by frequently monitoring and quickly eradicating new invasive plant populations.
- When working in vegetation types with relatively closed canopies, retain shade to the extent possible to suppress weeds and prevent their establishment and growth.
- If hay or straw is needed for a project, certified weed-free hay or straw would be used.

Post Project

- Identify site-specific invasive plant monitoring in project plans.
- Retain and replace native topsoil, when feasible.
- Establish native vegetation where project disturbance creates bare ground to prevent conditions that favor invasive plants. Revegetation may include topsoil replacement, planting, seeding, and weed-free mulching. Encourage drought-tolerant local native plant use in landscaping to eliminate the need for overhead watering systems that encourage invasive plants
- Survey project sites for a minimum of three years post project to ensure that invasive plants are detected and controlled. Conduct follow-up treatments and surveys as needed.

Routine Maintenance by Park Operations

- Inspect park vehicles, machinery, and equipment; make sure they are clear of soil and debris before moving to another site in the park, especially those that have been used in areas contaminated by invasive plants.
- Minimize soil disturbance during routine maintenance activities (e.g., road grading, snow removal).
- Maintain landscaped areas to minimize the risk of invasive species spreading into natural areas. Mulching, weeding, and mowing lawns can be effective methods of reducing the risk of invasive plants from spreading away from administrative areas. Convert existing non-native plant landscapes to local natives. Use low-flow drip irrigation to discourage invasive plant establishment.
- Do not use plants that have been shown to be invasive, such as foxglove and greater periwinkle, in landscaping. Where these plants are currently used in landscaping, work with park and concessionaire facilities managers as well as park inholders to replace these species with native species.

Wilderness Activities

- Before entering wilderness areas, ensure that boots, socks, additional clothing, camping equipment, helicopters, and all items entering the wilderness are free of invasive plant seeds and other propagules.
- Develop a comprehensive weed-free plan for stock use in wilderness areas in Yosemite National Park.
- Conduct directed surveys in wilderness areas and eradicate small invasive plant populations in wilderness areas promptly.
- Regularly inspect trailheads and other wilderness staging areas, and remove invasive plants.
- Coordinate invasive plant prevention and early detection and eradication activities with adjacent land management agency staff.

Housing Administration

- Ensure that housing policies do not promote the introduction and spread of invasive species in the park.
- Do not plant non-native species that have the potential to invade adjacent natural areas.
- Survey government housing to determine whether existing invasive plants are present, whether intentionally planted for landscaping or accidentally introduced. If invasive species are present, work with tenants to eradicate invasive plant populations and replace with native species.
- Support education efforts to assist inholders with invasive plant eradication.

Fire Management Activities

Yosemite National Park boasts one of the most active fire management programs in the country. Fire managers in Yosemite use prescribed fire, wildland fire, fire suppression, and mechanical fuels treatments to meet management objectives and restore and maintain fire as a natural ecosystem process. Operations are conducted parkwide in both frontcountry and backcountry settings, and occur year-round, although they are concentrated in the summer and fall months. Yosemite Fire Management employs a maximum of 80 people at the height of the season, and has an impressive fleet of engines, patrol vehicles, and water tenders, as well as a committed helicopter, crew buggies, trucks, and all-terrain vehicles. Off-park resources are often ordered to assist with managing fires in the park, and it is common for NPS crews, crews from other federal agencies, and contractor crews to work on incidents within the park. During the 1996 Ackerson Fire, up to 3,379 people staffed the fire. Yosemite fires and firefighting equipment have the potential to be significant vectors for invasive plant introduction and spread.

General

- Strive to retain shaded fuel breaks in forested areas to discourage invasive plants.
- Monitor and control invasive plants in fuel breaks.

Firefighter Inspection

- **Boots:** Inspect boots at the beginning and end of each shift. Wear leather laces to decrease the likelihood of picking up weed seed.
- **Clothing:** Inspect Nomex® pants, shirts, and socks for weed seed.
- **Gear:** Inspect initial attack gear (especially water bottle pockets and exterior of pack) for weed seeds.
- Dispose of any found weed seed in plastic bags and deposit in trash receptacle.

Tool/Equipment Inspection

- Ensure that hand tools, chainsaws, chaps, saw kits, pumps, weed whackers, and so forth are free of weed seed before and after each shift.

Vehicle Inspection

- Frequently wash soil and debris from body, tires, and undercarriage of all vehicles used on fire operations.
- Wash in designated vehicle washing stations.

Vehicle Washing Stations

- Establish portable vehicle washing stations in the four districts of the park (Crane Flat, El Portal, Hodgdon, Wawona, and Yosemite Valley) to catch, contain, and dispose of weed seeds and/or propagules.
- Acquire a mobile washing station for large incidents.

Off-Park Crews

- Ensure that incoming crews either arrive with clean vehicles, personnel, tools, and equipment, or report to a vehicle washing station within the park prior to reporting for duty.
- Incoming crews will be briefed by the incident commander, burn boss, or resource advisor on tactics (e.g., cleaning and inspections) necessary to prevent the introduction and/or spread of invasive plant species.

Resource Advisor/Fire Ecologist

- Incorporate invasive species management into briefings, "after action" reviews, and fire line operations by encouraging pre and post shift inspections. Alert personnel if they are working in areas of invasive plants, and point out invasive species during briefings (carry photos of the "Top 10"species).
- Incorporate spatial data of invasive plant populations into resource advisor maps.
- Familiarize firefighters with local invasive plants. Encourage reporting of suspected invasive plant populations to invasive plant managers.
- Discuss Yosemite's invasive plant management program and introduce a system of inspections, cleaning, and detection.
- Encourage the reporting of previously undetected invasive plant species sighted on the fire line.

Incident Commander/Burn Boss/Holding Specialist/Ignition Specialist

- If possible, conduct line construction away from areas of known infestation, and limit the amount of travel/ground disturbance through affected areas.

Burned Area Emergency Response (BAER)/Burned Area Rehabilitation

BAER assessments are conducted immediately following wildland fire containment. The assessments should address the potential of non-native invasive plant invasion, especially in all areas of soil disturbance such as handlines, dozer lines, spike camps, etc. BAER plans are produced to address emergency stabilization treatments and should especially include weed invasion into critical habitat. BAER plans address non-native plant invasion for the longer term—up to three years following fire containment.

Appendix E: Pesticide Registration

Prior to commercial use, all pesticides sold in the United States must be registered with the U.S. Environmental Protection Agency (EPA) in compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA allows state governments to impose their own registration processes and requirements, providing that such requirements are equal to or more stringent than the EPA requirements (CDPR 2004; EPA 2007b). All herbicides proposed for use in the *2010 Update* are registered with both the EPA and the California Department of Pesticide Regulation (CDPR).

Pesticide information was gathered from a variety of sources. Several of the more comprehensive sources are described here. The U.S. EPA is responsible for regulating the sale and use of pesticides, including herbicides, in the United States and ensuring that all pesticides can be used without causing adverse effects on humans or the environment. All herbicides allowed for use in the United States are first evaluated by the U.S. EPA in generalized registration assessments. This information can be found at http://www.epa.gov/pesticides/PPISdata.

The U.S. EPA Effects Determinations for the California red-legged frog and other California Listed Species for glyphosate, imazapyr, and triclopyr can be found here: http://www.epa.gov/espp/litstatus/effects/redleg-frog/index.html.

The California Department of Pesticide Regulation regulates approval and use of pesticides, including those used or proposed for use in Yosemite National Park. State of California pesticide registration information can be found at: http://www.cdpr.ca.gov/docs/chemical/monster2.htm.

The U.S. Forest Service (USFS) has also compiled risk assessment documents and worksheets for a variety of the pesticides that they use. These assessments go beyond those done by the EPA because they also assess project-specific application rates, spectrum of target and non-target organisms, and specialized exposure scenarios. Assessments for the two herbicides currently allowed for use in the park, glyphosate and aminopyralid, and three of the four herbicides proposed for use in Alternative 2 of this plan, triclopyr, chlorsulfuron and imazapyr, can be found at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml. The USFS has not yet completed a risk assessment for rimsulfuron.

EPA and California Mandated Testing

To obtain EPA registration, the applicant proposing to register must provide to the EPA the results of testing, and certify that testing was conducted in full compliance with Good Laboratory Practice standards [40 CFR§160.135(a)]. The EPA has "harmonized" testing, that is, tests required by a variety of government agencies consolidated into a single unified series of requirements (EPA 2007a). Federal data requirements are found in 40 CFR Part 158.

Eight testing series are required for all synthetic chemical herbicides:

1) Product performance
2) Product properties
3) Fate, transport, and transformation
4) Spray drift
5) Ecological effects
6) Residue chemistry
7) Health effects
8) Occupational and residential exposure

Two additional series exist, but they are required only for biochemicals and microbial pesticides; glyphosate and aminopyralid do not fall into either class. However, all synthetic chemical pesticides must be tested for the first eight series on the list (EPA 2007a).

Each series contains multiple individual tests and/or data requirements, as listed in the tables at the EPA website (http://www.epa.gov/opptsfrs/home/guidelin.htm). For instance, the Ecological Effects Test Guidelines require 49 individual tests and requirements, all subject to Good Laboratory Practices, and all subject to specific EPA-mandated methods (EPA 2007a).

Data required by the EPA also meets state of California requirements, although the CDPR may require additional testing beyond what the EPA requires. Testing done exclusively for California, however, is not required to meet Good Laboratory Practice standards. Additional testing required by California is included in the California Code of Regulations (CCR) (6176-6193.5) and is quoted on the CDPR website (CDPR 2004).

EPA Review of Data and Registration Process

Prior to analyzing the data, both the EPA and the CDPR require the applicant to provide sample labels that meet EPA labeling requirements (CDPR 2004; EPA 2007b).

Once data is presented to the EPA, it is analyzed by a project manager, who coordinates peer review and communicates with the applicant (the company that developed the pesticide under review). The proposed product and data provided are reviewed based on three broad classes of criteria. The first criterion is public health (with special emphasis on children and others who are particularly sensitive to contaminants). The second criterion is the health of the workers who would be exposed. The third criterion is the effect on the environment (EPA 2007b).

The EPA then compiles a comprehensive health and risk assessment, which looks at health and environmental impacts and is open to scientific peer review. The comprehensive health and risk assessment is used to develop mitigation measures and risk management (EPA 2007b).

The EPA then determines whether the pesticide can be used at all, and, if so, what restrictions would apply (EPA 2007b).

If the EPA determines that the health and environmental impacts associated with the proposed pesticide are too great, it notifies the applicant of the basis for rejection. The EPA may recommend changes in labeling restrictions or other modifications that would allow the product to be registered, or request additional data or further studies (EPA 2007b).

If the EPA approves the product, it approves registration, subject to risk mitigation and labeling restrictions, and publishes that approval in the Federal Register (EPA 2007b).

California Review of Data and Registration Process

The State of California will accept an application for registration only after the product has been successfully registered with the EPA. California requires that all data submitted to the EPA also be submitted to the CDPR, and has additional requirements as well, depending on the specific pesticide (CDPR 2004).

Data requirements specific to California that might have been applied to different glyphosate formulations and/or aminopyralid include:

Safety related to exposure	Residue data
Mixer, loader, applicator exposure	Efficacy
Management of poisoning	Hazards to bees
Spray adjuvants	Effects on pest management
Foliar and field reentry	Inert ingredient hazard
Field reentry	Volatile organic compounds
Residue test method	Acute effects dietary hazard

California data requirements are found in CCR sections 6159 and 6170 through 6200 (CDPR 2004).

California also requires the applicant to submit proposed labels for the product; many pesticides develop labels specifically for California due to the state's stringent regulation requirements (CDPR 2004).

California DPR scientists review the data (which may or may not result in additional data requests) and submit recommendations to a registration specialist, who opens the submission to a 30-day public review, prior to approving or disapproving. If approved, the product is registered for use in California (CDPR 2004).

References

California Code of Regulations (CCR). (n.d.)Retrieved from http://ccr.oal.ca.gov/linkedslice/default.asp?SP=CCR-1000&Action=Welcome

California Department of Pesticide Regulation (CDPR). (2004). Pesticide Registration, Desk Manual. http://www.cdpr.ca.gov/docs/registration/manual/toc.htm

Code of Federal Regulations (CFR). Retrieved from http://www.gpoaccess.gov/cfr/index.html

U.S. Environmental Protection Agency (EPA). (2007a). Harmonized test guidelines. Retrieved from http://www.epa.gov/opptsfrs/home/guidelin.htm.

U.S. Environmental Protection Agency (EPA). (2007b). Pesticide registration program. Retrieved from http://www.epa.gov/pesticides/factsheets/registration.htm.

Appendix F: Herbicide Use and Storage Protocol

Herbicides would be handled only by those working under the supervision of staff trained and certified by the California Department of Pesticide Regulation. All herbicides used would conform to U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and state of California work safety standards and pesticide regulations, as well as internal NPS work safety and integrated pest management policies.

Weed control efforts would use targeted application methods and ensure that only specific targeted plants are affected, and would use the least amount of herbicide needed to achieve management objectives. Precautions would be taken to reduce or eliminate non-target impacts and reduce spills. Only herbicides appropriate for the targeted species would be used within Yosemite National Park, and they would be applied as prescribed by their label and as approved by the regional or national integrated pest management coordinator.

Application Equipment

- Herbicide application equipment would be kept in good working order and routinely evaluated for leaks, cracks, loose fittings, bad gaskets, signs of spillage, or any other indication of current or potential leakage. Filters would be embedded in the sprayer wand to keep debris out of the spray nozzle in order to ensure an even and predictable spray pattern.
- Spray equipment would be equipped with pressure limiting and check valves to reduce pressure at the wand tip and to prevent dripping. Specialized tips would be installed to aid in control of droplet size and to reduce potential for drift.
- Crews would routinely calibrate spray equipment to ensure proper application rates.
- Crews would attempt to schedule work such that spray equipment would be empty at the end of the workday; however, if that were not possible, the spray equipment would be tagged to indicate the contents, stored in a plastic containment tub, and secured in a locked pesticide holding facility.
- Prior to longer-term storage, empty containers would be triple-rinsed in accordance with California Department of Pesticide regulations. Wastewater would be retained in containers labeled "Pesticide Waste Water," and the rinsed containers would list the pesticides contained. Wastewater would be stored, labeled, and handled in the same manner as herbicides. This wastewater would either be reused to dilute additional herbicide for application, or disposed of semiannually as chemical waste by the park Safety Office. Once triple-rinsed, containers would be labeled "Triple-Rinsed Pesticide Containers."
- Backpack sprayers containing herbicide would be kept upright.
- During transport or storage, backpack content would be labeled and stored in an EPA-approved plastic containment tub.
- Dye would be added to the herbicide to enable workers to see where herbicide is applied. Dye fades after two to three weeks.
- Meteorological conditions would be taken into account before and during spray hours. Herbicide application would not take place when wind speeds are at greater than 10 miles per hour.

Herbicide Handling and Mixing

- Procedures for the handling of pesticides are provided on the pesticide labels. Federal law requires that label guidelines be followed at all times. Mixers would wear appropriate personal protective equipment (PPE) while mixing and loading. Such PPE includes, but is not limited to, face shields, chemical-resistant gloves, long pants, long-sleeved shirts, impervious aprons, and respirators.
- Mixing would not take place near surface water sources such as streams, rivers, lakes, and riparian areas.
- An air gap would be maintained between any fresh-water source and equipment to avoid back-siphoning into the clean water.
- Mixing would take place over a plastic containment tub.

Worker Safety

- Employees working with or near herbicides would wear OSHA-recommended PPE at all times, including, but not limited to, boots, long pants, long-sleeved shirts, eye protection, and chemical-resistant gloves. The park would provide additional PPE to those employees who wish to use them.
- The park would provide employees with dedicated facilities to wash the clothing they wear while working with or near herbicides or to use in the event of contamination. This is to prevent the employees from taking contaminated clothing home and possibly contaminating their residences, families, roommates, pets, or shared laundry facilities.
- Access routes to, from, and around all application areas would be surveyed prior to entering the area with the sprayer. The scouting would focus on finding the safest routes to reduce the chance of falling or stumbling.
- Herbicides would never be transported inside the cab or passenger compartment of a vehicle.
- At every application site, the park would provide workers with contamination safety kits that include soap, clean water for washing, absorbent towels, spare clothing, and eyewash.
- At every application, storage, or handling site, workers would have access to MSDSs, product specimen labels, and information regarding emergency medical response, including directions to the nearest emergency care facility.

Public Safety

- Areas in which pesticide application is taking place would be signed. Signage information would include the type of herbicide in use, the target species, the time of application, the scope of treated area, the reentry time, and contact information.
- To prevent ingestion of contaminated fruit, mature fruit-bearing blackberry would not be sprayed. Plants would be first mowed, burned, or cut. Subsequent vegetative resprouts would then be treated with herbicide.
- In the event of a spill near or into a body of water, that body of water would be closed to public swimming or boating for at least 24 hours, or until water quality tests determine that the water is safe.

- On Mariposa County and Mariposa Unified School District land assignments and leases, and other land assignments in Yosemite National Park, the NPS would work with agencies and partners to achieve integrated pest management goals. The NPS would work with residents, parents, and other interested parties to develop the most appropriate solutions for high-priority invasive plant control on playing fields or playgrounds on NPS lands and the El Portal Administrative Site. Invasive plant control efforts would not take place without prior notification of local residents.
- Herbicides would not be applied in the yards of residences or within 25 feet of residences without consultation with and prior notification of occupants.

Spill Response

- A spill response plan will be created. The Invasive Plant Management Program manager, the Park Safety Office, and Dispatch will have a copy of a spill response plan on hand.
- Should a spill occur, the U.S. EPS, Yosemite Dispatch, the Park Safety Office, and the head of the Invasive Plant Management Program will be called to help determine the appropriate response.
- Appropriate PPE will be worn.
- Consult product labels and MSDSs to determine response and safety protocols.
- Report spills as warranted by information provided on pesticide container labels and MSDSs.
- Wear appropriate PPE when handling a spill. Crews would be familiar with, maintain, and carry a spill response kit at all times.
- If an accidental spill were to occur, the spilled herbicide would be immediately contained appropriately and disposed of. If it could be done safely, additional spillage would be prevented.
- Crew members would maintain and have access to a spill response kit while applying herbicides. Spill response kits would include a shovel, empty containers, dedicated miscellaneous tools, hose and hose clamps, duct tape, booms and socks, plastic tarp, heavy plastic bags, absorbent material, and spare hardware (nuts, bolts, and screws).
- Identify any spilled product and consult product labels and MSDSs for safety protocols.
- If in a building or pickup bed, use absorbent material to soak up liquid.
- Flag the spill area to indicate parameters.
- As soon as spill is contained, notify the safety officer, who will determine whether the spill is minor (can be handled using readily available resources) or major (requiring the notification of appropriate authorities).
- If the spill is on the ground, use booms or socks, and then shovel and scrape earth to form dikes to contain the spill. Use plastic sheeting and absorbent material as needed.
- If the spilled liquid is not in contact with soil, collect it with absorbent material and put into heavy plastic bags or containers. Label, store, and dispose of the contents in the appropriate manner.
- If the spilled liquid is in contact with soil, collect it with absorbent material and contaminated soils, and place in heavy plastic bag or containers. Label, store, and dispose of the contents in the appropriate manner.

Waste Disposal

- In accordance with the directions included on the EPA specimen labels, empty pesticide containers would be triple-rinsed, punctured (to prevent reuse), and disposed of with regular garbage.
- Wastewater from triple rinsing could be used to dilute herbicide, but only if the triple-rinsed container contained herbicide and adjuvants compatible with the herbicide being diluted and the desired application methods and sites.
- Liquid waste (including rinse water) that could not be used to dilute herbicide would be labeled and stored with the herbicide in clearly marked and locked locations.
- This waste would be disposed of during the twice-annual parkwide toxic waste disposal (in compliance with all state, federal, and local regulations).

Labeling/MSDS and Right-to-Know Regulations

- A Material Safety Data Sheet (MSDS) would be posted in each chemical storage area and taken with all vehicles when used.
- The restrictions printed on pesticide labels are legally binding federal regulations. Yosemite National Park would follow pesticide label restrictions, as well as all other laws and regulations that apply to pesticide handling, including purchase, storage, transportation, application, and reporting.
- OSHA Right-to-Know laws would also apply; all workers have the right to access MSDS for any toxic chemicals found in the work place. Yosemite National Park would follow all Right-to-Know regulations at all times.
- Pesticide labels are regulated by the EPA; each commercially sold pesticide formulation has a registered EPA number. These labels describe what can and cannot be done with a particular herbicide, including whether or not it can be used in aquatic situations, and restrictions on how much may be used per acre over a given period.
- Pesticide labels also contain information regarding public and worker safety, first aid, physical and chemical hazards, and many other safety-related subjects, as well as environmental fate and other natural resource-related subjects.
- The park would never conduct any activity specifically prohibited on the label of the pesticide in use at the time, such as exceeding maximum use rates or reentry intervals.

Reporting

- All herbicide use would be recorded and filed with the County Agricultural Commissioner and the NPS integrated pest management reporting system.
- Herbicide spills greater than 1 ounce undiluted aminopyralid or 1 gallon diluted aminopyralid, or 32 ounces undiluted aquatic glyphosate or 1 gallon diluted aquatic glyphosate, would immediately be reported to the park safety officer and the county agricultural commissioner.

Appendix G: Herbicide and Surfactant Information Sheets

Since 2008, resource managers have learned much about treatment efficacy and control of invasive plants regarding the use of herbicides in conjunction with physical and mechanical techniques. After consultation with resource managers from various parks and other agencies, as well as expert toxicologists, the park is now considering using triclopyr, imazapyr, rimsulfuron, and chlorsulfuron under Alternatives 2 and 3 in this EA. Such applications include: more effective treatment of woody species, such as Himalayan blackberry; pre-emergent applications after large disturbance (e.g. fire) to control spread of cheatgrass (*Bromus tectorum*); control of mustard family (*Brassicaceae*), which the park would not be able to do with the current toolbox; and effective treatment of tree-of-heaven (*Alianthus altissima*) and giant reed (*Arundo donax*).

The processes for pesticide registration are very thorough, and are described separately in Appendix E. The California Department of Pesticide Registration (CDPR) does not start its registration process until after an herbicide has been given federal registration by the EPA. The state of California requires additional testing and has more stringent requirements than the federal government.

The U.S. Forest Service (USFS) conducted human health and ecological risk assessments in order to better inform land managers and the public about possible risks of particular herbicides. The risk assessments were calculated using "worst case scenarios": the maximum application of herbicide active ingredient allowed according to the individual herbicide label per year, as well as maximum potential acute exposure rates and the lowest known thresholds for species effects. Because spot applications of herbicides are used in Yosemite National Park, human and wildlife exposure rates can reasonably be expected to be far lower than those used in the USFS risk assessments. These assessments are available for aminopyralid, glyphosate, chlorsulfuron, imazapyr, and triclopyr, but not for rimsulfuron. While many other sources were cited in the herbicide and surfactant information sheets presented in this appendix, the USFS risk assessments were the primary documents used in assessing whether a specific chemical is safe enough to be considered for use in Yosemite National Park. Four additional risk assessments were reviewed for rimsulfuron (see the Rimsulfuron Herbicide Information Fact Sheet below).

These assessments were particularly applicable to assessing herbicides for potential use in Yosemite National Park because USFS and NPS management goals and concerns are similar in many areas. The purpose of these assessments is to "quantitatively evaluate the probability (i.e. risk) that a pesticide use might pose harm to humans or other species in the environment." The USFS incorporates this information into their environmental assessment documents prepared for pesticide projects, and uses them to guide decision making and to disclose to the public potential environmental effects. These risk assessments are necessary because reliance on the EPA's pesticide registration process was found in several cases brought before the U.S. Court of Appeals for the 9th Circuit to be insufficient as a sole demonstration of pesticide safety (principally *Save Our Ecosystems v. Clark,* 747 F.2d 1240, 1248 (9th Circuit, 1984) and *Southern Oregon Citizens v. Clark,* 720 F. 2d 1475, 1480 (9th Cir. 1983)). The USFS assessments consider data collected from published scientific literature and data submitted to the EPA to support the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) product registration, whereas the EPA utilizes the latter data only. These court decisions and others affirmed that although the USFS can use EPA toxicology data, it is still required to do an independent assessment of the safety of pesticides rather than relying on FIFRA registration alone.

The U.S. EPA Registration Eligibility Decision Factsheets and Risk Assessments can be accessed at: http://www.epa.gov/opprd001/factsheets/

The California Department of Pesticide Registration Database can be accessed at: http://www.cdpr.ca.gov/dprdatabase.htm

The U.S. Forest Service Human Health and Ecological Risk Assessment for Aminopyralid can be accessed at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

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-) proposed under Alternatives 2 and 3 (but not Alternative 1) in the *Invasive Plant Management Plan.* This information sheet is intended to be a starting point in pursuing more in-depth information on aminopyralid.

Aminopyralid would be used on yellow star-thistle, Italian thistle, spotted knapweed, and ox-eye daisy when conditions are appropriate. Additional species not yet occurring in the park would be considered for treatment if they arrive in the park, including Canada thistle and various species of knapweed/star thistle (*Centauria* spp.). Aminopyralid would be applied by one of the following methods: via foliar spray using backpack sprayers; wiped on using a wick, sponge, paintbrush, or similar tool; cut stump application immediately after cutting the plant; or frill by application immediately after small cuts are made into the cambium. Aminopyralid is the active ingredient in Milestone®, manufactured by Dow AgroSciences. Milestone® is a terrestrial-use herbicide, intended for use up to the water line and during the dry phase of seasonally flooded wetlands (Dow 2005c). Aminopyralid (currently available only in the form of Milestone®) would be applied at no more than the equivalent of seven ounces per acre per year.

Overview

Aminopyralid is of the chemical class pyridine carboxylic acid. This class of chemicals also includes the herbicides clopyralid, picloram, and triclopyr. The formulations of aminopyralid found in Milestone® contain triisopropanolammonium salt of aminopyralid. Neither Milestone® nor Milestone VM® contains inert ingredients other than water and triisopropanolamine (SERA 2007).

Aminopyralid was approved for use in California in October 2006. It is a relatively new herbicide, specifically designed for non-crop or wildland areas for noxious and invasive weed species control. As is the case with all new herbicides, little published research exists on aminopyralid when compared with other herbicides that have been used for many years. Dow AgroSciences has produced toxicity studies to support registration by the EPA, as well as by the California Department of Pesticide Registration. The processes for pesticide registration are very thorough, and are described separately in Appendix E.

Mode of Action

Milestone® is a semi-selective broad-spectrum herbicide. At sufficient concentrations, it kills most vegetation with which it comes into contact. Members of the sunflower/composite (*Asteraceae*), pea/legume (*Fabaceae*), and nightshade (*Solonaceae*) families are more strongly affected by the chemical than most other types of plants. Grass (*Poaceae*) species are less affected than most other types of plants. By using lower concentrations, the herbicide can be used in a selective fashion (EPA 2005a). 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% Milestone® to 99.9975% water, although the solution can be diluted as much as 0.00012% Milestone® to 99.99988% water (Dow 2005c).

Aminopyralid is an auxin-like growth regulator (Dow 2005c). 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 process disrupts or alters plant growth in ways that lead to mortality or decreased vigor (EPA 2005a; PMRA 2007; Wood 2006).

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 (EPA 2005a; PMRA 2007). Orally ingested aminopyralid passes through the digestive tract largely unmetabolized and unchanged. When orally ingested, 96% of aminopyralid is excreted unchanged through urine and feces (PMRA 2007). A mechanism for toxicity to mammals has not been well established (SERA 2007).

According to the "U.S. Forest Service Human Health and Environmental Risk Assessment for Aminopyralid" (2007), the risk characterization for aminopyralid

> for both workers and members of the general public is reasonably simple and unambiguous: based on a generally conservative and protective set of assumptions regarding both the toxicity of aminopyralid and potential exposures to aminopyralid, there is no basis for suggesting that adverse effects are likely in either workers or members of the general public even at the maximum application rate that might be used in Forest Service or NPS programs.

In animal testing, Milestone® is non-mutagenic, is not likely to produce cancer in humans, has a low acute oral toxicity, and is not thought to bioaccumulate. In oral ingestion studies, less than 0.73% of ingested aminopyralid was recovered in animal tissues (EPA 2005a). The No Observed Adverse Effect level was greater than 1,000 milligrams per kilogram (mg/kg) per day in mammals, with lethal dose 50% concentration greater than 5,000 mg/kg per day (PMRA 2007). Milestone® formulation is slightly irritating to the eye (Dow 2005c; EPA 2005a; PMRA 2007).

Environmental Fate and Toxicity

The physical and chemical properties of aminopyralid suggest the potential of the molecule to degrade slowly and be mobile in the environment. Studies suggest that aminopyralid weakly sorbs to soil and is primarily degraded by photolysis (EPA 2005b). After application, aminopyralid is likely to degrade primarily 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 (EPA 2005b). Half-life in this study ranges from 6 to 533.2 days (EPA 2005a). The longest half-life (533.2 days) assumes that all non-extractable residues were the parent chemical (PMRA 2007). 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 (EPA 2005a).

In a lab experiment, aminopyralid in clear water degraded by photolysis with a half-life of 0.6 day (EPA 2005a). Aminopyralid is considered stable in an anaerobic environment (EPA 2005a) and stable to hydrolysis (Dow 2005c). In aerobic sediment-water systems, half-life ranges from 462 to 990 days (EPA 2005a).

Aminopyralid appears to have low acute and chronic oral toxicity to mammals, birds, terrestrial invertebrates, and aquatic animals, including amphibians (SERA 2007). According to the "U.S. Forest Service Human and Environmental Risk Assessment on Aminopyralid" (2007), the level of concern was not approached and there were no significant effects on soil microorganisms, fish, amphibians, terrestrial or aquatic invertebrates, or large or small mammals. However, "the risk characterization for birds is similar to that of mammals in that no hazard quotients exceed the level of concern (1.0)." In water, aminopyralid was shown to be toxic to aquatic vascular plants and algae, and slightly toxic to some species of oysters, fathead minnow (*Pimphales promelas*), and midges (*Chiromus riparus*). It tested as virtually non-toxic to all other species of fish tested (both freshwater and marine), amphibians, marine invertebrates, and marine algae (EPA 2005a; PMRA 2007).

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; the research will likely become more thorough over time. Mobility and degradation in field conditions are a concern. Further research will help to verify the preliminary research and widen the scope of knowledge regarding aminopyralid. Routine monitoring of research literature as part of the *Invasive Plant Management Plan* will keep knowledge current.

Glyphosate Herbicide Information Sheet

This information sheet summarizes existing scientific knowledge pertaining to the use of glyphosate proposed in Alternatives 2 and 3 (but not Alternative 1) in the *2010 Update.* This information sheet is intended to be a starting point in pursuing more in-depth information on glyphosate. Glyphosate has been widely studied and its use monitored worldwide. It is one of the most thoroughly researched herbicides.

Under Alternatives 2 and 3, glyphosate would be used on Himalayan blackberry, tree-of-heaven, cut-leaf blackberry, yellow star-thistle, spotted knapweed, perennial pea, black locust, perennial pepperweed, and other species listed in tables II-4 and II-6, when populations meet the defined thresholds for population size and location. The park would use different formulations depending on the location and the application method used. Glyphosate would be applied at no more than the equivalent of 4 quarts per acre per year. The herbicide would be applied by one of the following methods: foliar spray using backpack sprayers; wiped on using a wick, sponge, paintbrush, or similar tool; cut stump application immediately after cutting the tree or shrub down; or frill by application immediately after small cuts are made into the cambium.

Overview

Glyphosate is a broad-spectrum, non-selective systemic herbicide used for control of annual and perennial plants including grasses, sedges, broadleaved weeds, and woody plants. It is widely applied worldwide to agricultural and non-agricultural areas (WHO 1994). It is an isopropylamine salt of N-(phosphonomethyl) glycine, which is the active ingredient of Rodeo®/Aquamaster® and Roundup® (Monsanto 2001; Monsanto 2005). Glyphosate was the seventh most commonly used conventional herbicide in U.S. agricultural crop production, and the second most commonly used homeowners application in 1995 (EPA 1997).

The patent for glyphosate has expired and it is now manufactured by at least seven different companies, and sold under multiple brand names and formulations. The most common glyphosate formulation is Roundup®, which is labeled only for terrestrial use.

In secondary literature and news reports, the words "glyphosate" and "Roundup®" are frequently presented as synonyms (Belmonte 2006). This is incorrect and can be misleading. Roundup® itself is only one brand name of many that include glyphosate as an ingredient. Glyphosate is the active and primary ingredient in Roundup®, but is not the only ingredient (SERA 2003a) (Richard, Moslemi, Sipahutar, et al. 2005).

A major qualitative difference between the effects of glyphosate and glyphosate formulations on aquatic and terrestrial organisms concerns the surfactant used. For example, the surfactant in Roundup® is much more toxic than glyphosate to aquatic organisms. Unlike glyphosate, the surfactant is more toxic in alkaline water than in acidic water. Thus, the relative potency of the surfactant with respect to glyphosate is pH dependent. Relatively little information exists regarding the toxicity of Roundup Pro® to aquatic species. Nonetheless, the acute lethal potencies of Roundup® and Roundup Pro® are similar. Rodeo® (Dow AgroSciences) and Aquamaster® (Monsanto) are two products that have been developed specifically for application directly into water. Surfactants are addressed specifically later in this appendix, and discussed specifically in terms of being applicable to multiple brand formulations.

Mode of Action

Glyphosate is effective on plant control primarily due to its the inhibition of the shikimate pathway, which is involved in the synthesis of aromatic amino acids in plants and microorganisms. Glyphosate mimics the plant hormone auxin, which selectively binds to receptor sites on the enzyme 5-enolpyruvlyshikimate-3-phosphate synthase, which would normally accept phosphoenol-pyruvate to allow conversion of one amino acid (shikimate) to another (chorismate). Blocking this step in the shikimate acid pathway stops production of secondary products (aromatic amino acids) and causes a buildup of shikimate (Baumann, Dotray, and Prostoko 1999; Shaner 2006; SERA 2003a).

Glyphosate typically circulates through the entire plant and blocks the shikimate pathway. The plant continues to photosynthesize, but with the pathway blocked, the plant dies. Although microorganisms have the shikimate pathway, research suggests glyphosate has no effect or slight enhancement to microorganisms in soil (SERA 2003a;Powell, Kerby, and Rowell 1991; Haney, Senseman, and Hons 2002; Busse, Ratcliff, and Shestak 2001). The shikimate metabolic pathway does not occur in humans and other animals (SERA 2003a).

Human Toxicity

Multiple peer-reviewed scientific studies are available to estimate glyphosate exposure routes and toxicity. Glyphosate is partially absorbed through oral exposure. About 30% of ingested glyphosate is absorbed (SERA 2003a). Acute oral toxicity studies are based on the lethal dose to 50% (LD50) of laboratory animals. The LD50 for glyphosate in mammals ranges from about 2,000 to 6,000 milligrams of glyphosate to kilograms of body weight. The estimated LD50 in humans is approximately 3,000 milligrams per kilogram (mg/kg) (Williams, Kroes, and Munro 2000). For comparison, the LD50 for caffeine is 127 mg/kg (Science Lab 2005a), and the LD50 for salt (sodium chloride) is 3,000 mg/kg (Science Lab 2005b). A study on deliberate ingestion by humans has shown fatal doses to be greater than 200 milliliters (Lee, Chen, Chi, et al. 2000)

Glyphosate is poorly absorbed through dermal application. In vitro studies show absorption of 1.4% of the dose (Wester, Quan, and Meibach 1996). In vivo studies in rhesus monkeys have shown that 2% of glyphosate is absorbed in 12 hours (Wester, Melendres, Sarason, et al. 1991). Low concentrations of glyphosate have been found in agriculture workers and their families after application. On the day of application, 60% of farmers and 4% of spouses were found to have low concentrations of glyphosate in their urine (Acquavella, Alexander, Mandel, et al. 2004).

Glyphosate has not shown signs of causing neurotoxicity and has the lowest risk of carcinogenicity (EPA 1993a). Chronic or subchronic exposure to glyphosate tends to cause loss of body weight, and has not been shown to bioaccumulate (SERA 2003a). According to the U.S. Forest Service's "Glyphosate Human Health and Ecological Risk Assessment Final Report" (2003a), "The risk characterizations for both workers and members of the general public are reasonably consistent and unambiguous. For both groups, there is very little indication of any potential risk at the typical application rate of 2 lbs 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 quickly and strongly bonds to soil and does not displace easily. Soil bacteria and microorganisms metabolize and break it down. Glyphosate readily adsorbs to soil, with the equilibrium constant for dissociation ranging from 500 to 2,600 (SERA 2003a). 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 not likely that glyphosate will reach groundwater or surface water from upland use because of the binding with soil. The affinity between soil and glyphosate also helps eliminate glyphosate from water. Glyphosate is largely partitioned 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 (Tatum 2004).

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 1-197 days (Tatum 2004). Both bound and unbound molecules are biodegraded. Glyphosate is biodegraded rapidly, even while strongly bound to the soil (Dubbin et al. 2000). 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 (Ratcliff, Busse, and Shestak 2006).

The primary breakdown product of glyphosate is aminomethylphosphonic acid; this product breaks down primarily into carbon dioxide, ammonium, and phosphate. Like glyphosate, aminomethylphosphonic acid binds well with soil and sediments (Newton, Horner, Cowell et al. 1994) and has low toxicity (Williams et al. 2000). The literature on the effects of aminomethylphosphonic acid is limited (Cox 2004), but it is currently considered of less toxicological concern (SERA 2003a).

According to the U.S. Forest Service's "Glyphosate Human Health and Ecological Risk Assessment" (2003), "The current risk assessment for glyphosate generally supports the conclusions reached by U.S. EPA. Based on the current data, it has been determined that effects to birds, mammals, fish and invertebrates are minimal." In another survey of environmental toxicity data, Tu, Hurd, Randall, et al. concluded that glyphosate has relatively low toxicity to birds and mammals and moderate toxicity to aquatic species (2001). In determining the toxicity to aquatic species, the ecological context and effects of particular formulations should be considered. Aquatic toxicity is considered further in the surfactant section of this fact sheet.

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) proposed under Alternatives 2 and 3 (but not Alternative 1) in the *Invasive Plant Management Plan.* Triclopyr is a selective herbicide manufactured by Dow AgroSciences and is 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 (Tu et al. 2001). The formulations are marketed as Garlon 3A®, Garlon 4®, and Pathfinder ll®, respectively (Dow 2006b; Dow 2007). This information sheet is intended to be a starting point in pursuing more in-depth information on triclopyr.

Triclopyr is being considered under Alternatives 2 and 3 of this plan because it is more effective than glyphosate and aminopyralid at treating woody plants, broadleaved weeds, and vines (Dow 2008). It would be used on Himalayan blackberry and tree-of-heaven when conditions are appropriate. Additional species not yet occurring in the park would be considered for treatment if they arrive in the park, including purple loosestrife. Triclopyr would be applied per label instructions using one of the following methods: foliar spray using backpack sprayers; wiped on using a wick, sponge, paintbrush, or similar tool; cut stump application immediately after cutting the plant; or frill by application immediately after small cuts are made into the cambium.

Garlon 4 is the ester formulation of triclopyr, usually applied as an oil-based mixture diluted with specialty vegetable or mineral oils. The mixture includes kerosene, 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 also sold under the brand names Access®, Turflon Ester®, Crossbow®, ET®, Pathfinder II®, Redeem®, and Remedy®. Triclopyr ester is heavily used for wildland weed control in the United States; it is very effective for treating woody dicots, and is the most common herbicide used to treat salt cedar (Tu et al. 2001).

Garlon 4 should not be applied in any situation where the herbicide can contact water or in areas where amphibians are present (Dow 2007; SERA 2003b). Garlon 3A is the salt formulation of triclopyr. It is applied as a water-based mixture, usually with added adjuvants. Garlon 3A is 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's coming into contact with water. Garlon 3A is marketed as Turflon amine® or Brush-B-gone®. Garlon 3A can cause severe eye damage due to its high pH (Tu et al. 2001). Workers should wear eye protection and use caution when applying Garlon 3A.

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 sold predominantly as soluble or emulsifiable concentrates, such as ready-to-use liquids, wettable powders, and pellets (EPA 1998). Dow AgroSciences has produced toxicity studies to support registration by the U.S. EPA, as well as by the California Department of Pesticide Registration.

Mode of Action

Triclopyr is a selective herbicide that mimics the effects of plant hormones. 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 moved throughout the plant causing phytotoxicity (Ganapathy 1997). The chemical acts as a synthetic auxin, giving the plant an auxin overdose 1000 times that of natural levels, thereby disrupting the hormonal balance and interfering with growth. 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.

No one 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, not enough residue is left in the soil to injure plants the next growing season (Ghassemi, Fargo, Painter, et al. 1981).

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 (EPA 2005a; PMRA 2007). Orally ingested triclopyr passes through the digestive tract largely unmetabolized and unchanged. When orally ingested, 80% of triclopyr is excreted unchanged through urine (Carmichael, Nolan, Perkins et al. 1989). According to the U.S. Forest Service's "Triclopyr - Human Health and Ecological Risk Assessment" (2003), "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 from seconds in water to less than a day in soil. Triclopyr is slightly toxic to fish, mammals, and birds, and ranges from slightly toxic to practically non-toxic to daphnia. Triclopyr is practically non-toxic to bees (USFS 1996). Acute toxicity levels (LD50) of triclopyr for mammals and ducks 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 (the ability to cause genetic damage), but was weakly positive in one test in rats. It is not likely to produce cancer in humans, has a slight oral toxicity, and is not thought to bioaccumulate.

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" (USFS 1996). 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 the herbicide has not been studied in terms of 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; neither do other sources of information on endocrine-disrupting effects (EC 2000).

Environmental Fate and Toxicity

The outcomes of studies on triclopyr movement in the forest vary 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 triethylamine salt (TEA) is highly soluble in water and dissociates within one minute to 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 sediment, triclopyr dissipation rates ranged from 2.8 to 5.8 days in field studies. Triclopyr is, however, persistent under anaerobic aquatic conditions. It is highly water soluble and is not expected to bind with organic materials (Antunes-Kenyon et al. 2004).

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 (Ganapathy 1997). 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 12-27 days. Studies have classified triclopyr as ranging from "mobile" to "slightly mobile," perhaps due to the fact that sorption to soil increases with time, thus decreasing its potential for leaching (Ganapathy 1997). 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 the 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 (USFS 1996). The breakdown products are also not mobile.

According to the U.S. Forest Service's "Triclopyr - Human Health and Ecological Risk Assessment" (2003), "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 applied directly 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 (Ganapathy, 1997).

A USFS report (1984) 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% of the ingested triclopyr is incorporated into the tissues of deer and rabbits. Studies calculated that 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.

TCP (3,5,6-Trichloro-2-pyridinol) is the major initial product of degradation. Reported half-lives for TCP range from 8-279 days in tests on 15 soil types. TMP (3,5,6 -trichloro-2-methoxypy ridine) is another degredate, although it is found less often and in smaller amounts. Reported half-lives for TMP range from 50-300 days in three soils. Carbon dioxide has been identified as one final degradation product; other degredate were not identified (USFS 1996).

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 that 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 (Ganapathy 1997). 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.

Pro: Very effective at treating woody shrubs, trees, and vines. It is harmless to monocots (grasses, sedge, and similar species). Triclopyr is more effective than glyphosate for blackberry, locust, tree-of-heaven, and other species.

Con: Garlon 4 is very toxic to aquatic organisms and cannot be used in or near water; it also has a strong smell (aesthetically unpleasant, which can be an issue in visitor use areas). Garlon 3A is less toxic to aquatics and has no smell, but can cause immediate eye damage and has a California Department of Pesticide Regulation rating of category 2, with a mandatory label of "DANGER." Additional staff training is required before this substance is used.

Basis for Reconsideration: Specific plants targeted for treatment in the *2008 Plan* are treated more effectively with triclopyr. More effective treatment would require fewer repeated visits, reducing disturbance to a particular site, reducing resource expense and decreasing the potential for reinfestations.

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) proposed under Alternatives 2 and 3 (but not Alternative 1) in the *Invasive Plant Management Plan.* Imazapyr is manufactured by BASF. It was first registered in 1999 and was reassessed in 2003.

Overview

Imazapyr is a non-selective herbicide that is used to control annual and perennial grasses, broadleaved herbs, woody, riparian, and emergent aquatic species. Its primary advantage is its ability to translocate throughout the entire plant before killing the plant, which increases its effectiveness, especially with turf grasses, vines, and other plants that cover large areas (Tu et al. 2001). It can be used where total vegetation control is desired or in spot applications. Imazapyr is relatively slow acting, does not readily break down in the plant, and is therefore particularly good at killing large woody species (Tu et al. 2001). In Yosemite, imazapyr would be most useful for treating giant reed (*Arundo donax*) and tree-of-heaven (*Ailanthus altissima*), both of which are limited almost exclusively to El Portal, and purple loosestrife (*Lythrum salicaria*) and some other species that do not yet occur in the park. Legumes and some vines in the rose family (including Himalayan blackberry) are not strongly affected by this herbicide (BASF 2004).

Imazapyr is the active ingredient in Arsenal®, Habitat®, Chopper®, and Stalker®. Imazapyr is formulated as a liquid, a wettable powder (in water soluble bags only), and a granular (EPA 2006). Habitat® contains a weak acid, most likely acetic acid, as an inert ingredient. The acid is present in such small quantities that risk is not considered significant (Pless 2005). Imazapyr would be applied according to the directions on the label. Imazapyr would be applied via foliar spray using backpack sprayers, cut stump application immediately after cutting the plant, or basal application

Imazapyr is part of the imidazolinone chemical class, which also includes the herbicides imazapic and imazethapyr. It is used for pre- and post-emergence control of a broad range of weeds (EPA 2006). Because it is a highly effective herbicide, non-target plants that are inadvertently sprayed directly are likely to be severely damaged. Long-term adverse effects on non-target vegetation are not expected due to imazapyr's rapid degradation and dissipation.

Mode of Action

Imazapyr controls plant growth by preventing the synthesis of branched-chain amino acids (Tu et al. 2001). 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). Plant death usually is slow (several weeks) 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 (Pless 2005).

Human Toxicity

According to the U.S. Forest Service's "Imazapyr Human Health and Ecological Risk Assessment" (2004), 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.

Only plants have ALS so imazapyr is of low toxicity to animals (including fish and insects), and there is no evidence of acute or chronic neurotoxicity resulting from exposure (Tu et al. 2001; EPA 2006). Imazapyr shows no mutagenic or teratogenic potential (Tu et al. 2001). The reported acute oral LD50 for imazapyr in rats is greater than 5,000 mg/kg body weight (Pless 2005). Based on the highest doses tested and the U.S. EPA ecotoxicity categories for oral exposure, imazapyr is considered moderately or less than moderately toxic to birds. According to the U.S. EPA ecotoxicity criteria, imazapyr is practically non-toxic to insects (Pless 2005). Imazapyr is not a carcinogen and has no known reproductive effects (CETOS n.d.). The amount of the product needed to produce an acute effect is relatively large (LD50= >5000 mg/kg). Contact is most likely to occur during the application process. Imazapyr can irritate eyes and cause rashes, redness, and swelling at the site of exposure. Studies with rats indicate that imazapyr is excreted rapidly in the urine and feces with no residues accumulating in the liver, kidney, muscle, fat, or blood (Tu et al. 2001).

Environmental Fate and Toxicity

Imazapyr is an anionic, organic acid that is persistent, non-volatile, and three times less mobile in soil than hexazinone and chlorsulfuron (personal communication, Joseph DiTomaso, non-crop weed specialist, University of California at Davis). After direct application, or indirect release into surface water, degradation of imazapyr through photolysis in an aqueous environment has a half-life of approximately 3-5 days (EPA 2006). In forestry dissipation studies, reported values for the half-life of imazapyr range from 14-44 days in forest litter, 19-34 days in forest soils, and 12-40 days on plants (Buchwalter, Jenkins, and Kirkvliet 1996).

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 (Tu et al. 2001). In forest dissipation studies, it did not run off into streams, and no evidence of lateral movement was observed (Sensemen 2007).

Studies have detected imazapyr in surface as well as groundwater. If released into water or if the chemical moves through soils and finds its way to water, imazapyr is not expected to adsorb to suspended solids and sediment based upon the adsorption coefficient (CETOS n.d.). Due to its high functionality, low application rates, and the lack of need for reapplication, potential impacts on surface or groundwater are minimal (Buchwalter et al. 1996)

The major identified metabolites were pyridine hydroxy-dicarboxylic acid, pyridine dicarboxylic acid, and nicotinic acid. Under laboratory aerobic aquatic conditions, metabolism half-lives for hydroxy-dicarboxylic acid and pyridine dicarboxylic acid were in the range of 3-8 days in two different sediment/water systems. Metabolites hydroxy-dicarboxylic acid and pyridine dicarboxylic acid are expected to be more polar, and thus more rapidly excreted, than imazapyr, and no more toxic than the parent compound. Additionally, pyridine hydroxy-dicarboxylic acid is considered to be less stable than the parent compound. Nicotinic acid is a possible neurotoxin at high dose levels, but there is no concern for low exposures. Nicotinic acid (also called niacin and referred to as vitamin B3) is considered an essential nutrient. Imazapyr is not expected to bioaccumulate in aquatic organisms because it exists as an anion at typical environmental pH levels (EPA 2006).

According to the U.S. Forest Service's "Imazapyr Human Health and Ecological Risk Assessment" (2004), 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 generalize to 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.

Pro: Practically non-toxic to mammals, birds, insects, fish, invertebrates, and non-vascular, aquatic plants. Highly effective herbicide that is very successful against tree-of-heaven and giant reed.

Con: Imazapyr is potentially irritating to the eyes and can cause rashes at the site of exposure. Mobility and degradation in field conditions are a concern. Further research will help to verify the preliminary research and widen the scope of knowledge regarding imazapyr. Routine monitoring of research literature as part of the *Invasive Plant Management Plan* will keep knowledge current.

Basis for Reconsideration: Imazapyr is a more effective tool than currently available herbicides for treatment of some invasive species. A more effective tool reduces need for reapplication and disturbing an area, and ultimately could reduce the amount of chemical used.

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 proposed under Alternatives 2 and 3 (but not Alternative 1) in the *Invasive Plant Management Plan.*

Rimsulfuron would be used to control non-native invasive, annual, and perennial broadleaved weeds and grasses, such as cheatgrass and 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. It is most effective when applied to actively growing weeds. Broadleaved weeds are controlled best up to the two-leaf stage.

Overview

Rimsulfuron is the active ingredient in Titus® and Matrix® manufactured by DuPont. Titus® is a terrestrial-use herbicide, not intended for aquatic use. Rimsulfuron is of the chemical class sulfonylurea. This class of chemicals also includes the herbicides chlorsulfuron, bensulfuron-methyl, and nicosulfuron. Rimsulfuron was approved for use in California in January of 1996. DuPont has produced toxicity studies to support registration by the U.S. EPA, as well as by the California Department of

Pesticide Registration. Rimsulfuron has very low toxicity to humans and other animals because the enzyme ALS is present in plants but not animals (Vischetti, Perucci, and Scarponi 1997). Due to its toxicological profile and recommended low use rate, the rimsulfuron label has reduced Worker Protection standards. The low use rates place a low chemical load on the environment (DuPont 2007).

Mode of Action

Rimsulfuron controls annual and perennial broadleaved weeds and grasses, such as fleabane, marestail/horseweed, dandelion, filaree, crabgrass, quackgrass, barnyardgrass and foxtail. The degree and duration of control may depend on the infestation intensity, weed size at application, pre-emergence or post-emergence application timing, soil type, organic matter content, and environment conditions at the time of and following application (DuPont 2007).

Rimsulfuron inhibits acetolactate synthase (ALS), a key plant enzyme. 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. 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

A U.S. Forest Service Human Health and Environmental Risk Assessment was not available for rimsulfuron. Four additional risk assessments were reviewed from the California Environmental Protection Agency Department of Pesticide Regulation, New York Department of Environmental Conservation, Health Canada, and the European Commission for Health and Consumer Protectorate-General.

The California Environmental Protection Agency Department of Pesticide Regulation found that

> at the maximum exposure rates allowed by the label, exposure levels for agricultural workers and people who ate tomatoes sprayed with rimsulfuron remained at safe levels. (1997)

The New York Department of Environmental Conservation Human Health Risk Assessment (2009) found that:

> Neither rimsulfuron nor the formulated product was very toxic in acute oral, dermal or inhalation exposure studies in laboratory animals. In addition, neither was a skin sensitizer nor very irritating to the skin and eyes nor skin. Rimsulfuron caused some toxicity in subchronic and chronic animal feeding studies, including liver, kidney, and testicular toxicity. However, this chemical did not cause any developmental toxicity in offspring when administered to pregnant rats and rabbits during organogenesis. In a multi-generation reproductive toxicity study, reproductive effects did not occur, but decreased body weight and body weight gain in the F1 generation was reported. Rimsulfuron did not cause oncogenic effects in rat or mouse chronic feeding studies and was negative in a number of genotoxicity studies.

Health Canada, in the "Re-evaluation Decision Document for Rimsulfuron," (2006) found that:

> Rimsulfuron is unlikely to affect human health when used according to label instructions, and that dietary risks from food and water are not a concern (2008). Exposure rates for workers and visitors to Yosemite National Park can reasonably be

> expected to be far lower, given that small amounts of herbicides are used in the park and spot applications of herbicides only to invasive plants.

A review conducted by The European Commission Health and Consumer Protection Directorate-General found that "the residues arising from the proposed uses, consequent on application consistent with good plant protection practice, have no harmful effects on human or animal health."

The European Commission for Health and Consumer Protectorate-General (2005) found that:

> the residues arising from the proposed uses, consequent on application consistent with good plant protection practice, have no harmful effects on human or animal health [and that] additional intake from water and products of animal origin are not expected to give rise to intake problems.

The metabolism of rimsulfuron in animals (rats, goats, and hens) is adequately understood and is similar among the species evaluated. Rimsulfuron was eliminated rapidly via urinary and fecal excretion in rats. Approximately 60%-70% of the administered dose to rats was excreted within 24 hours (DuPont 2007). Rimsulfuron is non-hazardous to animals, fish, honeybees, 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 (Schneiders, Koeppe, Naidu, et al. 1993).

Rimsulfuron is metabolized to several breakdown products. Toxicology studies indicate that the primary metabolite in plants is non-toxic to rats and is non-mutagenetic. The EPA has determined rimsulfuron is not likely to be a human carcinogen.

In animal testing, Titus® is non-mutagenic, not likely to produce cancer in humans, has a low acute oral toxicity, and is not thought to bioaccumulate. Lethal dose 50% concentration are >5,000 mg/kg for rats and >2,000 mg/kg for rabbits. Testing with rabbits found Titus® formulation is not a skin irritant and is moderately irritating to the eye, returning to normal by 72 hours (DuPont 2007).

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 (Vischetti et al. 1997). 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 (DuPont 2007).

The New York Department of Environmental Conservation Ecological Effect Risk Assessment (2009) found that:

> "The rimsulfuron mode of action is to inhibit acetolactate synthase (also known as acetohydroxyacid synthase, AHAS), a key enzyme in biosynthesis of certain amino acids in plants. As this enzyme occurs in plants, rimsulfuron has little toxic impact on mammals, birds, fish, or aquatic invertebrates. Non-target plants, including aquatic plants potentially exposed through runoff or spray drift, are highly susceptible to rimsulfuron toxicity."

In a 2008 re-evaluation decision document, Health Canada found that:

> rimsulfuron poses negligible risk to wild birds and mammals, bees and other arthropods as well as to aquatic organisms like fish, amphibians and invertebrates because concentrations in the environment are not expected to be harmful. Rimsulfuron's major transformation products pose a negligible risk to earthworms and terrestrial plants, as well as to aquatic organisms such as fish, aquatic invertebrates, amphibians and aquatic plants.

The European Commission for Health and Consumer Protectorate-General (2005) found that:

> the residues arising from the proposed uses, consequent on application consistent with good plant protection practice, have no harmful effects on human or animal health.

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 metabolite 1 (N-(4,6 dimethoxypyrimidin-2yl)-N(3-(ethylsulfonyl)-2-pyridinylurea)), which itself was transformed into the more stable metabolite 2 (N-))3-(ethylsulfonyl)-2-pyridinyl)4,6-dimethoxyy-2-pyrimidineamine)), with half-lives of 2 and 2.5 days, respectively. Hydrolysis was instantaneous under alkaline conditions (pH= 10)(Martins, Chevre, Spack, et al. 2001). Half-lives in water at 25°C ranged from 4.6 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 (Dupont 2007). Additional studies showed the half-life in soil of metabolite 1 ranged from 3.9 to 5 days, while metabolite 2 was more persistent and its degradation was strongly dependent on the initial concentration, with half-life values ranging from 8.1 to 55 days at 2-10 mg/l, respectively (Martins et al. 2001). The diversity of findings from various studies suggests the link between rimsulfuron persistence in soil and physical and chemical properties of the soil. They also point to the possibility of a large range of half-lives depending on climatic conditions.

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 into soil is 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. Downward movement of the remaining rimsulfuron and its soil degradates is negligible; thus, the potential for movement into the groundwater is minimal (DuPont 2007). One study indicated that rimsulfuron can interfere with the growth and activity of soil microbial biomass, the extent of which depends on the difference in herbicide persistence (Vischetti et al. 1997).

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." Routine monitoring of research literature as part of the *Invasive Plant Management Plan* will keep knowledge current.

> **Pro:** Degrades rapidly in water. Reduced Worker Protection standards due to its toxicological profile and recommended low use rate. The low use rates place less chemical load on the environment.

Con: Possibility of a large range of half-life depending on climatic conditions; may interfere with the growth and activity of soil microbial biomass.

Basis for Reconsideration: Can be used as a pre-emergent tool for cheatgrass following large disturbances, such as the Big Meadow fire of 2009.

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 proposed under Alternatives 2 and 3 (but not Alternative 1) in the *Invasive Plant Management Plan.* This information sheet is intended to be a starting point in pursuing more in-depth information on chlorsulfuron.

Overview

Chlorsulfuron was first registered in the California in 1983 by Du Pont (EPA 2005c) and was the first commercial herbicide from the sulfonylurea group (Halloway 1997). It is 100 times more active than traditional herbicides, so very low rates are used in the field. It is a selective and translocated herbicide that is absorbed through the leaves and roots. Its main uses are for the control of a large variety of grasses and broadleaved weeds as pre-emergence or post-emergence application on wheat (*Triticum* spp.), barley (*Hordeum* spp.), and oat (*Avena* spp.). It may be a valuable pre-emergent tool for control of invasive grasses, such as cheatgrass (*Bromus tectorum*). It has low toxicity to mammals, birds, and fish. Chlorsulfuron acts on the ALS enzyme in plants; which is not present in animals; that is the main reason for its low toxicity. Chlorsulfuron presents little hazard to the environment because it is used at low rates and degrades relatively quickly in most field situations (Halloway 1997).

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 broadleaved weeds (DuPont 2007). Chlorsulfuron would be applied by one foliar spray using backpack sprayers or truck mounted sprayers. Chlorsulfuron is the active ingredient in Telar®, Glean®, and Corsair® (Bautista et al. 2006). Chlorsulfuron would be applied according to the directions on the label.

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 (DuPont 2007). Climatic conditions influence the efficacy of Telar XP®: 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 Telar XP®.

Although there is no imminent need for chlorsulfuron, Yosemite does not currently have any appropriate tool to use on invasive mustards (*Brassicaceae*). This family can germinate in low light levels, has high seed production, and has the ability to germinate in soils without mycorrhizal bacteria, further facilitating rapid spread. These variables make this plant extremely difficult to eradicate. Only certain tools have eradicated invasive species in this family. A long-term adaptive plan requires tools necessary to treat species, including perennial pepperweed (*Lepidium latifolium*) and whitetop (*Lepidium appelianum*), that are not yet occurring in the park, but pose imminent threat of entering the park from surrounding lands.

Mode of Action

Most of the chlorsulfuron applied to leaves is absorbed and then translocated in the phloem. Small amounts move out of the leaf to other shoots, and even less to the roots. Absorption by roots from the

soil solution is not as efficient, but this 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 (DuPont 2007). Secondary effects on photosynthesis, respiration, and ethylene production produce the symptoms of yellowing and reddening of grasses and leaf drop in broadleaved weeds (Halloway 1997). Chlorsulfuron has little effect on germination, and weeds may emerge and grow for a week or two before dying. Chlorsulfuron does not affect the microbes 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 non-toxic to honeybees (EPA 2005c). 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 non-toxic to honeybees.

Orally ingested chlorsulfuron passes through the digestive tract largely unmetabolized and unchanged. Studies with rats show approximately 85% of undegraded chlorsulfuron was excreted in urine. Therefore, minimal metabolism occurred. Laying hens eliminated approximately 90% of the administered chlorsulfuron in the excreta (DuPont 2007).

Chlorsulfuron has low toxicity if individuals accidentally eat, touch, or inhale residues. The chemical 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 studies on rats and mice. Studies evaluating human exposure scenarios, including adults and children eating drift-contaminated garden vegetables or children directly touching drift-contaminated berries or vegetation, suggest that chlorsulfuron poses negligible risks. Multiple studies show that chlorsulfuron is not a mutagen (OSU and Interox 2006). According to the U.S. Forest Service's "Human Health and Environmental Risk Assessment" (2007), "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. It may be transported to non-target areas by runoff and/or spray drift. Degradation by hydrolysis appears to be the most significant mechanism for degradation of chlorsulfuron, but is significant only in acidic environments (23 day half-life at pH = 5); it is stable to hydrolysis at neutral to high pH (EPA 2005c).

Chlorsulfuron has moderate affinity for soil organic matter, but adsorption to clay is low (DuPont 2007). Degradation half-lives in soil environments range from 14 to 320 days (EPA 2005c). Soil microbes break down chlorsulfuron, and breakdown is faster in moist soils and at higher temperatures. However, the rate of hydrolysis is increased at 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. 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.

Photodegradation is believed to play a minor role in the overall degradation of chlorsulfuron under field conditions. Chemical hydrolysis is moderately rapid at pH 6, but extremely slow at pH 8. Microbial breakdown is relatively more important in alkaline soils where chemical hydrolysis is slower. Field half-lives average 37 days at pH < 7 and 49 days at pH > 7. Persistence is increased by cool temperatures and generally by higher pH. Potential soil mobility is generally greater at higher pH and lower organic matter content (DuPont 2007).

Chlorsulfuron has a high potential to contaminate groundwater, but due to its relatively rapid degradation in plants and soils, low use rates, and low toxicity, it is not likely to cause significant contamination (Halloway 1997). 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 U.S. Forest Service's "Human and Environmental Risk Assessment" (2004), "There is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects on 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."

Pro: Effective with low rates of use, controls broadleaved weeds, and can be used on the mustard family. It degrades relatively quickly in most field situations

Con: Mobile in the environment. Potential to contaminate groundwater

Basis for Reconsideration: Chlorsulfuron fills a role not currently addressed by anything else in the resource management toolbox. When mustards invade the park, there will be need for rapid assessment and eradication.

Surfactant Information Sheet

This information sheet is a summary of existing scientific knowledge pertaining to the surfactants used in conjunction with herbicides proposed under the action alternatives in the *Invasive Plant Management Plan Update.* This information sheet is intended to be a starting point in pursuing more in-depth information on surfactants.

A surfactant is an adjuvant to an herbicide, used to increase the amount of active ingredient in the herbicide that is delivered to the target plant, thus increasing the effectiveness of the herbicide and decreasing the amount of herbicide required. In choosing a specific surfactant, factors such as environmental conditions before and after application and leaf surface characteristics are considered. Surfactants are part of the "inert ingredients" in most herbicide formulations.

Many formulations of glyphosate exist, most of which contain added chemicals (surfactants and other adjuvants) to enhance uptake of the herbicide by target plants. Different formulations are applicable in various circumstances. Some formulations do not come mixed with a surfactant. This arrangement allows the use of different surfactants for different applications.

Surfactants are rated as either aquatic or terrestrial. Most are registered as terrestrial instead of aquatic, and are required to be used only in terrestrial environments (in part, because many surfactants are very toxic to aquatic organisms) (USFS 2003b). The surfactants used with glyphosate frequently pose more risk to humans and other organisms than the actual herbicide itself (Tatum 2004).

In aquatic situations, the park will use the least toxic effective surfactant on the market registered for aquatic use.

Mode of Action

Surfactants are amphiphilic (i.e., soluble) in both organic solvents and water. Surfactant molecules have a hydrophobic end that preferentially is found in an organic solvent, and a hydrophilic end that preferentially is found in water. Because the surfactant has both hydrophobic and hydrophilic ends, it tends to be found along the molecular interfaces between water and organics.

When surfactants are used, plants with leaves that are thick and waxy, hairy, or very narrow will absorb significantly more herbicide than they will without the use of a surfactant (Miller and Westra 2006). They work by decreasing the surface tension of herbicide droplets on plants, thereby creating greater surface contact with the leaf tissue. The surfactant also helps the herbicide stick to the plant or leaf surface.

Toxicity

Although the Federal Insecticide, Fungicide, and Rodenticide Act regulates pesticides, it does not regulate surfactants. As a result, surfactants are generally not as thoroughly tested for human health and safety effects as are pesticides. Information regarding the health effects of surfactants is generally less encompassing, and information can be less accessible, than similar information regarding herbicides.

Agridex. AGRI-DEX® is a non-ionic blend of special surfactants and a refined spray oil. It is designed for use with a broad range of products where an oil concentrate adjuvant is recommended. AGRI-DEX® is used with Aquamaster®, the aquatic formulation of glyphosate. AGRI-DEX® has an LD50 (rats) of over 2000 mg/kg, suggesting a relatively low toxicity. It has an acute dermal LD50 (rats) of over 2000 mg/kg and is practically non-irritating to the skin of rabbits (Bayercropscience 2008). However, repeated or prolonged exposure to this product may cause irritation to the skin, eyes, or respiratory tract. Adsorption to sediment and soil can be expected. This product is expected to be inherently biodegradable. Bioaccumulation is unlikely due to the low water solubility of the product.

Hasten. Hasten is an esterified vegetable oil-based spray adjuvant. It is designed to be tank mixed and used to increase the effectiveness of the herbicide in non-aquatic applications. Yosemite uses Hasten with Milestone® (active ingredient aminopyralid). Hasten has an LD50 (rats) of >5000 mg/kg, suggesting a very low toxicity. Hasten has an acute dermal LD50 (rabbits) of 2000 mg/kg and may cause slight skin irritation. The substance has been shown to be non-toxic, with no known chronic effects. No known pre-existing medical conditions will be aggravated by exposure to Hasten.

POEA. POEA is a non-ionic surfactant used to increase the effectiveness of herbicide. It has not been as rigorously researched as glyphosate. POEA, the surfactant used in Roundup®, has an LD50 of approximately 1-2 grams per kilogram, which is consistent with other surfactants (SERA 1997). While consistent with other surfactants, POEA is more toxic than R-11. POEA is not registered for aquatic use. It is significantly more toxic to aquatic organisms than glyphosate (Tsui and Chu 2003), and toxicity increases as the tallowamine chain length is reduced (Brausch and Smith 2007). This toxicity makes POEA unsuitable for application in wetlands because of the potential effects on sensitive aquatic organisms.

POEA binds with soil and sediment. The concentrations in water decrease rapidly in the presence of sediment (Wang, Besser, Buckler, et al. 2005). Because of this binding with soil, POEA has low mobility in soil, and thus will remain primarily at the application site.

Studies published in recent years on the effects of Roundup® on amphibians were not available prior to 1995 (Relyea 2006). Recent studies have shown differences on the toxicity of Roundup® to different amphibian species (Mann and Bidwell 2004; Edginton, Sheridan, Stephenson et al. 2004; Howe et al.

2004). Roundup® has been found to reduce amphibian diversity when applied to wetlands (Relyea 2005). This likely results from the direct application of POEA to water (Thompson et al. 2006). The toxicity of POEA becomes an important environmental concern in small wetlands that are difficult to avoid when aerial applications are used.

Herbicides Considered but Dismissed for Use in Yosemite

Clopyralid

Clopyralid (3,6-dichloro-2-pyridinecarboxylic acid) is a selective herbicide used for control of broadleaved weeds, especially thistles and clovers. Clopyralid is known to persist in dead plants and compost and has accumulated to phytotoxic levels in finished compost in a few highly publicized cases. Because clopyralid is soluble in water and does not readily absorb to soil particles, groundwater contamination is possible where soils are very permeable and shallow water tables are present. Clopyralid was considered for inclusion in this plan, but was dismissed.

Pro: Effective and selective for broadleaved plants, especially thistles and clovers.

Con: Potential for ecological health issues.

Basis for Rejection: Aminopyralid is similarly selective, with fewer negative risks, and causes fewer non-target impacts.

2,4-D

2,4-D [(2,4-dichlorophenoxy) acetic acid] herbicide selectively controls broadleaved vegetation without harming grasses, reeds, sedges, and other "monocot" plants. The U.S. Forest Service conducted a risk assessment of 2,4-D, and concluded that it is toxic to the immune system and developing immune system, and has potential to cause harm to the reproductive system. In most cases, careful planning and strict guidelines for application can prevent these problems from occurring. However, the fact remains that 2,4-D does have a potential to cause greater harm to human health than many of the newer herbicides, many of which offer vegetation control similar to that offered by 2,4-D (USFS 2006).

Pro: Effective and selective for broadleaved herbaceous plants; harmless to grass and woody plants.

Con: Category 2 herbicides require additional permitting and have the potential for human health issues.

Basis for Rejection: Aminopyralid will fill the same need, but is more selective, causes fewer non-target impacts, and has reduced potential for health impacts.

Appendix H: Measures Common to All Alternatives for Protecting Resources and Visitor Experience

The National Park Service will apply the following measures to actions proposed in the *Invasive Plant Management Plan to* protect valued resources and the quality of the visitor experience.

Natural Resources

- The park shall, as necessary or feasible, revegetate or reseed treatment areas with native species if areas require revegetation after invasive plant control activities. Revegetation may be needed in areas where non-native vegetation formed monocultures, which, once removed, would leave the area without native plants.
- If weed control efforts leave areas devoid of vegetation, the park shall implement erosion control methods as needed.
- Prior to leaving weed control areas, all crews shall inspect boots, clothing, and equipment, and shall remove any seeds, dirt, mud, or other debris that might contain invasive plant seeds or propagules.
- All equipment shall be kept clean and free of mud, dirt, vegetative debris, or other materials that could contribute to the spread of weeds in the park.
- Vehicles used in invasive plant control projects shall be kept clean and shall be staged where weed populations do not exist.
- The park shall properly dispose of viable seeds and plant materials to prevent the spread of noxious weeds.
- All vegetation crews shall be "Bear Aware" by using appropriate food handling and storage techniques.

Cultural Resources

- Prior to any ground-disturbing activity, the park shall consult with NPS archeologists who will review proposed treatments for the development of mitigation strategies to ensure that there will be no adverse impacts on cultural resources.
- The park shall not conduct ground-disturbing activities on identified archeological sites without a cultural resource monitor present or without prior approval from cultural resource specialists.
- During the planning phase of invasive plant control activities, managers would coordinate with locally affiliated tribes (through the American Indian liaison) to ensure that there would be no adverse impacts on traditional cultural properties.
- During the planning phase of invasive plant control activities, project managers shall consult with NPS cultural resource specialists, including a landscape architect and an archeologist, to ensure that there would be no adverse impacts on historic cultural landscapes.
- The park shall incorporate the protection of cultural resources in annual training programs for invasive plant work crews.

Air Quality

- The park shall use low-smoke two-cycle oil in all two-cycle equipment employed to control non-native plants.
- As equipment powered by two-cycle engines wears out and becomes irreparable, it shall be replaced with equivalent four-stroke equipment, if such equipment exists and has sufficient power-to-weight ratios to be practical in the field.

Noise and Visitor Experience

- Plant management crews shall not leave motorized equipment running when it is not in use.
- All work that generates noise levels above 76 decibels near residential or visitor use areas shall be performed between 8:00 a.m. and 5:00 p.m.

Special Status Species

- During the planning phase of invasive plant control activities, the NPS shall determine whether special status plant species are present in the area. If special status species occur in the proximity of invasive plant control activities, the park shall develop site-specific mitigations to ensure that there will be no adverse effects on special status plant species. If federally protected plant species are discovered in proposed work areas, the U.S. Fish and Wildlife Service would be consulted, and no control activities would take place until that consultation is complete. Currently, no federally listed plants are documented in the park.
- During the planning phase of invasive plant control activities, biologists shall determine whether invasive plant control measures would take place in likely habitat for special status wildlife. If invasive plant control work would take place in likely special status wildlife habitat, surveys would be conducted before any type of invasive plant control measures are performed. In the event that special status wildlife occupy areas planned for treatment with herbicides, chemical treatments would not be conducted, and managers would develop site-specific mitigations to ensure that there would be no adverse effects on special status wildlife.
- Program managers shall work with the wildlife biologist to schedule invasive plant activities when such activities are least likely to disturb special status species.

Water Quality

- Only aquatic-approved formulations of herbicides would be used in wetlands or riparian areas.

Wild and Scenic Rivers

- Work crews shall follow recommended application guidelines and precautions (application rates, seasonal/weather considerations), and employ monitoring and adaptive management to ensure water quality protection of Wild and Scenic rivers and other waterways.

Wilderness

- Additional Wilderness Minimum Tool Requirements Analyses would be conducted as appropriate if other tools or techniques not described in this EA are considered more appropriate for

controlling a particular invasive species. Consideration would be given to the tool or technique which also preserves and protects wilderness character and resources.

- Work crews shall follow "Leave No Trace" camping and work protocols.
- Crews shall be limited to legal group size limits (15 in trailed areas, 8 in off-trail areas).
- Crews shall minimize the need for pack-stock support.
- Work crews shall follow the "Herbicide Use and Storage Protocol" in the *Invasive Plant Management Plan Update.*

Employee and Public Safety

- The *Invasive Plant Management Program Annual Work Plan* is posted online. This plan shows areas slated for physical, chemical, and other treatment.
- The NPS shall work with residents, parents, and other interested parties to develop the most appropriate solutions for priority invasive plant control on playing fields or playgrounds on NPS lands and the El Portal Administrative Site. Invasive plant control efforts shall not take place without prior notification of local residents.
- On Mariposa County and Mariposa Unified School District land assignments and leases, and other land assignments in Yosemite National Park, the NPS shall work with agencies and partners to achieve integrated pest management goals.
- In the case of non-native blackberry, to reduce the risk that wildlife or humans would ingest sprayed berries, appropriate mitigations may include posting signage, spraying before berries are edible or later in season when berries have passed, or clipping berries off plant prior to application.
- The NPS shall provide all necessary personal protective equipment (PPE) to park employees, interns, and volunteers. Depending on the task, this equipment includes (but is not limited to) hard hats, gloves, eye protection, snake gaiters, Kevlar chaps, hearing protection, mesh face shields, rubber boots, and reflective vests.
- Prior to project implementation and continuing throughout, all employees shall receive safety training, including (but not limited to) training in regard to dangerous plants and animals, heat-related health issues, fall protection, hazmat protection (for gas and oil associated with power tools), working around heavy equipment, traffic safety, defensive driving, and first-aid/CPR.
- Prior to project implementation, the park shall develop an Oil and Hazardous Materials Spill Prevention, Control, and Countermeasure Plan to address hazardous materials storage, spill prevention, and response. During project implementation, the park shall comply with all requirements of the Oil and Hazardous Materials Spill Prevention, Control, and Countermeasure Plan.
- Crews shall be familiar with, maintain, and carry spill response kits.
- Crews shall maintain and carry first-aid supplies for hazmat exposure accidents.
- With the exception of fuel used for cooking or lighting fires while camping, crews shall not store hazardous or flammable chemicals in the field overnight. All overnight storage shall occur in appropriate, locked facilities.
- Crews shall carry spill response materials, including absorbent pads and other materials to contain hazardous material spills, into the field.
- Crews shall inspect all equipment for leaks on a daily basis.
- Crews shall use absorbent pads when refueling equipment (including hand-held equipment), and shall not refuel equipment in wetland areas or in the River Protection Overlay. Fuel containers

brought into the field shall be stored on absorbent pads, on level ground, and away from working power equipment.

- The park Safety Office shall be notified in the event of a hazardous materials spill. All spills shall be documented and managed in accordance with EPA specifications.
- When working on road shoulders, workers shall wear appropriate PPE (e.g., reflective vests or jackets), and shall use appropriate signage or traffic control to ensure the safety of workers and visitors.
- When working in construction areas, workers shall wear appropriate PPE (e.g., hard hats, eye and hearing protection) and shall obey site control rules (sign in and out, etc.) as defined by the entity (NPS or contractor) that controls the construction site.
- Weed control workers (including park workers, as well as interns, volunteers, and contract labor) shall correctly wear all PPE that is appropriate to the job.
- Volunteers shall not operate power tools or motorized equipment.
- Storage of chemicals shall be conducted according to federal and state regulations.
- Pesticide labels and their Material Data Safety Sheets (MSDS) shall be carried into the field for all applications and should be located next to the storage cabinet and with Dispatch.
- An eye washing station should be located near the area where pesticides are mixed or transferred to other containers. A portable eye washing station should be maintained with the support vehicle in field operations.

Mitigations Measures Relating to Herbicide Use (Alternatives 2 and 3)

- The "Herbicide Use and Storage Protocol" for the *Invasive Plant Management Plan Update* (see Appendix F) shall be followed.
- The park shall develop an herbicide use, storage, and safety plan to ensure the safety of workers and visitors, as well as to prevent soil and/or water contamination. The plan shall include timing, locations, herbicide trade names, EPA registration numbers, authorized uses, chemical composition, formulation, original and applied concentration, application rates of active ingredients, and equipment used for application. The plan shall also include information on herbicide transportation and storage, as well as herbicide safety.
- Invasive plant program managers shall develop annual work plans that identify timing and locations of planned herbicide use. Herbicide treatment shall not take place outside of identified locations. Information shall be made available to the public via the Yosemite National Park website and other print media, prior to herbicide application.
- Herbicide application methods, equipment, and rates shall be selected to minimize the potential for drift and off-target impacts while meeting invasive species objectives.
- All use of herbicides with an EPA registration number must be approved by the National Park Service Pesticide Use Proposal System and the designated Regional or WASO integrated pest management coordinator. Annual pesticide use logs shall be filled out in the NPS Pesticide Use Proposal system. In addition, the park will file annually with the state the necessary pesticide use reports.

Appendix I: Cumulative Projects

This appendix presents the past, present, and reasonably foreseeable projects in and around Yosemite that have been evaluated in conjunction with the impacts of alternatives to determine cumulative impacts. These projects were included in the cumulative effects analysis presented in Chapter III of this *Invasive Plant Management Plan Update*.

Reasonably Foreseeable Actions

- Comprehensive Transportation Plan
- Scenic Vista Management Plan
- Wawona Road Resurfacing
- Wawona Tunnel Safety Improvements
- Yosemite Motels Expansion
- Yosemite Village Interim Parking Improvements

Present Actions

Local

- Ahwahnee Historic Hotel Rehabilitation
- Badger Pass Ski Lodge Rehabilitation
- Hetch Hetchy Communication System Upgrade Project
- High Elevation Aquatic Management Plan
- Hodgdon Meadow Housing Area Trailer Replacement Project
- Indian Cultural Center
- New Merced Wild and Scenic River Comprehensive Management Plan
- Parkwide Communication Data Network
- Tioga Road Rehabilitation
- Tuolumne Wild and Scenic River Comprehensive Management Plan
- Utilities Master Plan/East Yosemite Valley Utilities Improvement Plan
- Yosemite Lodge Area Redevelopment
- Yosemite Museum Master Plan

Regional

- Mariposa, Madera, & Fresno Counties Sierra-San Joaquin Noxious Weed Alliance
- California Department of Transportation (Caltrans) Invasive Plant Control
- Mariposa County Invasive Plant Control
- U.S. Forest Service, Region V Noxious Weed Management Strategy
- Tuolumne County Invasive Plant Control

Past Actions

- Cascades Diversion Dam Removal
- Cook's Meadow Ecological Restoration
- Curry Village Employee Housing
- El Portal Road Improvement Project – Park Boundary to Cascades Diversion Dam
- El Portal Road Improvements Project – Narrows to Pohono Bridge
- Fire Management Plan
- Glacier Point Road Rehabilitation
- Happy Isles Fen Habitat Restoration Project
- Lower Yosemite Falls Project
- Merced River Ecological Restoration at Eagle Creek
- Rehabilitation of the Yosemite Valley Loop Road
- Tunnel View Overlook Rehabilitation
- Yosemite Valley Shuttle Bus Stop Improvements

Project Descriptions

Reasonably Foreseeable Actions

Agency Name: National Park Service
Project Name: Comprehensive Transportation Plan

Description: This plan will study modern transportation solutions for the park. Many past plans have studied transportation, both parkwide and in specific areas such as Yosemite Valley. However, many areas such as the Wawona and Tioga Road corridors have not been reexamined since the 1980 *General Management Plan.* Previous plans defined problems and solutions to deal with visitation and demographic projections that reflected trends characteristic of that time. Since then, the park has continued to update transportation and visitor information through a grant from the Federal Transit Administration. These new data indicate that many previous predictions and assumptions are not consistent with current conditions; thus, a fresh examination of transportation systems and solutions is warranted. Park planners, social and natural scientists, and transportation managers will work together to prepare a new plan. They will compile past plans and decisions regarding visitor experience, access, and resource conditions relevant to our transportation system, and will examine how the system is currently functioning. In addition, with public input, they will identify issues, develop alternatives, and present solutions in a comprehensive transportation management plan.

Agency Name: National Park Service
Project Name: Scenic Vista Management Plan

Description: The purpose of the Scenic Vista Programmatic Management Plan EA is to provide a systematic program for documenting, protecting, and reestablishing Yosemite's important viewpoints and vistas, consistent with the natural processes and human influences that created them. The plan recognizes that although many vistas in the park have been diminished by human interruption of natural or traditional cultural processes, many other vista points exist as a result of human intervention.

This plan would:

- reestablish and maintain important historic views;
- develop an objective process for selecting and ranking vistas for treatment;
- develop target conditions and identify appropriate vegetation management actions to reestablish scenic vistas; and
- reestablish scenic vistas, whenever practicable, by restoring natural species composition, structure, and function to systems, using traditional American Indian vegetation management practices, including hand pulling and fire.

Agency Name: National Park Service
Project Name: Wawona Road Resurface Treatment

Description: The purpose of the proposed project is to make the existing historic Wawona Road safe for visitors and employees as it is currently aligned, and where necessary, repairs shall be limited to replacement in kind for all features within the existing road prism. The project limits are from Yosemite Valley at Southside Drive to the southern park boundary near Wawona. The specific work includes patching of potholes, crack sealing, shoulder and curb repair, and placement of an overlay, microseal, or chip seal, depending upon the best design for the specific location.

Agency Name: National Park Service
Project Name: Wawona Tunnel Safety Improvements

Description: The purpose of this project is to improve safety within the tunnel. Work includes the design and installation of new fire extinguishers and call boxes within the tunnel, and the design and installation of approximately 2600-LF of new underground power line.

Agency Name: Mariposa County
Project Name: Yosemite Motels Expansion

Description: This project site is located along the north and south sides of Highway 140 at the existing Yosemite View Lodge development, within the El Portal Town Planning Area. Permitting has been requested to construct a 78-unit motel and a multi-purpose chapel/recreation building. Proposed access to the 78-unit motel and multi-purpose chapel/recreation building would be from the north side of Highway 140.

Agency Name: National Park Service
Project Name: Yosemite Village Interim Parking Improvements

Description: In keeping with the actions outlined in the Yosemite Valley Plan, an interim project is needed to improve the visitor experience and park operations at the Yosemite Village main day visitor parking area. The parking area is located south of Yosemite Village and east of Sentinel Bridge, between the Merced River and Northside Drive. This area has hosted a variety of uses over the past 100 years and historically has been referred to as Camp 6. The project may include some or all of the following components:

- Parking for day visitors, including recreational vehicles and disabled persons;
- The relocation of tour bus loading and unloading facilities;
- Roadway realignments to improve vehicular and pedestrian traffic circulation and safety;
- Pedestrian/bicycle paths to improve pedestrian/bicycle traffic circulation and safety;

- Valley shuttle bus service operations and facilities;
- Interpretation facilities, including way-finding signs; and
- Other visitor facilities, such as restrooms.

Present Actions

Local

Agency Name: National Park Service
Project Name: Ahwahnee Comprehensive Rehabilitation Plan

Description: The purpose of this project is to develop a comprehensive plan for phased, long-term rehabilitation of The Ahwahnee National Historic Landmark hotel and associated guest cottages, employee dormitory, and landscaped grounds in order to:

- Restore, preserve, and protect the historic integrity and character-defining features of The Ahwahnee by rehabilitating aged or altered historic finishes and contributing landscape features.
- Enhance visitor and employee safety by bringing the buildings and grounds into compliance with current building, fire, life-safety, and seismic standards.
- Improve hotel energy efficiency and operations by repairing or replacing outdated or inefficient building systems and components.
- Protect and enhance the visitor experience at The Ahwahnee through improved operational efficiency, increased accessibility, and rehabilitation of historic resources.

Agency Name: National Park Service
Project Name: Badger Pass Ski Lodge Rehabilitation

Description: The purpose of the rehabilitation project is to provide a phased program for rehabilitation of the Badger Pass Ski Lodge that will:

- maintain and protect the integrity of the Badger Pass Ski Lodge, a contributing element of the Badger Pass Ski Area historic site
- ensure visitor and employee safety
- maintain and protect natural resources
- maintain ski lodge operations and service functions
- protect the winter recreation visitor experience at Badger Pass Ski Area. The rehabilitation would protect areas of primary historical significance, while allowing flexibility to accommodate the
- needs associated with current and future ski area use in non-character-defining areas

Agency Name: National Park Service
Project Name: Curry Village and East Yosemite Valley Campgrounds Improvements

Description: A site plan is being developed for east Yosemite Valley to implement actions called for in the *Yosemite Valley Plan.* The project area generally extends south of the Merced River from the eastern boundary of Housekeeping Camp to Happy Isles, and encompasses the area along Tenaya Creek for proposed campsites. The site plan will ensure that all related actions proposed for the east Valley are implemented in a logical, feasible, and cost-effective manner. Most of the improvement actions will not

begin for several years; however, at this time, the site plan will detail how, and in what order, the projects in the east Valley should be implemented. Following are examples of the many actions identified in the *Yosemite Valley Plan* for east Yosemite Valley:

- reconfiguring campgrounds at Upper and Lower Pines
- adding campsites at the new South Camp and Tenaya Creek Campgrounds
- removing Curry Orchard and restoring the area to natural conditions
- constructing new visitor cabins-with-bath in Curry Village
- relocating the Curry Village ice rink
- providing new and reconfigured food service and concession facilities at Curry Village
- relocating the concessioner stable
- converting Southside Drive to two-way traffic
- constructing a fire station in the Curry Village area

A Finding of No Significant Impact for this project was issued in February 2004. Construction activity will commence following resolution of the "Merced River Comprehensive Management Plan" planning process.

Agency Name: National Park Service
Project Name: Environmental Education Campus Project

Description: Since 1972, Yosemite Institute has partnered with the NPS to fulfill a shared mission of providing environmental educational opportunities in Yosemite for youth from diverse backgrounds. Yosemite Institute's immersive environmental educational programs cover field science, arts, backpacking, and leadership, and are designed to complement California State Educational Content Standards. Yosemite Institute programs inspire a personal connection to the natural world and foster future generations of environmental stewards. Each year, Yosemite Institute's nonprofit programs serve over 13,000 students and generate over 480,000 hours of visitor activities.

Yosemite Institute is a nonprofit organization and currently operates its environmental education campus at Crane Flat under a cooperative agreement with the park. The campus facilities are composed of older buildings and structures that have been assembled over time and were not originally designed for educational purposes. These old buildings are deteriorating, in need of extensive repairs, and barely adequate in terms of modern design standards for teaching, residential accommodations, and accessibility. The NPS and the Yosemite Institute are planning to create a new campus with upgraded and improved sustainable facilities that will provide a better learning environment and serve a greater number and diversity of students. The campus will be designed as an example of environmental sustainability, according to Leadership in Energy and Environmental Design Green Building standards.

The goals of this project are to:

- provide an environmental education campus location and program that serves the combined missions of Yosemite National Park and the Yosemite Institute.
- facilitate multi-day educational programs that complement California State Standards and offer opportunities for research and study of the natural world.
- provide a campus facility that is sustainable in design and enables high quality, immersive, and safe educational experiences for students.
- promote development of future stewards of the environment and the national park system.
- An environmental impact statement is currently being prepared.

Agency Name: National Park Service
Project Name: Glacier Point Road Rehabilitation

Description: Rehabilitation of the Glacier Point roadway is proposed to repair and resurface existing roadway pavement and drainage facilities. Pavement rehabilitation likely will involve some sort of in-place recycling of the existing deteriorated pavement, followed by the placement of new asphalt paving. All drainage culverts will be examined for condition, capacity, and proper location. Culverts found to be in poor condition, undersized, and/or poorly located will be replaced in improved locations with properly sized pipes. As necessary, the drainage channels to, and downstream of, existing culverts will be examined for potential improvements. Existing stone masonry at culvert headwalls and outlets may be salvaged and reused. The proposed pavement rehabilitation work likely can be accomplished within the existing disturbed road corridor. However, culvert relocation or rehabilitation and the improvement of drainage channels to existing culverts may require disturbance of some new areas. An environmental assessment is currently being prepared.

Agency Name: National Park Service, U.S. Forest Service, City and County of San Francisco, San Francisco Public Utilities Commission, and Hetch Hetchy Water and Power
Project Name: Hetch Hetchy Communication System Upgrade Project

Description: This project will update the communications infrastructure by replacing or updating components of the Hetch Hetchy communications system from the Bay Area to Tuolumne County, including adding one new communications site within Yosemite National Park, near Poopenaut Pass. The current equipment utilizes existing phone lines to transmit voice and data communications essential to the operation and security of Hetch Hetchy Water and Power's electric and water supply utilities and Hetch Hetchy dam. It is also used by Yosemite personnel for park communications in that area. The existing radio and fiber optic equipment is obsolete and is no longer supported by its manufacturers. The system upgrade will provide the framework necessary to support improved radio communications that are vital to park operational activities, such as law enforcement, search and rescue, and fire management, and to improve the capability to ensure dam security, visitor and staff safety, and protection of park resources. The project spans multiple jurisdictions; therefore, the NPS is currently working collaboratively with Hetch Hetchy Water and Power, the City and County of San Francisco, and the U.S. Forest Service to prepare an environmental assessment/initial study. The Finding of No Significant Impact for this project was signed in April 2008.

Agency Name: National Park Service
Project Name: High-Elevation Aquatic Resources Management Plan

Description: Yosemite National Park is preparing a High-Elevation Aquatic Resources Management Plan and environmental assessment (Aquatic Plan EA) to guide management actions by the NPS to protect Yosemite's diverse high-elevation aquatic ecosystems and to restore natural composition, structure, and function to systems that have been disturbed by past or ongoing human activities. The plan will include the lakes, ponds, wet meadows, and streams located above 6,000 feet in elevation, as well as the diverse plants and animals that inhabit these environments.

The Aquatic Plan EA will consider:

- Removal of non-native fish from selected areas of the park to restore natural biodiversity in critical basins. Chemical removal of non-native fish is not currently being considered in this plan.
- High-quality recreational fishing opportunities would continue to be available in diverse habitats throughout the park.

- Restoration of Sierra Nevada yellow-legged frogs, Yosemite toads, and other species to suitable locations within their historic range that are strategically important to survival of these species.
- The development of Best Management Practices for recreational and administrative activities within high-elevation aquatic ecosystems to ensure that park resources and values remain unimpaired.

Agency Name: National Park Service
Project Name: Hodgdon Meadow Housing Area Trailer Replacement Project

Description: This project will construct a duplex in the Hodgdon Meadow Housing Area and replace two obsolete trailers that were previously removed from the housing area. The new duplex, which will house up to eight park employees or two park employees and their families, will be located on a previously impacted site formerly occupied by one of the two trailers. This project is part of an agency-wide effort to replace trailers and other substandard housing with new cost-effective, energy-efficient structures. Upgrades to the well water disinfection system will accompany the duplex construction. The Finding of No Significant Impact for this project was signed in September 2007.

Agency Name: American Indian Council of Mariposa County, Inc. (Southern Sierra Miwuk Nation)
Project Name: Indian Cultural Center

Description: An Indian Cultural Center would be established by the American Indian Council of Mariposa County, Inc. (Southern Sierra Miwuk Nation) at the site of the last-occupied Indian village in Yosemite Valley (west of Camp 4). This center would provide a location for culturally associated Indian people to conduct traditional ceremonies, and to practice and teach techniques of traditional ways of life. While the center would be open to the public, access might be limited during special ceremonies. Some public interpretation would occur, but this cultural center would not replace the primary educational function of the current Indian Village of Ahwahnee at Yosemite Village.

Facilities at the Indian Cultural Center would consist of structures and landscape features typical of an Indian village from the mid- to late-19th century. One large, partly subterranean ceremonial roundhouse and a smaller sweatlodge would be constructed. Approximately 15 cedar bark *umachas* (conical houses) would be built near the roundhouse and sweatlodge. Plants important for food, basketry, and medicinal uses may be grown. Existing archeological features, such as mortar rocks, would remain in place and be incorporated into the village design. The last extant structure from the original village, a small cabin (the former Westley and Alice Wilson home), currently being used as an NPS office, would be moved back to the village and adaptively reused as the cultural center office. A new kitchen and restroom facility would be constructed. Utilities (water, sewer, propane, unimproved road access, and electrical service) would be provided. Screening would be established where necessary to visually separate the cultural center and Northside Drive, Yosemite Lodge, Camp 4, and Valley Loop Trail. The Valley Loop Trail could be relocated to a route south of the cultural center to minimize intrusions. Overnight parking for scheduled activities would be provided at the Indian Cultural Center or other administrative areas.

The environmental compliance for this project was completed in September 2003. The American Indian Council of Mariposa County, Inc. is presently preparing fundraising plans and activities to support this project.

Agency Name: National Park Service
Project Name: New Merced Wild and Scenic River Comprehensive Management Plan

Description: The NPS manages 81 miles of the Merced River, which includes the Main Stem and the South Fork that travels through Yosemite National Park and the El Portal Administrative Site. The Merced is a federally designated Wild and Scenic River protected by the provisions of the 1968 Wild and Scenic Rivers Act. Seventy-five percent of the Merced River in NPS jurisdiction is located in designated Wilderness; however, most visitors experience the Merced in Yosemite Valley. As a World Heritage Site, the Merced River in Yosemite Valley attracts millions of people each year from around the globe to gaze at the striking granite walls and thundering waterfalls. The focus of the agency's planning effort for the Merced River is on striking a balance between access and use of the river, and protection and enhancement of the "values" that made the river worthy of protection. These are known as Outstandingly Remarkable Values (ORV) according to the Wild and Scenic Rivers Act. To protect the ORV, a plan for the Merced River will be created to help guide future land managers in determining appropriate actions and uses along the river. Previous plans were developed for the Merced River in 2000 and again in 2005. However, the park was mandated by the U.S. District Court to complete a new plan, which is currently in process.

Agency Name: National Park Service
Project Name: Parkwide Communication Data Network

Description: Yosemite National Park proposes to upgrade the park's internal data communication system with modern technology to create a more reliable communication platform, which would greatly improve the safety and efficiency of park operations.

Agency Name: National Park Service
Project Name: Tuolumne Wild and Scenic River Comprehensive Management Plan

Description: The development of the "Tuolumne Wild and Scenic River Comprehensive Management Plan" will bring the park into compliance with the Wild and Scenic Rivers Act, and can be used to guide actions and evaluate the potential impacts of proposed improvement projects within the river corridor. In addition, the watershed on the Tuolumne Wild and Scenic River covers over 50% of Yosemite's backcountry areas and Wilderness. This plan would be a comprehensive tool for watershed planning and management of sensitive areas within the Tuolumne River watershed. In addition, this plan would include much-needed natural and cultural data that have not been previously compiled for the river corridor and its watershed. These data would be used to create effective and modern management tools, such as river protection overlays and much-needed compliance necessary for managing resources and visitor use in the entire Tuolumne Meadows area, as well as the Tuolumne River corridor. The plan would also be an important tool for examining many outstanding issues concerning the complicated management of the Hetch Hetchy Reservoir, including water quality management and watershed issues with the City of San Francisco.

The development of the "Tuolumne Wild and Scenic River Comprehensive Management Plan Environmental Impact Statement" is currently in process.

Agency Name: National Park Service
Project Name: Utilities Master Plan/East Yosemite Valley Utilities Improvement Plan

Description: The existing utility infrastructure serving Yosemite Valley was identified in the Yosemite Valley Plan as a potential problem due to its age, condition, inadequate capacity, inaccessibility to future facilities, and inappropriate location in environmentally sensitive areas.

The NPS completed a *Utilities Master Plan* for the east Yosemite Valley in 2003. This plan incorporated information on existing utility conditions and required repairs identified in the *Yosemite Valley Sanitary Sewer Capital Improvement Plan,* completed in 2002. The *Utilities Master Plan* assessed the current condition of utilities (water, wastewater, electric, and communications) in the Valley and the future Valley utility needs based on facilities proposed in the *Yosemite Valley Plan.* The *Utilities Master Plan was* developed to allow for efficient relocation and upgrading of utility systems to provide for utility needs while reducing long-term environmental impacts from utility repair and maintenance activities.

An environmental assessment for the *Utilities Master Plan* was completed in June 2003, and a Finding of No Significant Impact was signed in October 2003. Implementation of the utility improvements will occur in three phases over ten years. Construction of phase 1 of the improvements began in 2005. The remaining phases of this project will commence following resolution of the "Merced Wild and Scenic River Comprehensive Management Plan" planning process.

Agency Name: National Park Service
Project Name: Yosemite Lodge Area Redevelopment

Description: This project is tiered off the Yosemite Valley Plan. The project collectively known as the Yosemite Lodge Area Redevelopment includes four separate actions as described in the *General Management Plan* and the *Yosemite Valley Plan*: redevelopment of Yosemite Lodge, redesign of Camp 4, relocation of Northside Drive, and design of the Indian Cultural Center (this action is described further as a separate project). All actions occur in the Yosemite Lodge area of Yosemite Valley, and include the following:

- Yosemite Lodge will be changed from a motel-type establishment to one with more of a park lodge-type environment.
- Yosemite Lodge facilities in the river protection zone and the floodplain will be removed.
- Camp 4 will be redesigned to accommodate the expansion and improvements called for in the *Yosemite Valley Plan*.
- Northside Drive in the Yosemite Lodge and Camp 4 area will be relocated south of the lodge to reduce conflicts between vehicles and pedestrians, and to provide safer pedestrian access between the lodge and the Lower Yosemite Falls area.
- Through a cooperative agreement with the American Indian Council of Mariposa County, Inc., an Indian Cultural Center will be established at the site of the last historically occupied Indian village in Yosemite Valley (just west of Camp 4 and Yosemite Lodge). See the project description below.

An environmental assessment was prepared for this project in September 2003, and a Finding of No Significant Impact was issued in February 2004. Construction activity will commence following resolution of the "Merced Wild and Scenic River Comprehensive Management Plan" planning process.

Agency Name: National Park Service
Project Name: Yosemite Museum Master Plan

Description: The Yosemite Valley Museum Master Plan is a joint project of the NPS and the Yosemite Fund to provide locations and conceptual designs for facilities housing museum exhibits, storage, work spaces, a library, archives, and museum collections of Yosemite National Park. The master plan must also address the potential reintegration of Valley museum collections with collections at several locations outside of Yosemite Valley, including El Portal and Wawona. The environmental compliance process for the *Yosemite Museum Master Plan* is in process.

Regional

Agency Name: California Department of Transportation
Project Name: Invasive Plant Control

Description: The California Department of Transportation (Caltrans) controls invasive plants along rights-of-way in several areas adjacent to Yosemite National Park. Yellow star-thistle is controlled along Highway 120 in Tuolumne County outside the park using the herbicide Transline (clopyralid). Caltrans does not currently use herbicides along Highway 140 within the Merced River corridor. Additionally, Caltrans works with individual county agricultural commissioners to respond to reports of invasive plants within the Caltrans rights-of-way.

Agency Name: Mariposa County
Project Name: Invasive Plant Control

Description: Mariposa County actively controls several species of invasive plants in areas adjacent to the park. Mariposa County treats yellow star-thistle with a combination of mechanical, biological, and herbicide control techniques. Herbicides include Transline (clopyralid), Milestone® (aminopyralid), Roundup® (glyphosate), Rodeo® (glyphosate), and Accord (glyphosate). Yellow star-thistle control occurs in several locations throughout the county, and includes the Merced River Canyon up to the park boundary. Other priority species under county control are Iberian star-thistle and diffuse knapweed.

Agency Name: U.S. Forest Service, Inyo National Forest
Project Name: Invasive Plant Control

Description: Very few invasive plant populations are known to occur in areas adjacent to Yosemite National Park. Dandelion, cheatgrass, and bird's-foot trefoil (*Lotus corniculatus*) are treated physically in areas near the park. A single spotted knapweed was found in 2000 along Highway 120 east of the park boundary near the Tioga Pass Resort. The Inyo National Forest is currently in the process of developing an "Invasive Plant Management Plan and Environmental Assessment."

Agency Name: Tuolumne County
Project Name: Invasive Plant Prevention and Control

Description: Priority invasive plant populations in Tuolumne County include yellow star-thistle, Canada thistle, spotted knapweed, and diffuse knapweed. Isolated populations of knapweeds are currently pulled by hand. A population of spotted knapweed exists near Camp Mather. Small isolated populations of Canada thistle occur on Evergreen Road at the Diamond O campground and are treated with glyphosate in the form of Rodeo® and Aquamaster®. Tuolumne County is currently seeking funding to begin treatment of yellow star-thistle along Highway 120 outside of Yosemite National Park in cooperation with Caltrans.

Agency Name: Interagency
Project Name: Mariposa, Madera, & Fresno Counties Sierra-San Joaquin Noxious Weed Alliance

Description: Weed management areas are local organizations that bring together landowners and managers (private, city, county, state, and federal) in a county, multicounty, or other geographical area to coordinate efforts and expertise against common invasive weed species. The weed management area functions under the authority of a mutually developed memorandum of understanding, and is subject to statutory and regulatory weed control requirements. To date, groups in California have been initiated

by either the leadership of the county agricultural commissioner's office or a federal agency employee. Weed management areas are unique because they attempt to address agricultural (regulatory) weeds and "wildland" weeds under one local umbrella of organization. It is hoped that participation will extend from all agencies and private organizations. Weed management areas have printed weed identification/control brochures; organized weed education events; written and obtained grants; coordinated demonstration plots; and instituted joint eradication, mapping, outreach, and other effective weed management projects.

Past Actions

Agency Name: National Park Service
Project Name: Cascades Diversion Dam Removal

Description: The Cascades Diversion Dam was located on the main stem of the Merced River at the far west end of Yosemite Valley. The dam was a timber "crib" structure with associated concrete abutments. Removing the dam was part of the overall intent of the *Merced Wild and Scenic River Comprehensive Management Plan and Final Environmental Impact Statement* and the *Yosemite Valley Plan* to restore free-flowing conditions to the Merced Wild and Scenic River. In its deteriorated condition, the dam presented a significant public health and safety hazard due to the potential for uncontrolled collapse. Cascades Diversion Dam was located adjacent to El Portal Road. Removal of the structure and related facilities was completed in 2004.

Agency Name: National Park Service
Project Name: Cook's Meadow Ecological Restoration

Description: This project is restoring a dynamic and diverse wetland ecosystem. This project was completed at the end of 2005, and ongoing monitoring will continue. The Cook's Meadow restoration project involved the following actions:

- filling four drainage ditches created by early Euro-American settlers
- removing a raised, abandoned roadbed and a trail that bisected the meadow
- reconstructing the trail on an elevated boardwalk that now allows water to flow freely and reduces foot traffic on sensitive meadow plants
- installing culverts under Sentinel Road to direct runoff into the meadow and restore the natural flow of water from the Merced River during seasonal periods of high water
- reducing non-native plant species encroaching on native species by using physical, mechanical, and chemical control methods

Agency Name: National Park Service
Project Name: Curry Village Employee Housing

Description: This project includes the design and construction of new employee housing and related facilities to accommodate approximately 217 concessioner employees in the area west of Curry Village in Yosemite Valley. This housing will replace concessioner housing lost in the January 1997 flood. The employee housing units have been designed in accordance with the character of the area, with particular focus on the Curry Village Historic District. The scope of this housing project includes providing parking and access, an employee wellness center, concessioner housing, management offices, maintenance facilities, postal facilities, and housing-related storage. The compliance for this project was completed in 2004, and construction was completed in 2007.

Agency Name: National Park Service
Project Name: El Portal Road Improvement Project – Park Boundary to Cascades Diversion Dam

Description: This federal jurisdiction transportation project, which was located entirely within Yosemite National Park boundaries, involved road improvements to 6.5 miles of El Portal Road, from the Yosemite National Park boundary in El Portal to just east of the intersection with Big Oak Flat Road. The project improved access to Yosemite Valley and reduced safety concerns. El Portal Road is a primary route for visitors accessing Yosemite Valley and is the shortest all-weather route to the Valley. It also serves as the primary commuting route for park employees living in El Portal, Midpines, and Mariposa. The project was completed in 2000.

Agency Name: National Park Service
Project Name: El Portal Road Improvements Project - Narrows to Pohono Bridge

Description: Original designs for El Portal Road improvements called for the entire one-mile segment from just east of the Big Oak Flat Road intersection to Pohono Bridge to be completed as one project, referred to as "Segment D." Due to litigation, that project has been scaled back; at this time, the project will address only an unstable portion of road beginning at the Big Oak Flat Road intersection and extending east approximately 1,350 feet (the subject of this environmental assessment). Road improvements will eventually be necessary throughout the remainder of El Portal Road. This segment of road has two narrow travel lanes, each 9.5 feet wide. Road improvements would be designed to improve safety and minimize the chance of roadway failures in the future.

Agency Name: National Park Service
Project Name: Fire Management Plan/Environmental Impact Statement

Description: *The Yosemite National Park Fire Management Plan/Environmental Impact Statement* guides the implementation of a complex fire management program. The program includes wildland fire suppression, wildland fire used to achieve natural and cultural resource benefits, fire prevention, prescribed fire, fire ecology research, and the use of mechanical methods to reduce and thin vegetation in and around communities.

One goal of the program is to reduce the threat of wildland fire to public safety and to the park's wildland urban interface communities, as well as to its natural and cultural resources. Another goal is to return the influence of natural fire to park ecosystems so that they are restored to, and maintained in, as natural a condition as possible.

The *Fire Management Plan/Environmental Impact Statement* reduces risk to park wildland urban interface communities within 6 to 8 years of implementation, and restores park ecosystems within 15 to 20 years. Some of the work will involve mechanical methods to reduce the risk of unwanted wildland fire in and adjacent to wildland urban interface communities. The primary methods of reducing wildland fire risk and restoring park ecosystems will be prescribed. The Record of Decision for the *Yosemite National Park Fire Management Plan/Environmental Impact Statement* was signed in March 2004.

Agency Name: National Park Service
Project Name: Glacier Point Road Rehabilitation

Description: The Selected Alternative will improve driving conditions on the first 5.1 miles of the Glacier Point Road by reconstructing portions of the road, modifying unsafe sections, repaving the road, and improving minor developed areas and overlooks, such as the Chinquapin Intersection, the

Badger Pass Ski Area Parking Lot, and the El Portal Overlook. Systematic general improvements will include (where needed):

- changing the angle of the road
- modifying turnouts
- trimming vegetation
- constructing and maintaining paved/unpaved ditch
- adjusting the centerline
- modifying drainage
- removing rockfall hazards

Maintenance activities will also continue. There will be no obvious realignment or widening of the Glacier Point Road. Upon completion of the project, the road will continue to be a narrow, steep, winding road with natural vegetation close to the road.

Agency Name: National Park Service
Project Name: Happy Isles Fen Habitat Restoration Project

Description: The Happy Isles Fen is a two-acre wetland immediately west of the Happy Isles Nature Center in east Yosemite Valley. In 1928, the NPS filled in about three additional acres of the fen to create a parking lot. The asphalt parking lot was removed in 1970, although imported fill remained. The area impacted by parking lot construction was restored to wetland conditions by removing imported fill and associated upland vegetation, and revegetating with native wetland plants.

Agency Name: National Park Service
Project Name: Lower Yosemite Falls Project

Description: This project consists of improving and rehabilitating the physical infrastructure at the 56-acre Lower Yosemite Falls area. The project work includes rebuilding/rehabilitating trails; removing several trail segments; rebuilding/rehabilitating five pedestrian bridges; constructing one new pedestrian bridge; removing one pedestrian bridge; removing the existing parking area and revegetating it to natural conditions; constructing a new shuttle bus stop; replacing/relocating the restroom; creating new access points; fabricating and installing new directional signs; creating a meeting area for groups; restoring portions of forest and creekside habitat to natural conditions; installing amenities such as bike racks, picnic tables, public telephones, trash cans, and wayfinding signs; enlarging the viewing areas near the base of the fall; and providing educational exhibits. This improvement project will enhance a world-class visitor experience, create a loop trail system that is fully accessible to people with mobility impairments, reduce the perception of crowding and congestion at main views and along the trail, and improve the hydrology of the braided stream system by replacing the narrow bridges that impede the natural streamflow. To address removal of the tour bus loading/unloading and parking area from the Lower Yosemite Falls area, replacement loading/unloading and parking spaces will be provided for tour buses. Long-term tour bus loading and unloading would occur at the future new transit center in Yosemite Village. This project was completed in 2005.

Agency Name: National Park Service
Project Name: Merced River Ecological Restoration at Eagle Creek

Description: Eagle Creek flows into Yosemite Valley immediately west of the Three Brothers rock formations and joins the Merced River about 0.5 mile downstream from Yosemite Lodge. The creek banks of the reach of Eagle Creek between Northside Drive and the Merced River are badly eroded and only sparsely vegetated, partly due to trampling by pedestrians. The eroded riverbank was recontoured, and then revegetated; the trampled river terrace was decompacted; and fences were constructed to

direct visitors to sandbars for river access. This project was completed in 2003. The ecological restoration effort involved the following:

- Plug remaining portions of abandoned sewage lines with concrete, and remove the manhole and the concrete structure that crosses the creek bed.
- Restore the eroded creek channel using methods previously tested on the banks of the Merced River (restoration techniques require building up the bank with willow cuttings, woody debris, rock, and mulch).
- Revegetate the bank of Eagle Creek with native shrubs, cuttings, and seeds.
- Redirect visitors to access the river in a more appropriate location that will not cause bank impacts.

Agency Name: National Park Service
Project Name: Rehabilitation of the Yosemite Valley Loop Road

Description: The Yosemite Valley Loop Road, a historic feature in Yosemite National Park, was first built as a stagecoach road in 1872. The initial pavement was laid in 1909, and culverts were first installed a year later beneath stretches of Southside Drive. Spot repairs have been made along the roadway as required over time. However, much-needed comprehensive maintenance/repair of the roadway and associated drainage structures has not been performed for many decades. Since 1980, annual visitation to Yosemite National Park has averaged 3.4 million people, 95% of whom are focused in Yosemite Valley. Dramatic scenery, the Merced Wild and Scenic River, and diverse recreational opportunities draw visitors to the Valley year round, making it one of the most heavily developed areas of the park. As a result, the Yosemite Valley Loop Road experiences the heaviest traffic volumes of any area in Yosemite National Park. Automobiles make up the majority of the volume, but tour buses and public transportation vehicles also contribute to Yosemite Valley traffic. Bus transportation in Yosemite National Park includes regional public transportation, charter and tour bus operators, concessioner-operated tours, and shuttle bus services provided by the park concessioner. With the exception of shuttle bus services in Tuolumne Meadows and between the Mariposa Grove and Wawona, nearly all park buses travel to, from, and within Yosemite Valley.

The purpose of this project is to repair and resurface existing roadway pavement, rehabilitate or replace adjacent drainage features (e.g., culverts, diversion ditches, and headwalls), and improve the condition of adjacent roadside parking along approximately 12.5 miles of the Yosemite Valley Loop Road in Yosemite Valley. No roadway widening (outside of the original road prism width of 22 feet), realignment, or changes to vehicular or pedestrian circulation patterns, as called for in the *Final Yosemite Valley Plan Supplemental Environmental Impact Statement*, will be undertaken.

The need for this project is evidenced by the poor condition of the existing road surface and associated drainage features; major maintenance repairs have not been undertaken for many years. Numerous existing culverts are undersized, in disrepair, and/or ineffectively located to capture peak seasonal runoff. In addition, informal roadside parking along stretches of the Yosemite Valley Loop Road presents visitor safety and resource impact concerns.

Agency Name: National Park Service
Project Name: Tunnel View Overlook Rehabilitation

Description: The Tunnel View scenic overlook is a historic site located adjacent to Wawona Road. This overlook affords expansive views of Yosemite Valley, El Capitan, Bridalveil Falls, and Half Dome that have evoked the awe of visitors for nearly 75 years. Tour buses, tram tours, and single-family vehicles bring an estimated 5,000-7,000 people to the site per day during the height of the tourist season. The

Tunnel View Overlook Rehabilitation Project will remedy longstanding vehicle-to-vehicle and vehicle-to-pedestrian safety issues, correct drainage deficiencies, provide clear circulation patterns for pedestrians and vehicles, enhance and maintain viewing opportunities for visitors, provide accessibility to viewing areas for visitors with disabilities, correct safety problems associated with the Inspiration Point trailhead, and address sanitation issues. The Finding of No Significant Impact for the *Tunnel View Overlook Rehabilitation Environmental Assessment* was signed on December 12, 2007.

Agency Name: National Park Service
Project Name: Yosemite Valley Plan

Description: The National Park Service Pacific West Regional Director signed the Record of Decision for the *Final Yosemite Valley Plan* and its *Supplemental Environmental Impact Statement* on December 29, 2000. The purpose of the *Yosemite Valley Plan* is to present a comprehensive management plan for Yosemite Valley—from Happy Isles at the east end of the Valley to the intersection of the El Portal and Big Oak Flat Roads near the Cascades area at the west end. It also presents actions in adjacent areas of the park and the El Portal Administrative Site that directly relate to actions proposed in Yosemite Valley. The specific purposes of the Yosemite Valley Plan within Yosemite Valley are to:

- restore, protect, and enhance the resources of Yosemite Valley
- provide opportunities for high quality, resource-based visitor experiences
- reduce traffic congestion
- provide effective park operations, including employee housing, to meet the mission of the National Park Service

The Record of Decision was signed in December 2000.

Agency Name: National Park Service
Project Name: Yosemite Valley Shuttle Bus Stop Improvements

Description: This project consists of the preparation of preliminary design plans, environmental compliance documents, and construction drawings; the construction of six 10'x80' concrete braking pads; and the rehabilitation or replacement of 94,000 square feet of asphalt road approaches. Construction has begun on this project.

Appendix J: Draft Wilderness Minimum Tool Requirement Analysis for the Invasive Plant Management Plan for Yosemite National Park

The National Park Service is updating the *2008 Invasive Plant Management Plan* (*2008 Plan*) for Yosemite National Park. A Minimum Tool Requirement Analysis (MRA) for the *2008 Plan* was signed on July 25, 2008.

The purpose of this appendix is: 1) to determine whether the alternatives proposed in the *2010 Update* are appropriate or necessary for administration of the area as Wilderness, and do not pose a significant impact to Wilderness resources and character; and 2) if the *2010 Update* is appropriate or necessary in Wilderness, to ensure that techniques and equipment minimize impacts on Wilderness resources and character.

The purpose of the *2010 Update* is to protect park natural and cultural resources from adverse impacts caused by non-native invasive species. About 95% of Yosemite National Park is designated Wilderness, most of which is still free from the negative impacts of invasive plants. The most effective and efficient strategy for keeping invasive plants out of the Wilderness and averting the need for larger scale control efforts is to detect and eradicate invasive plants early, and to initiate measures to keep new invasive plant propagules from entering the Wilderness. All of the alternatives in the *2010 Update* incorporate early detection and early control of invasive plants. The no-action alternative proposes a variety of techniques for invasive plant control, including use of two herbicides, glyphosate and aminopyralid. Alternative 2 proposes a variety of invasive plant control techniques, including four additional herbicides, imazapyr, triclopyr, rimsulfuron, and chlorsulfuron. Alternative 3 proposes a variety of invasive plant control techniques, including the same four additional herbicides as Alternative 2 and an adaptive management protocol used in specified situations to introduce new herbicides should they be needed.

The steps that complete the Minimum Tool Requirement Analysis (MRA) for the *2010 Update* are described below:

Step 1 - Determine Whether the Proposed Action Takes Place in Designated Wilderness (or a Potential Wilderness Addition).

The proposed action of the *2010 Update* takes place in designated Wilderness and potential Wilderness additions.

Areas of Concern. The following areas in the Yosemite Wilderness currently contain the greatest concentrations of invasive non-native plants:

- Merced River corridor from Little Yosemite Valley to Merced Lake
- Little Yosemite Valley up toward Half Dome
- Hetch Hetchy Reservoir to Beehive Spring
- Pate Valley
- Rancheria Falls and Tiltill Valley
- Miguel Meadows Rancheria Falls
- Tuolumne River Corridor including and downstream from Poopenaut Valley

Species of Concern. Of the 200+ non-native plant species found in Yosemite, 33 species have been found to date in Wilderness (see Table N-1). Of these, six are targeted for removal: bull thistle, velvet grass *(Holcus lanatus)*, Himalayan blackberry, common dandelion *(Taraxacum officinale)*, common mullein, and yellow salsify (*Tragopogon dubius)*. An alert will be maintained for the following highly invasive species that are not currently found in the Yosemite Wilderness: Italian thistle (*Carduus pycnocephalus)*, perennial pepperweed *(Lepidium latifolium)*, yellow star-thistle (*Centaurea solstitialis)*, and spotted knapweed (*Centaurea maculosa)*. Program managers will update this list as invasion patterns change.

Step 2 - Determine Whether the Proposed Action Is Required for the Administration of the Yosemite Wilderness.

Invasive plants have adverse effects on core Wilderness values, including Wilderness character, wildness, and natural processes. Invasive plants affect the natural qualities of Wilderness, and can directly compete with and displace native plants, or cause changes in biological diversity, the food base for wildlife species, and soil conditions. The proposed action would advance efforts to prevent invasive plants from entering the Wilderness; detect priority invasive plant populations early that have made their way into the Wilderness; and treat invasive plants effectively, before they can spread and require larger control efforts. These efforts are crucial for the administration of the natural attributes of Wilderness in Yosemite National Park.

Table N-1: Invasive Plant Species in Yosemite National Park Wilderness
(targeted species are in bold)

Aira caryophyllea	European hairgrass	*Poa annua*	annual bluegrass
Agrostis gigantean	redtop	*Poa bulbosa*	bulbous bluegrass
Agrostis stolonifera	creeping bent grass	*Poa compressa*	Canadian bluegrass
Avena sp.	wild oat	*Poa pratensis*	Kentucky bluegrass
Bromus diandrus		***Rubus armeniacus***	**Himalayan blackberry**
Bromus tectorum	ripgut grass	*Rumex acetosella*	sheep sorrel
Chenopodium album	cheatgrass	*Rumex crispus*	curly dock
Cirsium vulgare	lamb's quarters	*Sisymbrium altissimum*	tumble mustard
Cynosurus echinatus	**bull thistle**	*Sonchus sp.*	sow thistle
Erodium cicutarium	hedgehog dogtail	*Spergularia rubra*	purple sandspurrey
Holcus lanatus	storksbill	***Taraxacum officinale***	**common dandelion**
Hordeum marinum	**velvet grass**	***Tragopogon dubius***	**yellow salsify**
Hypochaeris glabra	Mediterranean barley	*Trifolium repens*	white clover
Lactuca serriola	smooth cat's-ear	*Urtica urens*	dwarf nettle
Leucanthemum	prickly lettuce	***Verbascum thapsus***	**common mullein**
vulgare	ox-eye daisy	*Vulpia myuros*	foxtail fescue
Phleum pratense	timothy grass		
Plantago lanceolata	English plantain		

Step 3 - Determine whether Objectives of the Invasive Plant Management Plan Can Be Met With Actions Outside of Wilderness or Potential Wilderness.

Actions must take place within Wilderness or potential Wilderness to meet the objectives of the *2010 Update*. Objectives of the update include eradicating invasive plants from Wilderness and preventing invasive plants from spreading into uninfested areas of the park, including Wilderness.

Step 4 - Develop a List of Options to Meet the Objectives of the Plan; Include Ways to Reduce or Mitigate the Impacts of Each Alternative.

The most effective and efficient strategy for keeping invasive plants out of the Wilderness is to detect invasive plants early and initiate measures to keep new invasive plant seeds and propagules from entering the Wilderness. Invasive plant species make their way into the Wilderness via humans in a variety of ways: hikers may carry invasive plants seeds on their boots, socks, and other gear; pack-stock users may carry invasive plant seeds on their gear or stock feed and manure; and firefighters may bring in seeds with their vehicles, equipment, and gear. Currently, the park provides information to Wilderness users on how they can prevent invasive plants from entering the Wilderness by cleaning shoes, clothing, camping gear, and other items before entering the Wilderness. Stock users are encouraged to use weed-free feed while visiting Yosemite's Wilderness.

Invasive plant management in Designated Wilderness is guided by integrated pest management, which includes the use of physical, mechanical, cultural, biological, and chemical tools. All of the alternatives in the *2010 Update* emphasize early detection and prevention; the alternatives vary in the methods of controlling invasive plants. There are three main control options for removing invasive plants from designated Wilderness:

1) Physical control techniques (non-motorized control): hand pulling, lopping, severing plant from root crown with a shovel, removing root mass by shovel or trowel, mowing using a scythe or grass whip, or flaming. These actions are prescribed under all of the alternatives in the *2010 Update*.
2) Motorized control techniques (also known as mechanical control): gas-powered weed whacker (string or blade). These actions are prescribed under all of the alternatives in the *2010 Update*.
3) Herbicide application: backpack spraying or cut-and-dab. These actions are prescribed under all of the alternatives in the *2010 Update*.

Option 1 – Use Physical Techniques to Remove Invasive Plants (Physical Control)

Option 1 uses physical techniques with hand tools such as shovels and loppers to remove invasive plants. Work crews would hike or backpack throughout areas of concern following "Leave No Trace" protocols in work and camp settings. Additional logistical support provided by stock or humans would be considered when distances are greater than a two-day hike to the work area, or a volunteer group is being used for weed removal. For all invasive plant species, work crews would remove flowering and seed heads and bag, carry, and dispose of the plants in a closed dumpster. Work crews may also burn flowering heads in pre-existing fire-rings. Once the flowering or seed head is removed, the body of the plant would be severed from the roots at the root crown or pulled to remove the root. In the case of Himalayan blackberry (or other species with similar growth characteristics), the entire root mass would be removed and burned on site in a pre-existing fire ring.

Impact Minimization Protocols

- Crews would follow "Leave No Trace" camping and work protocols.
- Crews would rove and change their camp locations frequently and not create a long-term base camp.
- Crews would camp in areas that have a durable surface such as decomposing granite, bare ground, or granite slabs.
- Crews would educate the public regarding their work.
- The park would provide information at the visitor center and trailheads regarding invasive non-native plant issues in Wilderness and the importance of controlling these species.
- Each area would be surveyed prior to work activities to determine that eradication would not damage sensitive species, as well as biological, physical, cultural, and aesthetic resources in the area. Eradication techniques would be modified to protect those resources.
- Crews would be limited to legal group size limits—15 in trailed areas, 8 in off-trail areas.
- Crews would be supported by pack stock only when more than two days would be required to travel to a work area.

Option 2 – Use Physical and Mechanical Techniques to Remove Invasive Species

In addition to the physical techniques used in Option 1, work crews would use motorized equipment such as a gas-powered weed whacker to remove invasive plants. Motorized equipment would be used in situations where it is required for immediate and effective invasive plant control of rapidly spreading invasive plants. This may also include the use of motorized vehicles to access invasive plants after wildland fires, specifically where vehicles were used during fire suppression efforts and it is not feasible to sufficiently manage invasive plants via foot access. Motorized equipment would be used only if doing so would preclude the need for larger, more invasive control actions in the near future.

Impact Minimization Protocols

- Impact minimization protocols would be the same as under Option 1.
- Work would occur during the middle of the day, when hikers are more likely to be moving through an area and not camping in the area.

Option 3 – Use Cultural Techniques to Prevent the Spread of Invasive Plants

In addition to the physical and mechanical techniques used in Options 1 and 2, cultural techniques, such the cleaning of boots and equipment to remove weed seeds and plant parts to prevent the spread of invasive plants, would be used. Visitors and work crews would be educated regarding invasive seed transportation via clothes, boots, pack stock, vehicles, and equipment.

Option 4 – Use Physical and Mechanical Techniques to Remove Invasive Plants, as Well as Herbicides

In addition to the physical and mechanical techniques used under Options 1, 2, and 3, herbicide use would be considered to control invasive plant populations. Herbicides would be used where they would be the most effective tool to keep rapidly spreading invasive plant populations in check, and use of an herbicide would preclude larger, more invasive control efforts in the future. Many plant species, especially rhizomatous species such as Himalayan blackberry, do not respond well to physical control. Lopping blackberry stems does not kill underground roots and rhizomes, and can stimulate the growth of multiple stems for species such as tree-of-heaven. Digging up of roots can take as much as 100 times the person hours as herbicide control, and requires multiple return control visits each year over many

years to ensure success. Additionally, digging up of roots causes a great deal of soil disturbance, which can result in the disturbance of archaeological resources or create conditions for establishment of other non-native species.

Impact Minimization Protocols

- Impact minimization protocols would be the same as under Option 1.
- Work would occur during the middle of the day, when hikers are more likely to be moving through an area and not camping in the area.
- Work crews would follow the "Herbicide Use and Storage Protocol" in the *2010 Update.*

Step 5 - Determine the Effects of Each Option on Wilderness Health and Character

Option 1. Use Physical Techniques to Remove Invasive Plants		
Effects on the Natural Attributes of Wilderness Character	**Effects on Solitude and Unconfined Recreation**	**Effects on the Undeveloped Aspects of Wilderness Character**
Reduction in invasive plant populations. Minor soil disturbance. Increased size and abundance of native plant populations.	In the short term, the presence of work crews would decrease opportunities for solitude for other visitors. Work crews would increase imprint of human activity and management presence. Long-term effects include the return of ecological integrity and the reduction of the human footprint in Wilderness.	In the short term, wildness, or the untrammeled quality of Wilderness, would decrease during work activities. Evidence of invasive plant control work, such as pulled plants and disturbed soil, would be visible in the short term. In the long term, naturalness would increase as natural processes resume and invasive species, a sign of human-induced change, are removed.
Option 2. Use Physical and Mechanical Techniques to Remove Invasive Plants		
Effects on the Natural Attributes of Wilderness Character	**Effects on Solitude and Unconfined Recreation**	**Effects on the Undeveloped Aspects of Wilderness Character**
Protection of native plant populations from displacement by non-native plants. Reduction in number and spatial extent of invasive plant populations. Short-term minor soil disturbance. Long-term negligible beneficial impact on soil attributes, such as soil microorganisms and chemical and hydrologic cycles, as invasive plants are controlled.	Short-term effects include the presence of work crews, which would decrease opportunities for solitude for park visitors. Work crews would increase imprint of human activity and management presence. Noise and smells created from motorized tools would impact natural sounds and smells of Wilderness. Long-term effects include the return of ecological integrity and the reduction of the human footprint in Wilderness.	In the short term, wildness, or the untrammeled quality of Wilderness, would decrease during work activities. Evidence of invasive plant control work, such as pulled plants and disturbed soil, would be visible in the short term. In the long term, naturalness would increase as natural processes resume. Wildness would increase with removal of human-induced change.

Option 3. Use Cultural Techniques to Remove Invasive Plants		
Effects on the Natural Attributes of Wilderness Character	**Effects on Solitude and Unconfined Recreation**	**Effects on the Undeveloped Aspects of Wilderness Character**
Using cultural controls would have a long-term negligible beneficial impact to the natural attributes of wilderness character	Using cultural controls would not impact the solitude and unconfined recreational attributes of wilderness character.	Using cultural controls would not impact the undeveloped attributes of wilderness character.
Option 4. Use Physical and Mechanical Techniques and Herbicides to Remove Invasive Plants		
Effects on the Natural Attributes of Wilderness Character	**Effects on Solitude and Unconfined Recreation**	**Effects on the Undeveloped Aspects of Wilderness Character**
Protection of native plant populations from displacement by non-native plants. Reduction in number and spatial extent of invasive plant populations. Minor soil disturbance. Short-term negligible adverse effect on soil quality. Long-term moderate beneficial impacts on soil microorganisms, soil chemistry, and hydrologic cycles as invasive plant populations are controlled and eradicated.	Short-term effects include the presence of work crews, which would decrease opportunities for solitude for other visitors. Work crews would increase imprint of human activity and management presence. Wildness would decrease during project due to noise and smell from motorized equipment. Long-term effects include the return of ecological integrity and the reduction of the human footprint in Wilderness.	Wildness, or the untrammeled quality of Wilderness, would be decreased during work activities. Wildness would decrease during project due to use of motorized tools and application of herbicide. Long-term effects: In the long term, naturalness would increase as native plants and natural processes resume. Wildness would increase with removal of human-induced change.

Step 6 – Determine the Management Concerns of Each Option

Option 1. Use Physical Techniques to Remove Invasive Plants	
Health and Safety Concerns	**Societal, Economic, and Political Concerns**
There would be safety concerns associated with physical work in a remote setting. These concerns would be mitigated with proper training and supervision.	There could be positive perceptions of the National Park Service as actions protect the biological, physical, and experiential aspects of Yosemite Wilderness. There would be economic costs related invasive plant control actions. The program currently is funded through Yosemite Fund and the Centennial Challenge.
Option 2. Use Physical and Mechanical Techniques to Remove Invasive Plants	
Health and Safety Concerns	**Societal, Economic, and Political Concerns**
There would be safety concerns associated with physical work in a remote setting, and the inherent danger to park staff in using motorized cutting tools. These concerns would be mitigated with proper training and supervision. The acts of carrying motorized tools and fuel over long distances would require additional training.	There could be positive perceptions of the National Park Service as actions protect the biological, physical, and experiential aspects of Yosemite Wilderness. There could be negative perceptions of the National Park Service due to use of motorized equipment in a Wilderness setting. There would be economic costs related to invasive plant control actions. The program currently is funded through Yosemite Fund and the Centennial Challenge.

Option 3. Use Cultural Techniques to Remove Invasive Plants	
Health and Safety Concerns	**Societal, Economic, and Political Concerns**
There would be no health and safety concerns associated with using cultural techniques to remove invasive plants.	There would be no societal, economic, or political concerns associated with using cultural techniques to remove invasive plants.
Option 4. Use Physical and Mechanical Techniques and Herbicides to Remove Invasive Plants	
Health and Safety Concerns	**Societal, Economic, and Political Concerns**
There would be safety concerns associated with physical work in a remote setting. These concerns would be mitigated with proper training and supervision. The acts of carrying motorized tools and fuel over long distances would require additional training. There could be additional hazards related to transporting, mixing, and applying herbicides in a remote setting.	There could be positive perceptions of the National Park Service as actions protect the biological, physical, and experiential aspects of Yosemite Wilderness. There could be negative perceptions of the National Park Service due to the use of motorized equipment and herbicides in a Wilderness setting. There would be economic costs related to invasive plant control actions. The program currently is funded through Yosemite Fund and the Centennial Challenge.

Step 7 – Evaluate the Options

The *2010 Update* aims to protect Wilderness character by keeping invasive plants from spreading in Wilderness. All of the alternatives in the *2010 Update* emphasize early detection and prevention practices that would preclude larger, more invasive control actions in the future. Invasive plant control actions would restore and preserve areas of the Wilderness that have reduced biodiversity and impaired ecological function resulting from invasive plant populations.

This document also evaluates whether the techniques and equipment used to control invasive plants are the minimum required to preserve Wilderness character. Invasive plant removal techniques that use non-motorized methods, as described under Options 1 and 3, minimize negative effects on solitude in Wilderness. This control method would generally be the most appropriate method to protect the unique characteristics of Wilderness. Option 2 adds the use of motorized equipment, such as a gas-powered weed whacker, if it would prevent the intrusion of rapidly spreading invasive plants into the Wilderness and preclude larger invasive plant control efforts in the future. Motorized equipment would also be used if the size of the population to be controlled is too large for non-motorized techniques to be effective. Option 4 adds the use of herbicides if the park is unable to meet management objectives through other control methods, if invasive plant populations demonstrate a potential ecosystem-level threat to Wilderness character, and the use of herbicides would prevent the intrusion of rapidly spreading invasive plants in Wilderness and preclude larger invasive plant control efforts in the future.

Option 4 is the most efficient and effective method of keeping invasive plants out of Yosemite Wilderness and treating new infestations early and completely. Option 4 provides a range of tools for responding to a variety of potential invasive plant threats, and providing effective and thorough early treatments to prevent infestations from growing and integrating into natural habitats. Under Option 4, invasive plant removal using non-motorized equipment (physical control) is the preferred method of invasive plant control. Work crews would use motorized equipment only if physical control is ineffective at early prevention and control. Work crews would utilize herbicides as a last resort, and only if physical and mechanical control methods do not effectively control rapidly spreading invasive

plant populations. In this latter case, herbicides may be the minimum tool required to control a fast-moving species with the potential to alter native plant communities and underlying soil composition. Option 4 allows a full range of options for early and effective treatments to keep invasive plant populations small, before control efforts entail large amounts of soil and vegetation disturbance, and the presence of long-term workers compromise values of solitude and wildness for other Wilderness travelers. For these reasons, the tools and use criteria specified under Option 4 are the minimum tool required to meet management objectives for Wilderness in Yosemite.

All proposed alternatives in the *2010 Update* would be consistent with Option 4 described in this Wilderness Minimum Tool Requirement Analysis.

Impact minimization protocols

- Crews would follow "Leave No Trace" camping and work protocols.
- Crews would rove and change their camp locations frequently and not create a long-term base camp.
- Crews would camp in areas that have a durable surface such as decomposing granite, bare ground, or granite slabs.
- Crews would educate the public regarding their work.
- The park would provide information at the visitor center and trailheads regarding invasive non-native plant issues in Wilderness and the importance of controlling these species.
- Each work area would be surveyed before work activities commence to determine that eradication would not damage sensitive species or other biological, physical, cultural, and aesthetic resource in the area. Eradication techniques would be modified to protect those resources.
- Crews would be limited to legal group size limits—15 in trailed areas, 8 in off-trail areas.
- Crews would be supported by pack stock only when more than two days would be required to travel to a work area.
- Motorized clearing would occur during the middle of the day, when hikers are more likely to be moving through an area and not camping.
- Work crews would follow the "Herbicide Use and Storage Protocol" in the *2010 Update*.

Minimum Requirement Decision Process

Check one:

☐ The proposed action is a temporary one-time activity.

☐ The proposed action will be an ongoing long-term activity.

Reviewed by:

_____

Wilderness Manager Date

Concurred:

_____

Chief Ranger Date

Concurred:

_____

Chief, Resources Management and Science Date

Concurred:

_____

Superintendent Date

Appendix K: Priority Invasive Plant Species Abstracts

Ailanthus altissima

Common Name: Tree-of-Heaven, Ailanthus
Family: Simaroubaceae
Listed: Cal-IPC (B)

Ailanthus (*Ailanthus altissima*) is a fast-growing deciduous tree 30-65 feet tall, with gray bark (Bossard, Randall, and Hoshovsky 2000). It can grow in most environments and in inhospitable soil conditions below 6,000 feet (DiTomaso and Healy 2007). Ailanthus reproduces by seed and, most readily, vegetative root sprouts. Ailanthus can produce up to 1 million seeds a year, but seedling establishment in California is infrequent. Reproduction in California is primarily through root sprouts, and ailanthus can produce abundant sprouts, some up to 50 feet away from the nearest shoot, producing dense thickets over a large area that displace native vegetation, particularly in riparian zones. Ailanthus also produces chemicals that resist insects (DiTomaso and Healy 2007), and may contribute to the displacement of native vegetation and wildlife (Bossard et al. 2000).

Ailanthus is native to eastern China, and was widely planted until the 1890s during the California Gold Rush by Chinese miners (Bossard et al. 2000). Within California, ailanthus is widely distributed, but is most common along the coast and in the Sierra Nevada foothills (Bossard et al. 2000).

In Yosemite National Park boundaries, Ailanthus is found near the Ansel Adams Gallery in Yosemite Valley and occasionally in the Merced River canyon near the park border. Ailanthus is well-established just outside the park in El Portal. Control efforts have been limited to physical removal of trees (including seedlings and saplings) in the riparian corridor in El Portal.

Carduus pycnocephalus

Common Name: Italian thistle
Family: Asteraceae
Listed: Cal-IPC (medium); CDFA (C); USGS (1)

Italian thistle *(Carduus pycnocephalus)* is a winter annual broadleaf that grows up to six feet tall with spiny stems. Italian thistle grows along roadsides, in pastures, and in waste areas at elevations up to 3,280 feet (Hickman 1993). Italian thistle reproduces only from seeds, and it dominates sites by the blanketing effect of overwintering rosettes, severely reducing the establishment of other plants. The seeds disperse by way of animals' fur and humans' clothing, being carried by ants, as a contaminant in hay and soil, and by vehicles and wind (Gerlach et al. 2003). Wind can carry seeds an average of 75 feet from the parent plant, and seeds can travel more than 325 feet in strong winds. Italian thistle seeds remains viable in the soil for over ten years (Bossard et al. 2000). Italian thistle grows in sandy to clay soils (DiTomaso and Healy 2007).

Italian thistle is native to the Mediterranean. It occurs throughout southern Europe, North Africa, and Pakistan. In North America, it is found in Oregon, Idaho, and California (Bossard et al. 2000). In California, it occurs in the southern North Coast and North Coast ranges, Sierra Nevada Foothills, and Central Western California bioregions (Hickman 1993). Its range in the Sierra Nevada seems to be increasing (Gerlach et al. 2003).

Italian thistle has been found in the El Portal administrative site near the community pool. It has also been found in Yosemite Valley at the Lower River Campground. National Park Service crews have

worked with adjacent land management agencies (U.S. Forest Service and Bureau of Land Management) to reduce the potential spread of Italian thistle from adjacent public lands.

Centaurea maculosa

Common Name: Spotted knapweed
Family: Asteraceae
Listed: CDFA (A); USGS (1); Cal-IPC (high)

Spotted knapweed *(Centaurea maculosa)* is a biennial to short-lived perennial that grows up to one meter tall (DiTomaso and Healy 2007) in disturbed sites, riparian areas, grasslands, wet meadows, and forests at elevations up to 9,800 feet (Gerlach et al. 2003). Spotted knapweed plants generally live three to seven years. Plants re-grow from the root crown. Reproduction is by seed, and plants are capable of producing 500-4,000 seeds per square foot per year. Seeds can remain viable in the soil for more than eight years. Most seeds are dispersed near the parent plant, but can be transported by people, wildlife, livestock, and vehicles, and in soil, crop seed, and contaminated hay. Spotted knapweed out-competes native plant species, reduces native plant and animal biodiversity, and decreases forage production for wildlife. It may degrade soil and water resources by increasing erosion, surface runoff, and stream sedimentation (Carpinelli 2003).

Spotted knapweed is native to central Europe. It now occurs in east to central Russia, Caucasia, and western Siberia. It is a widely distributed species reported to occur throughout Canada and in every state of the U.S. except Alaska, Georgia, Mississippi, Oklahoma, and Texas. It has been designated as a noxious weed in Arizona, California, Colorado, Idaho, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming (Carpinelli 2003). In California, it occurs in northwestern California, the Cascade Range, the Sierra Nevada, the northern Sacramento Valley, northern central western California, the southern Peninsular Ranges, the Modoc Plateau, and northeast of the Sierra Nevada bioregions (Hickman 1993).

In Yosemite, spotted knapweed has been found in Foresta, in Yosemite Valley in the former Upper River Campground, and along the El Portal Road. Spotted knapweed has been removed physically from all known locations within Yosemite National Park and inholdings, with repeated follow-up.

Centaurea solstitialis

Common Name: Yellow star-thistle
Family: Asteraceae
Listed: Cal-IPC (high); CDFA (C); USGS (1)

Yellow star-thistle *(Centaurea solstitialis)* is an winter annual, sometimes biennial, herbaceous plant growing up to 6.5 feet (DiTomaso and Healy 2007). It flowers from May to October, and the spread of yellow star-thistle is by seed. Each seed head can produce from 35 to 80 seeds (Murphy and Ehrlich 1989), and seeds can remain viable in the soil for more than 10 years (Gerlach, et al. 2003). Star-thistle produce two types of seeds, most lacking pappus bristle and some with pappus bristles that are wind dispersed. The plumeless seeds fall from the mother plant and create the invasional front commonly seen in disturbed areas (DiTomaso and Healy 2007) Seed dispersal mechanisms include animals, humans, vehicles, contaminated crop seed, hay or soil, and road maintenance. Yellow star-thistle invades and infests areas, choking out native plants and reducing biodiversity, wildlife habitat, and forage (Murphy and Ehrlich 1989). It grows in disturbed areas around developments and grassy slopes in the chaparral/oak-woodland and mixed conifer zones at elevations up to 1,200 meters (Botti 2001).

Yellow star-thistle is native to the Mediterranean region of southern Europe, as well as to northern Africa. It occurs in 41 states in the U.S. (with the exception of Maine, Vermont, five southeastern states,

Alaska, and Hawaii). Yellow star-thistle is most concentrated in California, where the plant infests nearly 12 million acres of rangeland and wildland (Murphy 2003). It occurs in the California Floristic Province and Mojave Desert bioregions within the state (Hickman 1993), in which the largest populations are in the central and northern valleys and foothills, and it is extending its range into the central Sierra Nevada region (Gerlach et al. 2003).

In Yosemite National Park, yellow star-thistle is currently found in the El Portal administrative site. It has been found and controlled in the past along El Portal Road, at the Foresta and McCauley Ranch, along the Wawona Road, along Tioga Pass Road, on Big Oak Flat Road, on Aspen Valley Road, and at Tuolumne Meadows.

Cirsium vulgare

Common Name: Bull thistle
Family: Asteraceae
Listed: Cal-IPC (medium); CDFA (NR); USGS (3)

Bull thistle (*Cirsium vulgare*) is a biennial that can grow up to 6.5 feet tall and reproduces only by seed. Generally, bull thistle remains as a rosette the first year; it flowers the second year, sets seed, and dies. Some plants will flower their first year, while other plants may remain as a rosette for several years (Bossard et al. 2000). Bull thistle grows in disturbed places around developments, along roadsides, and in undisturbed, often wet places, including marsh edges, coastal grasslands, meadows, and forest openings in the chaparral/oak-woodland and mixed conifer zones at elevations up to 6,500 feet (Botti 2001). Individual plants seed only once, but large plants can produce tens of thousands of wind-dispersed seeds. Bull thistle is a noxious plant that spreads aggressively; it competes with and displaces native species (Bossard et al. 2000).

Bull thistle is native to Europe, western Asia, and North Africa, and was likely introduced to North America as a seed contaminant around 1600. By 1925, bull thistle was reportedly in several locations in California (Bossard et al. 2000). In California, it occurs in the California Floristic Province and Great Basin Floristic Province bioregions (Hickman 1993).

In Yosemite, bull thistle is common throughout middle elevations (below 8,500 feet) in both frontcountry and backcountry areas. It is found in nearly all Yosemite Valley meadows, as well as along roadsides near Crane Flat and in disturbed areas in the Mariposa Grove (Botti 2001).

Genista monspessulana

Common Name: French broom
Family: Fabaceae
Listed: Cal-IPC (high); USGS (1); CDFA (C)

French broom *(Genista monspessulana)* is an upright evergreen shrub that grows up to 16.5 feet tall. French broom becomes reproductive at two to three years of age. It flowers from March to July, and seeds survive at least five years in soil. Seedlings and mature plants alike can easily resprout after cutting (Bossard et al. 2000). French broom commonly grows in disturbed places at elevations up to 1,640 feet (Hickman 1993). French broom is considered an ecological threat for many reasons. French broom is a strong competitor and can dominate a plant community, forming dense monospecific stands that shade out tree seedlings and displace native plant and forage species. Its foliage and seeds are toxic; infestations of broom degrade wildlife habitat quality and displace native forage species. It burns readily and carries fire to the tree canopy layer, increasing both the frequency and intensity of fires. It can also change microclimate conditions at soil levels (Bossard et al. 2000).

French broom is native to Mediterranean Europe and northwest Africa. Within California, French broom occurs in the Outer North Coast Ranges, Inner North Coast Ranges, San Francisco Bay Area, Outer South Coast Ranges, southern Channel Islands, Western Transverse Ranges, and the Peninsular Ranges (San Diego County) bioregions (Hickman 1993). Within these bioregions, it is most widespread along the coast, suggesting that it is invading the areas around the Central Valley (Gerlach et al. 2003).

In Yosemite, French broom has been found in the past, and has been controlled along the El Portal Road in the Merced River canyon, the Arch Rock entrance station, Happy Isles, and the El Portal administrative site.

Holcus lanatus

Common Name: Velvet grass
Family: Poaceae
Listed: Cal-IPC (medium); USGS (2)

Velvet grass (*Holcus lanatus*) is a tufted perennial with erect or decumbent stems that are 60-200 centimeters high and velvety hairy. Velvet grass flowers from June to August and reproduces through seeds (DiTomaso and Healy 2007). Velvet grass seed dispersal mechanisms are wind, and ingestion by birds and animals. Seeds are found in bird droppings, dung, mud, and soil, in which seeds remain viable for over 10 years (Gerlach et al. 2003). Velvet grass grows in moist, disturbed places around developments in the mixed conifer zone at elevations up to 5,250 feet (Botti 2001). The fibrous roots are deep, especially in low-nitrogen soils (DiTomaso and Healy 2007).

Velvet grass is native to Europe and is cultivated as feed for livestock. In California, velvet grass occurs in the California Floristic Province, Great Basin Floristic Province, and Mojave Desert bioregions (Hickman 1993).

Within Yosemite, velvet grass occurs generally (but not always) in wet areas at mid elevations; it has been found in one location above 6,560 feet. It is found throughout Yosemite Valley, in Wawona, the Mariposa Grove, Hodgdon Meadow, Foresta, and the Hetch Hetchy area, as well as in backcountry locations such as Pate Valley and Tiltil Valley.

Humulus lupulus

Common Name: European hop, common hop, hops
Family: Cannabaceae
Listed: none

Hops (*Humulus lupulus*) is a perennial herb with a twining stem. Plants grow in disturbed places, persisting from cultivated plants, at elevations up to 9,850 feet. Hops also reproduce vegetatively. Rhizomes can grow very quickly, allowing the plant to spread quickly and out-compete other species (Hickman 1993).

Hops is native to Eurasia and was brought to the U.S. as a cultivar; it is often cultivated as an ornamental and major source of aroma and flavor of beer. In California, hops is found in the Outer North Coast Ranges, northern and central Sierra Nevada foothills, South Coast, and Western Transverse Ranges (Hickman 1993).

Hops was likely introduced to Yosemite by early European settlers. In Yosemite Valley, hops is found in parts of Cook's Meadow and the Yosemite Falls areas. Hops has also been found at the Wawona golf course.

Lathyrus latifolius

Common Name: Perennial sweet pea, everlasting pea
Family: Fabaceae
Listed: USGS (1)

Perennial sweet pea (*Lathyrus latifolius*) is a perennial vine with robust stems that are distinctly winged. It reproduces by rhizomes vegetatively and by seed. Perennial sweet pea flowers from May to September. The fruiting pods and vegetation are toxic to livestock and humans, resulting in a degenerative motor neuron disorder (DiTomaso and Healy 2007).

Perennial sweet pea is native to Eurasia and northern Africa, and was likely introduced to the U.S. as an ornamental. It can be found throughout much of coastal and central California within the California Floristic Province (Hickman 1993).

Yosemite perennial sweet pea is known as an escaped ornamental in Yosemite Valley, El Portal, and Foresta.

Lepidium latifolium

Common Names: Perennial pepperweed, slender perennial peppercress
Family: Brassicaceae
Listed: Cal-IPC (high); CDFA (B)

Perennial pepperweed (*Lepidium latifolium*) has multiple stems and grows in erect colonies up six feet tall from a semi-woody stem base. It flowers from June to August and produces small, flattened pods. Perennial pepperweed rarely produces seedlings in the field, and the seeds lack a hard seed coat and lose viability rapidly. The plant mainly propagates clonally from its brittle, rhizome-like, vigorously creeping roots that can penetrate to depths of 10 feet, and new plants spring from root sections as small as 2 inches. Perennial pepperweed is highly competitive and spreads quickly (DiTomaso and Healy 2007). Water acts as the main mechanism for root dispersal. Perennial pepperweed can invade a wide range of habitats, including riparian areas, wetlands, marshes, and floodplains at elevations up to 6,250 feet. It adapts readily to natural and disturbed wetlands. As it establishes and expands, the plants create large monospecific stands that displace native plants and animals. It also adversely affects food quality and nesting habitat for native birds (Boelk 2003).

Perennial pepperweed is native to Eurasia. Infestations have been reported in coastal, intermountain, and mountainous areas in New England, and all the states west of the Rocky Mountains except Arizona. It also occurs in Canada and Mexico (Boelk 2003). In California, perennial pepperweed occurs throughout the state, except in the Klamath and Desert ranges (Hickman 1993).

In Yosemite, perennial pepperweed has been found in Foresta.

Leucanthemum vulgare

Common Name: Ox-eye daisy
Family: Asteraceae
Listed: Cal-IPC (medium); USGS (1)

Ox-eye daisy (*Leucanthemum vulgare*) is a prostrate perennial herb with stems that sprout laterally from a creeping rootstock. Ox-eye daisy spreads both vegetatively and through seed production. Vegetative spread is accomplished through rhizomes (Bossard et al. 2000). Each plant can produce an abundant amount of seeds that can remain viable in soil for up to 39 years. Seeds disperse by adhering to animals, clothing, dung, hay, and wildflower mixes (Gerlach et al. 2003). Due to ox-eye daisy's prolific seed

production and ability to spread through rhizomes, it can exclude other vegetation from an area, thereby decreasing biodiversity (Bossard et al. 2000). Ox-eye daisy grows in disturbed areas and around developments in meadows and grassy places in the mixed conifer zone at elevations up to 4,530 feet (Botti 2001). Ox-eye daisy often grows in poor soils, but it will thrive in moist clay soil conditions (DiTomaso and Healy 2007).

Ox-eye daisy is native to Europe and escaped cultivation as an ornamental in all of the contiguous United States (DiTomaso and Healy 2007). In California, ox-eye daisy can be found in the North Coast Range and the Sierra Nevada (Bossard et al. 2000).

In Yosemite Valley, ox-eye daisy has been reported at the North Pines Campground, Yosemite Lodge, and Concession Stables. It is also widespread in Foresta and the Big Meadow area, as well as in Yosemite West.

Robinia pseudoacacia

Common Name: Black locust
Family: Fabaceae
Listed: Cal-IPC (low)

Black locust is a fast-growing tree that can reach 40-100 feet in height at maturity. Black locust reproduces vigorously by root suckering and stump sprouting to form groves (or clones) of trees interconnected by a common fibrous root system. Physical damage to roots and stems increases suckering and sprouting. Although black locust produces abundant seeds, they seldom germinate. Black locust populations spread easily into natural areas, where their shade reduces competition from other plants. Dense stands of black locust create shaded islands with little ground vegetation. Flowers of black locust compete with native plants for pollinating bees (Wieseler 2006). Black locust also inhabits roadsides, riparian areas, canyon slopes, disturbed woodlands, and floodplain forests. This species does not tolerate excessive shade and soil moisture (DiTomaso and Healy 2007).

Black locust is native to the southeastern United States. It is distributed outside of its native range in the United States in the northeastern and western states, as well as in Texas (Wieseler 2006).

Black locust populations are found in Yosemite Valley between the chapel and Sentinel Bridge, in Cook's Meadow, the trailhead to Four Mile trail, along Southside Drive, along the Merced River near El Capitan Bridge, in Lower River Campground, in the Merced River Gorge, and along the Merced River in the El Portal Administrative Site.

Rubus armeniacus

Common Name: Himalayan blackberry
Family: Rosaceae
Listed: Cal-IPC (high); USGS (1)

Himalayan blackberry is a bramble-forming perennial that can grow up to several feet high. Stems are five-angled and have many prickles that are wide at the base, generally becoming somewhat curved. Flowering occurs from May through September. Himalayan blackberry reproduces both vegetatively and through sexual and asexual seed production. Vegetatively, Himalayan blackberry spreads through vigorous sprouting of roots and suckers; in addition, canes can root from its apices (Bossard et al. 2000). Fruits are readily eaten, and the seeds disperse long distances within animal scat, especially that of birds (DiTomaso and Healy 2007). In 2005, a fungal rust called *Phragmidium violaceum*, discovered on the Oregon coast, caused significant damage to Himalayan blackberry. This plant has currently spread to California and may be found to be an effective bioagent against Himalayan blackberry (DiTomaso and

Healy 2007). Strategies to control blackberry include cutting and burning of stems in the fall, which can prevent tip rooting; repeat cutting during flowering exhausts root stores. Goats can decimate new growth patches effectively. The most effective control strategy for blackberry is to apply systemic herbicide in the summer to early fall (DiTomaso and Healy 2007).

Blackberry is native to Armenia and spreads as a common garden escape in Eurasia, South Africa, Australia, the United States, and New Zealand (DiTomaso and Healy 2007). In western North America, Himalayan blackberry occurs from California to British Columbia. In California, it is found in the Coast Ranges, the Central Valley, and the Sierra Nevada foothills and mountains (Bossard et al. 2000).

Within Yosemite, approximately 40 acres of Himalayan blackberry exist in Yosemite Valley; it occurs in meadows and other lightly forested, seasonally wet areas. Himalayan Blackberry also occurs in El Portal, at the Arch Rock entrance station, and in at least one Wilderness location. It likely occurs in similar habitats throughout the park.

Rubus laciniatus

Common Name: Cut-leaved blackberry
Family: Rosaceae
Listed: USGS (1)

Cut-leaved blackberry (*Rubus laciniatus*) is a bramble-forming perennial that can grow up to 10 feet tall. Cut-leaved blackberry reproduces vegetatively and through both sexual and asexual seed production. Vegetatively, cut-leaved blackberry spreads through vigorous sprouting of roots and suckers. Fruits are readily eaten, and the seeds disperse long distances within animal scat, especially that of birds. Cut-leaved blackberry flowering occurs from May through July. Similar management strategies to control Himalayan blackberry are effective at controlling cut-leaved blackberry (DiTomaso and Healy 2007).

Cut-leaved blackberry is native to Eurasia and was likely introduced to the U.S. as a food crop or an ornamental. In California, cut-leaved blackberry occurs in the Coast Range, the Central Valley, and the Sierra Nevada foothills and mountains (Hickman 1993).

In Yosemite, cut-leaved blackberry grows at mid elevations in disturbed areas and is often associated with Himalayan blackberry. It is established in Yosemite Valley and the Wawona areas (Botti 2001).

References

Boelk, D. (2003). Least wanted, Plant Conservation Alliance's alien plant working group: Perennial pepperweed. Retrieved from http://www.nps.gov/plants/alien/fact/lela1.htm

Bossard, C. C., Randall, J. M., & Hoshovsky, M. C. (2000). *Invasive plants of California's wildlands.* Berkeley: University of California Press.

Botti, S. J. (2001). *An illustrated flora of Yosemite National Park.* El Portal, CA: Yosemite Association.

Carpinelli, M. (2003). Least wanted, Plant Conservation Alliance's alien plant working group: Spotted knapweed. Retrieved from http://www.nps.gov/plants/alien/fact/cest1.htm

DiTomaso, J. M., & Healy, E. A. (2007). *Weeds of California and other Western states.* University of California Department of Agriculture and Natural Resources.

Gerlach, J. D., Jr., Moore, P. E., Johnson, B., Roy, G., Whitmarsh, P., Lubin, D. M., . . . Keely, J. E (2003). Alien plant species threat assessment and management prioritization for Sequoia and Kings Canyon and Yosemite National Parks. Carson City, NV: U.S. Geological Survey: 149.

Hickman, J. C. (Ed.). (1993). *The Jepson manual: Higher plants of California.* Berkeley: University of California Press.

Murphy, A. (2003). Least wanted, Plant Conservation Alliance's alien plant working group: Yellow starthistle. Retrieved from http://www.nps.gov/plants/alien/fact/ceso1.htm

Murphy, D. D., & Ehrlich, P. R. (1989). Conservation biology of California's remnant native grasslands. In L. F. Huenneke & H. A. Mooney, *Grassland structure and function: California annual grassland* (pp. 201-211). Dordrecht, The Netherlands: Kluwer Academic.

Wieseler, S. (2009). Least wanted, Plant Conservation Alliance's alien plant working group: Black locust. Retrieved from http://www.nps.gov/plants/alien/fact/rops1.htm

Appendix L: Draft Impairment Determination for the Preferred Alternative

This appendix contains a draft impairment determination for the preferred alternative of the *2010 Invasive Plant Management Plan Update Environmental Assessment* (*2010 Update)*. *The Draft Interim Guidance for Impairment Determinations in NPS NEPA Documents* (2010) requires that this impairment determination be included in the appendices of NEPA documents. The impairment determinations included for each resource topic and alternative analyzed in the text of Chapter III address only the 1999 Programmatic Agreement.

NPS *Management Policies* (NPS 2006b, section 1.4) requires analysis of potential effects to 1) determine environmental consequences of implementing the preferred or other alternatives, and 2) determine whether proposed actions would impair a park's resources and values. The fundamental purpose of the National Park Service, established by the Organic Act and reaffirmed by the General Authorities Act (as amended), begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws do give the NPS the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that the NPS must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values (NPS 2006b). Whether an impact meets this definition depends on a number of factors, including: the particular resources that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park,
- 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.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and cannot be further minimized. Impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park. Impairment findings are not necessary for visitor experience, socioeconomics, public health and safety, environmental justice, land use, park operations, and so forth, because impairment findings relate back to park resources and values.

Preferred Alternative

Under Alternative 3, the preferred alternative, an adaptive management protocol would be introduced to allow for more effective protection of park natural and cultural resources from displacement or other degradation resulting from the introduction and spread of invasive plants. A decision tree, a literature review, expert consultations, and a calculation of individual hazard quotients would be used to assess the inclusion of additional herbicides in the park's IPM toolbox. These assessment tools would be used to evaluate the need for application of herbicides in water to control aquatic invasive species.

Draft Impairment Determinations

Ten resource topics were analyzed: soils, hydrology and water quality, wetlands, vegetation, special status plants, wildlife, special status wildlife, designated Wilderness, archeological resources, traditional cultural properties and ethnographic resources, and cultural landscapes. A determination of impairment is not required for either visitor experience and recreation or park operations. Environmental justice, geology and geologic hazards, prime and unique agricultural lands, socioeconomics, noise, air quality, and scenic resources were dismissed from further analysis because implementation of this plan would not result in measurable effects on these resources.

Soils: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on soil microorganisms and chemistry, Alternative 3 would not result in impairment of the park's soils for future generations.

Hydrology and Water Quality: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on hydrology, water quality, or aquatic flora and fauna, Alternative 3 would not result in impairment of the park's soils for future generations.

Wetlands: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on wetland, riparian, and lakeshore soils, hydrology, and wildlife, Alternative 3 would not result in impairment of the park's wetlands for future generations.

Vegetation: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 3 would not result in impairment of the park's vegetation for future generations.

Special Status Vegetation: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on non-target vegetation, Alternative 3 would not result in impairment of the park's special status plants for future generations.

Wildlife: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 3 would not result in impairment of the park's wildlife for future generations.

Special Status Wildlife: Because the proposed actions would not result in any more than localized short-term negligible adverse impacts on individual animals or species populations, Alternative 3 would not result in impairment of the park's special status wildlife for future generations.

Designated Wilderness: Because the proposed actions would be expected to result in negligible adverse impacts, Alternative 3 would not result in impairment of the park's wilderness character for future generations.

Archeological Resources: Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 3 would not result in impairment of the park's archeological resources for future generations.

Traditional Cultural Properties and Ethnographic Resources: Because the proposed actions would result in minor adverse impacts, Alternative 3 would not result in impairment of the park's traditional cultural properties or ethnographic resources for future generations.

Cultural Landscapes: Because any impacts resulting from the proposed actions would be minimized in accordance with stipulations outlined in the 1999 Programmatic Agreement, Alternative 3 would not result in impairment of the park's cultural landscapes for future generations.

Appendix M: Total Herbicide Use by Species Applied in Yosemite National Park in 2009 and 2010

		2009		*2010*	
Species	***Herbicide***	**Gallons Concentrate Used**	**Canopy Acres Sprayed**	**Gallons Used**	**Canopy Acres Sprayed**
bull thistle	Milestone®*	0.2	4.7	0.6	11.1
Himalayan blackberry	Milestone®	0.6	11.1		
Italian thistle	Milestone®			0.004	0.1
ox-eye daisy	Milestone®	0.02	0.4	0.38	6.9
perennial sweet pea	Milestone®	0.01	0.2		
purple vetch	Milestone®	0.01	0.4		
St. John's wort	Milestone®			0.002	0.03
yellow star-thistle	Milestone®	0.4	8.2	0.78	16.6
Total (as of 8/19/10) **Est. Total 2010**		1.2	25.0	1.8 2.2	34.8 43.4
cheatgrass	Roundup Pro® Max®**	0.01	0.01		
velvet grass	Aquamaster®	1.7	1.7		
Himalayan blackberry	Aquamaster®	0.03	0.03		
Himalayan blackberry	Roundup Pro®	8.7	4.5		
Himalayan blackberry	Roundup Pro Max®	7.4	5.1	15.7	20.9
hops	Roundup Pro®	0.3	0.3		
Tree-of-heaven	Roundup Pro Max®	1.1	0.1		
yellow star-thistle	Aquamaster®	2.1	1.8	4.4	7.4
yellow star-thistle	Roundup Pro®	4.3	2.2		
yellow star-thistle	Roundup Pro Max®			1.5	2.0
Total (as of 8/19/10) **Est. Total 2010**		25.6	15.7	21.5 26.9	30.3 37.9

*Milestone® is the trade name for aminopyralid
**Upland and aquatic formulations of glyphosate

Yosemite National Park
P.O. Box 577
Yosemite, CA 95389

www.nps.gov/yose/

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

EXPERIENCE YOUR AMERICA **November 2010** Printed on recycled paper