National Park Service
U.S. Department of the Interior

Crater Lake National Park

Invasive Vegetation Management Plan

Environmental Assessment

March 2017

ON THE COVER

Top: Crater Lake as seen from Cloudcap Overlook. Photograph by Jennifer Beck.

Bottom left: Bull thistle (*Cirsium vulgare*) in a diverse meadow near Castle Creek. Photograph by Jennifer Beck.

Bottom center: Invasive Vegetation Management staff controlling St. John's Wort (*Hypericum perforatum*) in the remote Red Blanket Canyon. Photograph by Jennifer Beck.

Bottom right: Cheat grass (*Bromus tectorum*) found in the Crater Lake National Park backcountry. Photograph by Jennifer Beck.

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Introduction

Crater Lake National Park staff is proposing to implement a new plan for the management of non-native, invasive plant species. The National Park Service (NPS) 2006 Management Policies (USDI NPS 2006) define native and non-native species: "Native species are defined as all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system. Exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as non-native, alien, or invasive species." Not all non-native species are considered invasive species. Executive Order 13112 defines an invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (USDI 2007).

Invasive plant species are widely considered to be one of the greatest threats to natural areas through their ability to change vegetation composition and structure, biodiversity, relationships with and distribution of pollinators and wildlife, soil biology, and ecosystem processes such as nutrient cycling and disturbance regimes. The purpose of this environmental assessment is to expand current invasive vegetation management efforts and implement a more comprehensive strategy. The proposed action will help protect the composition, structure, and function of the park's native plant communities and the species that depend on them.

Background

Established in 1902, Crater Lake National Park protects approximately 183,000 acres of forested and non-forested ecosystems, which includes the iconic Crater Lake. The park is located in the Cascade Range of southwestern Oregon (Figure 1). Under the park's enabling legislation and NPS Management Policies (2006), park staff is mandated to protect and preserve its natural and cultural resources and natural processes while minimizing human influence on these resources.

Thanks to early botanists who studied and documented the flora of Crater Lake National Park, there is a spotty record of non-native plant invasion. F.V. Coville found one non-native plant species out of approximately 175 plant taxa in 1897, which comprised 1% of the flora (Coville 1897). E.I. Applegate recorded 13 non-native plant species out of 564 plant taxa from 1934-1938, which was 2% of the flora (Applegate 1939). P.F. Zika recorded 49 non-native plant species out of 682 plant taxa from 1993-2001, comprising 7% of the flora (Zika 2003). To date 86 non-native plant species have been found within the park out of 786 plant taxa, which is 10.9% of the flora. Over the last 5 years, new-to-the-park non-native plant species have been recorded each year. In the 2015 field season alone, 12 new non-native plant species were discovered; 7 new non-native plant species were found in the 2016 field season.

Park staff has made efforts to control non-native, invasive plant species over the years. There are records of employees manually removing weedy plant species during the 1960s and 1990s. However, regular and recurring efforts to control invasive plant species did not commence until 2003. In this year, park management funded one dedicated seasonal employee to conduct a baseline inventory of non-native plant distribution and abundance throughout the park focusing on park roadsides. The Invasive

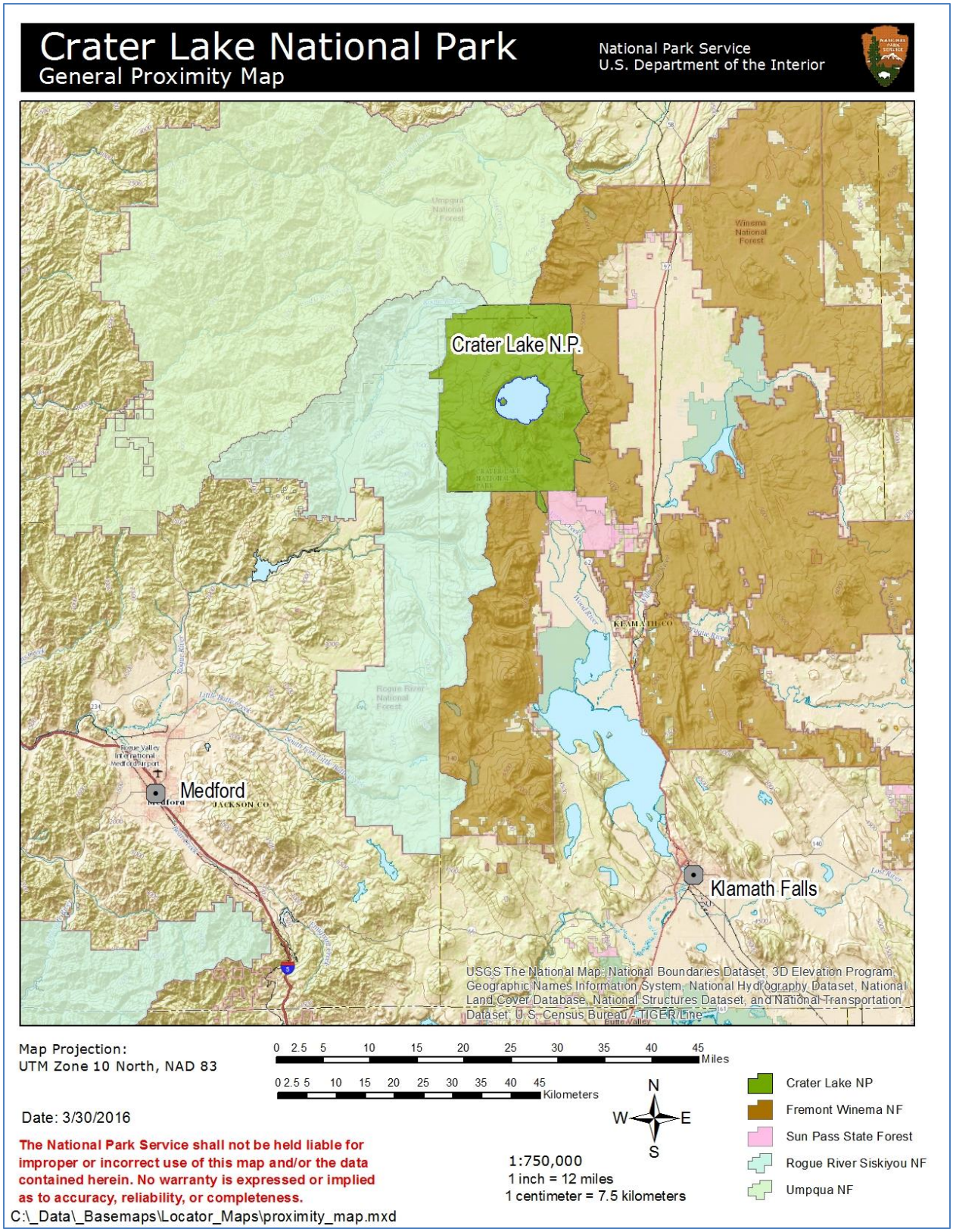

Figure 1. Proximity map for Crater Lake National Park. Map by Chris Wayne.

Vegetation Management program has made annual efforts since 2003 to survey for and control infestations of invasive plants and monitor treatment efficacy. Invasive Vegetation Management staff size has fluctuated from one seasonal employee during the early years to a maximum of seven seasonal employees during the 2016 field season. The park's Invasive Vegetation Management program will be an ongoing effort for the foreseeable future.

Purpose

The purpose of the Invasive Vegetation Management Plan is to provide a framework for managing non-native, invasive plants in order to protect the park's native ecosystems. This plan will provide guidance for preventing new infestations of invasive plant species and outline an adaptive management process for controlling existing populations of invasive plants within the park using manual, mechanical, cultural, biological, and chemical methods. Additionally, the Invasive Vegetation Management Plan will establish methods for tracking and reporting invasive plant species' occurrence and their control in order to measure effectiveness over many years. This plan will provide park staff with tools to protect and enhance native vegetation and biodiversity, and maintain the integrity of park ecosystems and their associated processes. The duration of the Invasive Vegetation Management Plan is 15-20 years; however, adjustments may be made as determined by the adaptive management process.

The goals of the Invasive Vegetation Management (IVM) plan are:

1. *Prevention*: Prevent the introduction and spread of invasive plant species within Crater Lake National Park.

2. *Early Detection and Rapid Response*: Survey for new invasive plant infestations to allow for swift treatment and control.

3. *Effective Control:* Control invasive plant species within the park through eradication, containment, and reduction of invasive plant population densities and abundance. Utilize an adaptive management framework based on the best available science and current knowledge to determine the most effective and appropriate treatment options for proactively controlling invasive plant species.

4. *Monitoring and Data Management:* Monitor treatment efficacy and use results of monitoring to inform management. Manage invasive vegetation data to enable regular reporting of results and progress.

5. *Outreach and Education:* Educate and inform park visitors, employees, and partners on the park's Invasive Vegetation Management program and involve them in prevention, control, and monitoring efforts.

6. *Collaboration*: Communicate regularly with park partners, including other federal, state, and county entities, and collaborate on invasive vegetation management and control.

Need

Invasive plant species are one of the biggest threats to the park's ecosystems. Eighty-six non-native plant species have been documented within the park, with new species found on an annual basis. Park staff lacks a comprehensive strategy outlining goals and objectives for preventing the establishment of invasive plant species, controlling their spread, and monitoring the efficacy of control treatments. National Park Service policy directs park units to develop plans for managing invasive plant species as one of the fundamental ways to uphold its mission to protect and preserve park resources for future generations to experience and enjoy (USDI NPS 2006).

Relationship to Other Plans and Policies

The Invasive Vegetation Management Plan is consistent with the following documents outlining park management goals and objectives:

- Crater Lake National Park General Management Plan (2005)
- Crater Lake National Park Fire Management Plan (2004)
- Crater Lake National Park Resource Management Plan (1999)

Additional National Park Service (NPS) and federal policy guiding this plan include:

- Executive Order 13112 on Invasive Species (2016)
- Department of Interior Integrated Pest Management (2007)
- Plant Protection Act of 2007
- NPS Management Policies (2006)

National Park Service and other federal agencies are required to assimilate Integrated Pest Management (IPM) into resource management activities. National Park Service IPM is "a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage, by cost-effective means, while posing the least possible risk to people, resources, and the environment" (USDI NPS 2006). One of the main functions of IPM is to identify the underlying causes of the pest issue to help remedy the problem before it starts. For invasive vegetation management, this often means increased efforts to prevent the introduction and spread of invasive species. IPM is conducted on a case-by-case basis so that treatments are targeted and specific to increase efficacy (McCrea and DiSalvo 2001). IPM also permits the combination of two or more treatment methods to achieve synergistic effects.

Public Participation and Scoping

Internal scoping was held during 2013-2014 by an interdisciplinary team of park resource specialists, and stakeholder scoping was held from November 3rd to December 3rd, 2014. During stakeholder scoping, a letter seeking input to the proposed plan was sent to over 30 federal, state, and local agencies and institutions including U.S. Forest Service, U.S. Fish and Wildlife Service, county and IPM managers, and

tribal representatives. No feedback was received by the park during the stakeholder scoping period. Public scoping on the purpose and need for the Invasive Vegetation Management Plan was held from February 3 to March 9, 2016. A press release announcing public scoping was sent out on February 3, 2016 to local media organizations. One phone call was received during the public scoping period; the caller requested more information on the Invasive Vegetation Management Plan and information was shared with the interested party. No comments were received from the public during this scoping period.

Impact Topics Dismissed From Further Analysis

Impact topics for this environmental assessment were identified based on federal laws and NPS policies, and input from NPS subject matter experts and the public. During this process, some impact topics were dismissed from further analysis because: (1) they did not occur within the analysis area, (2) they would not be affected by the proposed actions or impacts were not expected to occur, (3) due to the application of mitigation measures any impacts would be minor or less, and minimal controversy exists on the subject.

Air Quality

Crater Lake National Park has been designated as a Class 1 airshed under the Clean Air Act of 1963 (42 U.S.C. 7401 et seq.) due to its exceptional air quality. Park staff is mandated by law to meet all federal, state, and local air pollution standards. The actions proposed under both alternatives include use of mechanical equipment and/or herbicides that would have little impact on air quality resources. Use of mechanical equipment, including string trimmers or chainsaws, would be very limited in area and duration. Herbicide formulations proposed for use under both alternatives are not considered volatile and the amount of herbicide applied, even if volatilization into a hydrocarbon occurred, would result in negligible impacts to air quality. This topic was dismissed from further analysis.

Climate Change and Sustainability

The actions proposed in this environmental assessment would not affect or contribute to greenhouse gas emissions or associated climate change. While climate change is affecting the range and abundance of invasive plant species, the actions proposed under both alternatives would not further contribute to or accelerate this process. Within the expected duration of the Invasive Vegetation Management Plan, no foreseeable changes in weather will occur that could alter conditions favoring colonization or regeneration of invasive plant species or affect efficacy of planned control methods. This topic was dismissed from further analysis.

Environmental Justice

Under Executive Order 12898 *General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, federal agencies are required to assess whether proposed actions contribute disproportionately to human health and/or environmental impacts for minority and low-income populations and communities. The actions proposed in this environmental assessment would not occur in areas where minority or low-income populations could realize disproportionate impacts to human health and the environment. This topic was dismissed from further analysis.

Floodplains

Executive Order 11988 *Floodplain Management* directs federal agencies to avoid construction in 100-year floodplains to the extent possible. No action proposed in this environmental assessment would affect floodplain values or contribute to hazardous floodplain conditions. This topic was dismissed from further analysis.

Geologic Resources

Under the 2006 Management Policies, the NPS is required to protect geological resources from adverse human impacts and maintain natural processes. The manual, mechanical, and chemical treatments proposed in this environmental assessment would cause negligible impacts, if any, to geological resources. This topic was dismissed from further analysis.

Indian Trust Resources

Secretarial Order 3175 requires Department of Interior agencies to explicitly address any proposed actions that may affect Indian trust resources. There are no Indian trust resources at Crater Lake National Park, and no Indian trust resources would be affected by the proposed actions in this environmental assessment. This topic was dismissed from further analysis.

Museum Collections

Director's Order 24 *Museum Collections*, requires consideration of impacts to museum collections and provides policy guidance for preserving, documenting, protecting, and providing access to and use of NPS museum collections. The proposed actions in this environmental assessment would cause negligible impacts, if any, on museum collections. This topic was dismissed from further analysis.

Natural Lightscapes

Invasive vegetation management activities will not be conducted at night, so none of the proposed actions in this environmental assessment will affect natural lightscapes. This topic was dismissed from further analysis.

Prime and Unique Farmlands

Federal agencies are required by the Farmland Protection Policy Act of 1981 to consider adverse impacts to prime and unique farmlands that would result in their conversion to non-agricultural uses. Crater Lake National Park does not contain any prime or unique farmlands, nor would any prime or unique farmlands be affected by any of the proposed actions in this environmental assessment. This topic was dismissed from further analysis.

Socioeconomics

Crater Lake National Park plays an important role in recreational and economic life in Southern Oregon, with benefits to local businesses and gateway communities. The proposed actions in this environmental assessment would not change local and regional land use nor affect park gateway and economic activities. This topic was dismissed from further analysis.

Soundscapes

The 2006 Management Policies and Director's Order 47 *Sound Preservation and Noise Management* direct NPS units to preserve natural soundscapes. The absence of human-created sound defines a natural soundscape. Noise from mechanized string trimmers and chainsaws may cause short-term, negligible impacts to the park's soundscapes. Mechanical treatments proposed by this environmental assessment would be conducted outside of the park's recommended wilderness. Since the impacts of using mechanized equipment would be short-term and negligible, this topic was dismissed from further analysis.

Alternatives

This chapter discusses two alternatives (No Action and Proposed Action) for invasive vegetation management at Crater Lake National Park. Alternatives were developed by an interdisciplinary team of park resource specialists in December 2014 after holding stakeholder scoping to identify potential concerns and approaches that should be considered in the planning process. The Proposed Action was developed to outline the best strategy to uphold the park's mission and meet the goals and objectives of the park's Invasive Vegetation Management program. The Proposed Action (Alternative 2) and the No Action alternative (Alternative 1) are evaluated in this environmental assessment.

Description of the Alternatives

Under Alternative 1 (No Action), park staff would continue with its current strategy for invasive vegetation management. The park's existing program is grounded in prevention of invasive plant species' establishment and spread; early detection of new invasive plant species and populations, and rapid response in treating new infestations; control of existing invasive plant infestations to either eradicate, prevent further spread, and/or reduce extent of populations; monitoring of treatments to gauge effectiveness; public outreach and education efforts; and collaborating with park partners. Control methods are limited to manual removal for all park invasive plant species, with chemical control allowed only for roadside St. John's wort (*Hypericum perforatum*) with the herbicide fluroxypyr (trade name "Vista").

Under Alternative 2 (Proposed Action), park staff would embark on a new strategy for Invasive Vegetation Management. This new strategy would retain the emphasis on prevention, early detection and rapid response, control, effectiveness monitoring, outreach/education, and collaboration. The new strategy would utilize an adaptive management framework to evaluate the most effective and appropriate control method for each invasive plant species and utilize approved treatment methods. This alternative would establish a protocol for evaluating and approving invasive plant treatment methods and include an expanded array of current and new treatment options to enable park staff to respond swiftly and appropriately to new invasions and to more effectively treat existing infestations. This adaptive management protocol would also allow park staff to utilize more effective and environmentally sensitive control methods as they become available. This approach would capitalize on time and resources to limit the size and spread of new invasions and most appropriately treat existing infestations to best protect park resources and biodiversity.

Elements Common to Both Alternatives

Integrated Pest Management

NPS Management Policies (USDI NPS 2006) require an Integrated Pest Management approach in the management of invasive vegetation. The central tenets of the IPM approach include prevention, early detection, control, monitoring, and collaboration and are common to the No Action and Proposed Action alternatives.

Prevention

The most effective way to manage invasive species is to prevent their introduction and spread. This can be achieved through the adoption of various methods, called Best Management Practices (BMPs), which lessen the probability of inadvertent invasive plant introduction and spread. Prevention principles include (Cal-IPC 2012):

- Ensure adequate planning occurs, including conducting pre-project surveys and identifying mitigations to avoid exacerbating the invasive plant situation.
- Do not move invasive plant materials and seeds.
- Minimize soil and vegetation disturbance.

Early Detection and Rapid Response

Another effective way to manage invasive plant species is to catch infestations when they are small in size and eradication is feasible (Welch et al. 2012). This is achieved through annual invasive plant survey and control efforts that prevent new infestations from spreading beyond their introduction point.

Effective Control

The first step of the effective control process is setting management priorities and determining which non-native species warrant treatment. Control of invasive vegetation is expressed as: 1) eradication of small infestations; 2) containment of established invasive plant populations to prevent further spread; and 3) reduction in established invasive plant population size and abundance. Treatments for invasive vegetation control are determined on a case-by-case basis, taking into account the invasiveness of the non-native plant species, management priorities, the target plant's life history, the location of infestation (including any site-specific considerations), and permissible treatment methods. Treatment methods may include manual, mechanical, chemical, and cultural techniques and biological control.

Monitoring and Data Management

In order to document and track patterns in invasive vegetation and gauge progress made by control efforts, a standard set of data is collected. Invasive plant infestations are documented by species, location, size, abundance, phenological state, and treatment method. Treatments are documented and monitored to determine whether management objectives were achieved, or if tactics and strategies should change to better meet objectives.

Collaboration

Invasive vegetation is managed across political and jurisdictional boundaries using different methods and levels of effort to control non-native plant species. Priorities on control vary with the missions and goals of various land managers. Working with park neighbors and partners is essential to identify mutual goals and coordinate efforts across jurisdictional boundaries to assure successful invasive vegetation management.

Alternative 1: Continue Current Management (No Action)

Under the current management, invasive plant species are prioritized for control based on their management priority and control strategy, location, and feasibility of control (Appendix A). Invasive Vegetation Management goals are focused on prevention, early detection and rapid response, effective control, monitoring and data management, education and outreach, and collaboration. However, the use of herbicides is limited and restricted to one currently approved herbicide. Under Alternative 1, Crater Lake National park would continue its current course of action in managing invasive vegetation using the following IPM principles.

Prevention

Ensuring Adequate Planning

Crater Lake National Park natural resource staff reviews all proposals for projects to be implemented within the park within the context of how they may lead to the establishment and spread of non-native, invasive plant species. For any project causing ground or vegetation disturbance, project sites are surveyed for invasive plant species prior to project implementation so that treatment of invasive plants can occur and mitigations developed to prevent the spread of existing populations. The park uses its Resource Advisor for Wildland Fire program to share maps of known invasive plant populations and integrate local knowledge of the park's invasive plant situation to help guide fire management activities (e.g., avoiding the staging of personnel and equipment in areas with invasive plant populations). Major construction activities in the park must allow for several years of survey and treatment of invasive plant species before and after project implementation.

Preventing Movement of Invasive Plant Materials and Seeds

To minimize the introduction and spread of invasive plant species, all projects and management activities within Crater Lake National Park utilize vehicles, equipment, gear, tools, clothing, etc. that are clean and free of plant propagules, seeds, organic debris, and soil. Incoming vehicles and equipment arrive in the park clean and are inspected by project leaders prior to commencing work. Inspection standards follow those developed by the Department of Interior, Bureau of Reclamation (DiVittorio et al. 2012). For large and protracted activities such as construction projects or fire management incidents, a mobile wash station may be established within the park and staffed to provide inspections and cleaning as equipment enters the park. For work occurring within areas of the park where invasive plants are known to occur, all potential vectors of invasive plant spread (e.g., vehicles, equipment, gear, tools, and clothing) are cleaned prior to commencing work at a new worksite. A designated cleaning station has been established at park headquarters.

The Superintendent's Compendium (USDI NPS 2017) requires the use of certified weed-free pellet feed for all horses and pack animals brought into the park. The use or transport of hay, straw, or seed-type feeds is prohibited within park boundaries. Horses and pack animals must be fed certified weed-free feed for several days prior to entering the park to reduce the chance of spreading non-native, invasive plant species through manure.

Any incoming earthen materials (e.g., base rock, gravel, road sand, topsoil, fill, etc.) should come from a pre-approved source that has been inspected by the park's natural resource staff. Preferably, native

materials (i.e., fallen rock and ditch fill) sourced from within the park would be used when available. Use of certified weed-free sources may be an option. As of this writing, Crater Lake National Park does not have a local weed-free source for earthen materials. Therefore, mitigations have been developed for use of materials from potentially contaminated sources.

All projects within the park that create a substantial amount of ground disturbance require restoration including revegetation to rehabilitate the site. This helps reduce the amount of bare ground available for colonization by invasive plant species. Revegetation and erosion control efforts do not use straw, hay, off-site mulch, off-site compost, or off-site topsoil in restoration efforts. When large areas are to be disturbed, on-site weed-free topsoil is first removed and retained close to the project site for replacement after the project is completed to aid in revegetation efforts. Revegetation efforts utilize native genotypes appropriate for and collected on site, and seeding uses site-specific seed mixes collected around project areas within the park whenever possible.

Park visitors, employees, and partners are encouraged to maintain their vehicles, clothing, footwear, gear, pets, etc. in a clean state free of soil, plant materials and seeds, and organic debris as to not introduce or spread invasive plants within the park.

Minimizing Soil and Vegetation Disturbance

Projects within the park are required to limit disturbance to soils and vegetation to the greatest degree practical. Equipment and tools are selected that make the least possible impact upon soils and vegetation, such as small, rubber-tracked vehicles or hand-held equipment that can precisely direct impacts to desired targets. When implementing projects such as clearing roadside vegetation or removing debris from culverts, park personnel employ light-on-the-land tactics that achieve project objectives in an environmentally sensitive manner that also helps prevent the introduction and spread of invasive plant species. Fire management personnel routinely employ “Minimum Impact Tactics” that are aligned with light-on-the-land principles, allowing for successful fire management while protecting park resources, including preventing the introduction and establishment of invasive plant species.

Project managers work with the park botanist to consider the biology and phenology of the vegetation to be disturbed or removed. Vegetation management activities are timed to occur after periods of seed production and release of native species to allow dispersion, and outside periods of seed production in invasive species to prevent their spread.

Early Detection and Rapid Response

Two methods for early detection of invasive plants are currently employed within the park. Select road and trail segments are sampled every other year by the NPS Klamath Inventory and Monitoring Network staff. Crater Lake National Park is one of the six NPS units comprising the Klamath Inventory and Monitoring Network. Any findings are reported to the park botanist. This enables the rapid treatment of new infestations.

Additionally, the park’s Invasive Vegetation Management program conducts annual surveys for new invasive plant infestations. Problem areas for invasive plants (including maintenance yards, quarries, campgrounds, park headquarters, certain road segments, and high visitor use areas) are surveyed at

least two times per growing season so that new infestations can be rapidly discovered and treated. Crater Lake National Park maintains a "Watch List" of species that have not yet been found within the park but are known to be present near park boundaries or on the move in the region. New Invasive Vegetation Management crew members are trained in identification of these watch-listed species.

Effective Control

All non-native plant species documented within Crater Lake National Park are assessed within the context of whether they pose a threat to biodiversity and, if so, whether their control is feasible. Control of invasive vegetation is expressed as: 1) eradication of small infestations; 2) containment of established invasive plant populations to prevent further spread; and 3) reduction in invasive plant population size and abundance. Treatments for invasive vegetation control are determined on a case-by-case basis, taking into account the invasiveness of the non-native plant species, management priorities, the target plant's life history, the location of infestation (including any site-specific considerations), and permissible treatment methods. Treatment methods include manual, chemical, and cultural techniques.

Manual Control

The most commonly employed control methods to date at Crater Lake National Park are hand pulling and using hand tools to remove plants. Plant propagules, flower heads, fruits, seeds, and any other plant material capable of reproduction are bagged and removed from the site; vegetative material is typically left to desiccate and biodegrade on site when it will not cause aesthetic or logistical problems to park visitors, employees, or partners.

Chemical Control

Herbicides are currently used at Crater Lake National Park in a very limited manner for control of invasive vegetation. The park has received approval in the past to use the herbicide fluroxypyr (Vista) to treat roadside St. John's wort through the National Park Service Integrated Pest Management program and the environmental compliance process.

Cultural Methods

Cultural control methods currently used in the park include avoiding disturbance of soils and vegetation; maintaining healthy native plant communities; and restoring disturbed areas via revegetation and rehabilitation efforts. All park projects are analyzed to limit the project disturbance footprint to the greatest degree practical. Another cultural treatment method that is used at CRLA is covering invasive plants to deprive them of sunlight. This covering treatment has used weed cloth, plastic sheeting, or plywood to smother invasive plant species. This method is appropriate only for very dense invasive plant populations or where there is low cover of native plant species to avoid impacts to neighboring native vegetation.

Monitoring and Data Management

Invasive plant infestations are documented by species, location, size, abundance, phenological state, and treatment method. All Invasive Vegetation Management data collected since 1998 are stored within a geodatabase and Access database maintained on the park server. Treatments are documented

and monitored to determine whether Invasive Vegetation Management objectives were achieved, or if tactics and strategies should change to better meet management objectives. A report is compiled each year that summarizes findings and trends in invasive vegetation management and assesses treatment efficacy.

Outreach and Education

One method for preventing the establishment and spread of invasive plant species is educating park visitors, employees, and partners on the threat posed by these invaders and sharing information on what can be done to help keep invasive plant species out of the park. Outreach and education efforts for the Invasive Vegetation Management program include:

- Park website and newspaper – provide information about the Invasive Vegetation Management program and its importance, and ways to help keep invasive plants out of the park.

- Mobile device applications – participate in citizen science and public reporting efforts through applications such as IPAlert, a service-wide tool for reporting invasive plant observations on mobile devices.

- Interpretive programs – incorporate information on the Invasive Vegetation Management program and invasive plant species into interpretive programs such as campfire talks, lodge talks, and Classroom at Crater Lake.

- All-Employee training – ensure all employees understand the threat posed by invasive plant species and are aware of ways they can help prevent the establishment and spread of invasive plant species. Inform employees on requirements for maintaining clean vehicles, gear, tools, equipment, etc. and locations of cleaning stations. Provide guides for invasive plant identification and means for reporting any invasive plant species observed.

- Annual reporting and outreach efforts – report annual work efforts and findings in a timely manner and disseminate this information to park staff and the general public through the NPS information delivery system known as Integrated Resource Management Applications (IRMA): https://irma.nps.gov/App/Reference/Profile/2220226

- Interpretive waysides and boot brushing stations – install informational signs and maintain boot brushing stations in key areas to help inform park visitors of the invasive plant problem and ways they can help protect the park's native vegetation.

- Volunteer work days – solicit assistance from volunteer groups to assist with control of large invasive plant populations. Volunteers may also assist with surveying for new invasive plant infestations and monitoring treatment efficacy.

- Foster the development of an invasive plant prevention culture – use opportunities to inform park visitors, employees, and partners about methods for preventing invasive plant

establishment and spread such as including weed prevention guidelines on permits for backcountry use, special and commercial use, project compliance, and research.

Collaboration

Crater Lake National Park and the Oregon Department of Agriculture's (ODA) Noxious Weed Control program established a memorandum of understanding (MOU) in 2007 to allow ODA to treat roadside St. John's wort populations with the herbicide fluroxypyr. Park staff communicates with ODA, the Rogue River-Siskiyou National Forest, the Fremont-Winema National Forest, the Umpqua National Forest, Sun Pass State Forest, and Klamath County regarding invasive plant infestations occurring near park boundaries, treatments planned near the park, and invasive plant species to watch for in the region.

Crater Lake National Park also works with partners in invasive plant treatment and control. Assistance has been received from the Friends of Crater Lake and the Youth Conservation Corps in removing large populations of invasive plants. The Crater Lake Natural History Association has also supported invasive vegetation control efforts.

Currently the Botany program at Crater Lake National Park does not receive funding for seasonal staff from the park's base operational budget. Therefore, it is critical to work with local and regional NPS staffs to help fund the Invasive Vegetation Management program. Ensuring park-based projects include support for invasive plant survey and control efforts, soliciting Natural Resource Cyclic Maintenance funds from the NPS regional office, and pursuing opportunities from the NPS Fire Management program to survey for and control invasive plants in recently burned areas are some relationships that must be maintained to support this planning effort.

Collaboration with park partners is essential to ensure that operations within the park are aligned with the goals and objectives of the Invasive Vegetation Management program. Coordination with partners such as Xanterra (the park's concessionaire) and the Federal Highways Administration occurs as needed to mitigate impacts of projects occurring within park boundaries on invasive plant establishment and spread.

Alternative 2: Adaptive Management of Invasive Vegetation (Proposed Action)

This strategy employs an adaptive management framework that prioritizes invasive plant species for treatment and then uses a Treatment Selection Protocol (TSP – Figure 2) to identify the most effective and appropriate treatment method. The Treatment Selection Protocol links knowledge of invasive plant species' biology and life history with the most effective control technique; it also identifies the most appropriate treatment method by considering site specific factors, how to cause the least ecological damage, and cost-effectiveness. The Treatment Selection Protocol is based on best available science and current knowledge, and incorporates National Park Service, regional, state, and Crater Lake-specific concerns. Additionally, the Treatment Selection Protocol is adaptive to enable park staff to adjust management actions and respond effectively and appropriately to changing conditions. This is important as new invasive plant species are observed within the park on an annual basis; having the appropriate methods available to respond to these new invasions is critical. The Treatment Selection

Protocol allows park staff to utilize new treatment methods, including herbicides that are safer, more effective, and more selective as they become available if they are approved through the TSP process.

Under Alternative 2, ten new herbicides would be approved for use within the park as determined by implementation of the TSP. The TSP would also be employed to assess additional herbicides as needed. Additionally, biological control of invasive plant species would be considered on a case-by-case basis if an approved biocontrol method is identified and approved through the TSP process.

Similar to current actions under Alternative 1, Alternative 2 is grounded in Integrated Pest Management principles.

Prevention

See the "Actions Common to All Alternatives" section. Actions would be the same as Alternative 1.

Early Detection and Rapid Response

See the "Actions Common to All Alternatives" section. Actions would be the same as Alternative 1.

Effective Control

Under Alternative 2, park staff would embark on a comprehensive Invasive Vegetation Management program grounded in adaptive management. Alternative 2 establishes a Treatment Selection Protocol that identifies the proper treatment of each invasive plant species through a decision tree process. The protocol continues to employ the same manual and cultural control methods as Alternative 1. In addition the protocol would add ten new herbicides under chemical control and a process for evaluating and approving the use of emerging herbicides. The proposed protocol also identifies mechanical and biological controls as potential control methods. Control methods proposed for use under Alternative 2 put the park in the best possible position from which to respond to new plant invasions, and to provide the park with a complete toolbox with which to effectively manage invasive vegetation.

Crater Lake National Park staff would prepare a short-term Invasive Vegetation Management work plan that outlines proposed treatment methods by invasive plant species and location. This work plan would be reviewed annually by park service resource specialists (Botanist; Wildlife Biologist; Aquatic Ecologist and/or Fisheries Biologist; Cultural Resource Specialists; Wilderness Coordinator; and the NPS Regional IPM Coordinator) and incorporate site-specific mitigations and recommendations to avoid and mitigate impacts to sensitive species and resources and ensure compliance will all applicable laws and regulations. The work plan will be reviewed by Cultural Resources Specialists to ensure proposed undertakings do not affect historic properties, or that any effect is mitigated, through the process outlined in Section 106 of the National Historic Preservation Act. The proposed 2017 Invasive Vegetation Management work plan is outlined in Appendix B. This work plan sets forth projects that could begin in, but not necessarily be completed in, 2017. Invasive Vegetation Management work plans would be approved on an annual basis through the park compliance review process by resource specialists to ensure conditions, impacts, or concerns have not changed.

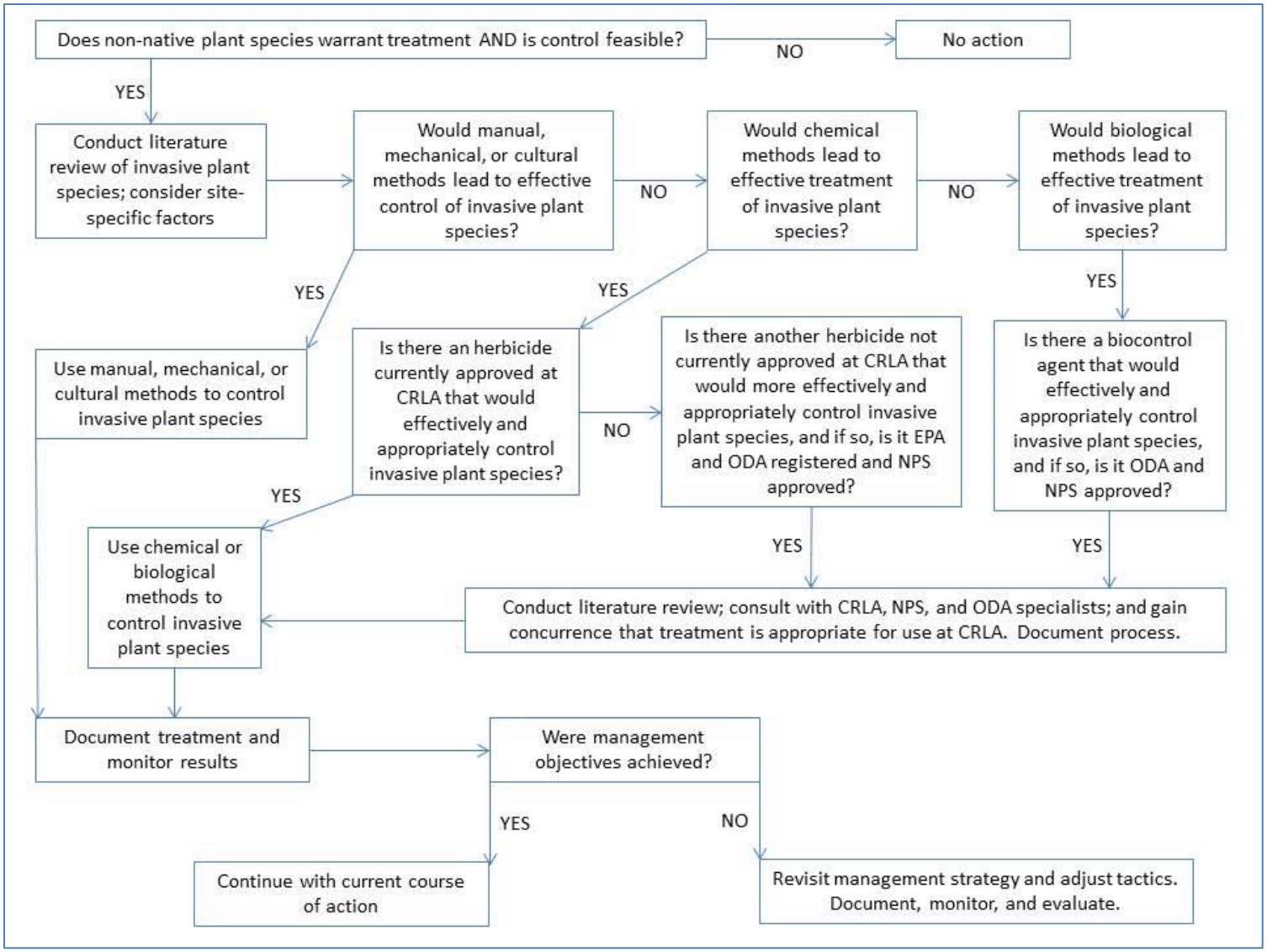

Figure 2. Invasive Vegetation Management Treatment Selection Protocol. Adapted from Yosemite National Park's Invasive Plant Management Update Environmental Assessment (USDI NPS 2010).

Mechanical Control

This treatment method would involve mechanical equipment to control invasive plant species. Mechanized tools may include chainsaws, string trimmers, brush cutters, and clearing saws. This type of treatment would be timed to occur outside of periods of seed dispersal to avoid exacerbating invasive plant infestations. Mechanical treatment under Alternative 2 may be combined with chemical treatment methods to improve chances of achieving effective control. Proposed mechanical control methods in habitat for sensitive, threatened, or endangered species would require consultation with the park's Terrestrial Ecologist and the USFWS if warranted. Surveys may need to occur and mitigations established prior to treatment implementation to avoid impacts to species of concern or cultural resources. Presently there is no need to implement mechanical control; any future mechanical treatments are likely to be very limited in size and scale.

Chemical Control

Under Alternative 2, ten new herbicides (Table 1) would be approved for use within the park for effective control of invasive vegetation. All of these proposed herbicides have been approved by the U.S. Environmental Protection Agency (EPA), the ODA, the NPS, and Crater Lake National Park staff.

Herbicide risk assessments have been completed for federal land management agencies and are available here:

http://www.fs.fed.us/foresthealth/pesticide/risk.shtmlhttp://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/vegeis.Par.13055.File.dat/Rimsulfuron%20Ecological%20Risk%20Assessment.pdf

The herbicides proposed for use under Alternative 2 were selected after considering herbicides recommended for control of the park's known and watch-listed invasive plant species; considering herbicides used at other NPS units and those used on neighboring national forest land and in USFS Region 6 (Oregon and Washington); and after consultation with park staff, NPS IPM coordinators, and ODA Noxious Weed Control program staff. All of the herbicides proposed for use under Alternative 2 have been previously approved by the NPS IPM program. Approval for herbicide use would be obtained annually from the NPS IPM program through the submission of Pesticide Use Proposals. When selecting chemical treatment methods, park staff would choose the most selective, environmentally compatible and effective herbicide that minimizes impacts to human health, native vegetation, aquatic resources, wildlife, and cultural resources that still meets invasive vegetation management goals.

Table 1. Herbicides proposed for use under Alternative 2. Information derived from DiTomaso et al. (2013).

Herbicide	Trade Name*	Selectivity	Treatment Type	Use Areas
Aminopyralid	Milestone	Broadleaf and woody plants	Pre- and post-emergence	Terrestrial to water's edge
Chlorsulfuron	Telar	Broadleaf plants and some grasses	Pre- and post-emergence	Terrestrial
Clopyralid	Transline	Broadleaf and woody	Pre- and post-	Terrestrial

Herbicide	Trade Name*	Selectivity	Treatment Type	Use Areas
		plants	emergence	
Glyphosate	Roundup, Aquamaster	Grasses, broadleaf, and woody species	Post-emergence	Terrestrial and Aquatic formulations
Imazapic	Plateau	Annual & perennial grasses, broadleaf plants, and vines	Pre- and post-emergence	Terrestrial
Imazapyr	Arsenal, Habitat, Stalker	Grasses, broadleaf plants, some brush and vines, aquatic plants	Pre- and post-emergence	Terrestrial and Aquatic formulations
Metsulfuron	Escort	Broadleaf plants	Pre- and post-emergence	Terrestrial
Rimsulfuron	Matrix	Broadleaf plants and grasses	Pre-emergence	Terrestrial
Sulfometuron	Oust	Broadleaf plants and grasses	Pre-emergence	Terrestrial
Triclopyr	Garlon	Woody and herbaceous broadleaf plants	Post-emergence	Terrestrial and Aquatic formulations

**Note: trade names provided in this table are examples and additional trade names may be considered for use.*

The ten herbicides proposed for use under Alternative 2 were selected to encompass a spectrum of possible chemical control needs for the park's IPM toolbox. All herbicides would be applied using selective methods such as foliar spray, wicking or wiping, frill, or stem injection:

- Foliar spray – herbicides are sprayed on leaves of invasive vegetation using a hose attached to a backpack sprayer or tank mounted on a truck or utility-task vehicle (UTV). Truck and UTV applications would be limited to existing park roads that are approved for vehicular traffic.

- Wicking or wiping – this application method applies herbicides more selectively by using a wick, sponge, pad, brush, or other method. Herbicide can be precisely applied to the target invasive plant with lesser impacts to soil, non-target plants, or water. This method is more labor-intensive and may be less effective than the foliar spray method.

- Stem injection – herbicide is injected directly into the invasive plant (most likely woody species) using a syringe, hatchet, or other method. This method is highly selective but labor-intensive.

- Cut stump and frill – cut stumps of woody invasive vegetation (e.g., vines, shrubs, or trees) are treated with herbicide. This method is similar to stem injection in that it is highly selective but labor-intensive.

Under Alternative 2, additional herbicides not listed in Table 1 could be approved for use through the Treatment Selection Protocol. New herbicides would be considered only if they: 1) offered increased selectivity or increased effectiveness with equivalent or lower environmental and human health and

safety risks as currently approved herbicides; or 2) fulfilled a control need for an invasive plant species not effectively treated by currently approved herbicides. For such products, advance compliance would occur as required by the National Park Service Integrated Pest Management program.

Herbicides often require the addition of adjuvants such as surfactants to increase their efficacy. Only surfactants approved for use by the NPS will be used under Alternative 2. Temporary dyes may be added to herbicide applications to increase visibility of treated areas and improve worker safety.

Herbicide applications would be performed in accordance with national and state laws and NPS policies. All herbicide applications would be performed by or under direct supervision of a licensed Oregon State Pesticide Applicator and adhere to label instructions.

Biological Control

Biological methods are included as an invasive vegetation treatment option under Alternative 2's Treatment Selection Protocol. Currently, park staff has no need to implement this treatment method. If conditions change and park staff is faced with a large infestation of invasive plants for which biocontrol agents are the best treatment method as identified by the Treatment Selection Protocol, approved biocontrol agents would be allowed for use if deemed appropriate after consultation with the NPS, ODA, and CRLA staff. To minimize impacts of introducing non-endemic agents to the park, approved biocontrol would be considered only when: 1) there are no other feasible treatment options for the control of an invasive plant species; 2) the ecological impacts of the invasive plant species justify the introduction of non-endemic biocontrol agents; 3) scientific literature supports the effective control of the target invasive plant by the biocontrol agent; 4) host specificity of the biocontrol agent has been confirmed and no non-target impacts have been documented; 5) the effects of the biocontrol agent on native wildlife species are understood and have been documented; and 6) consultation with the NPS, ODA, and CRLA staff has resulted in approval of the biocontrol agent for control of the target invasive plant species. If during the consultation process any impacts emerge as being other than short-term and minor, additional NEPA compliance would be pursued prior to using biological methods.

Monitoring and Data Management

See the "Actions Common to All Alternatives" section. Monitoring and data management would be the same as Alternative 1.

Outreach and Education

See the "Actions Common to All Alternatives" section. Outreach and education would be the same as Alternative 1.

Collaboration

See the "Actions Common to All Alternatives" section. In addition to the actions under Alternative 1, Alternative 2 would allow for more collaboration with park neighbors, as effective cross-boundary treatments of mutually undesirable invasive plant species (e.g., Canada thistle, St. John's wort) could occur with an expanded array of chemical treatment options.

Alternatives Considered and Dismissed

Alternatives which were inconsistent with NPS policy and mandates, which did not meet the purpose and need of the Invasive Vegetation Management Plan, which would have severe impacts upon park resources, or which were impossible to achieve due to logistical or technical reasons were eliminated from further analysis. The following alternatives were discussed but dismissed from further consideration:

1. No use of chemical control treatments.

2. Controlling invasive plants only in the front-country and along park roadsides.

These alternatives were not given further consideration because they would not allow the park to use the best available science and tools or allow the park to meet its policy mandate and management goals to protect resources for future generations. Chemical treatment methods can be effective tools for managing groups of vegetation such as perennial, rhizomatous, or resprouting invasive plant species that are difficult to control using other methods. Chemical treatment methods are also cost-efficient ways to manage invasive vegetation large natural areas such as those encompassed by Crater Lake National Park. The park's backcountry includes pristine and diverse native ecosystems including recommended wilderness and Research Natural Areas that the park is mandated to protect. Controlling invasive plants park-wide, including backcountry areas, would fulfill the purpose and need of the Invasive Vegetation Management Plan in a timely and efficient manner.

Affected Environment and Impact Analysis

This chapter describes existing environmental conditions and potential impacts of proposed actions on nine impact categories at Crater Lake National Park: soil resources; water quality; wetlands, shorelines, and riparian areas; vegetation; wildlife and fish; cultural resources; recommended wilderness; visitor experience; and park operations. Descriptions are provided for direct, indirect, and cumulative impacts of proposed actions on impact categories. These impact categories were identified through the scoping process as those potentially affected by managing invasive vegetation. Impacts of actions proposed in this environmental assessment are considered for each impact category based on the following:

- Type of impact: beneficial or adverse
- Duration of impact: short-term or long-term
- Intensity of impact: negligible, minor, moderate, or major
- Context of impact: site-specific, park-wide, or regionally

Soil Resources

Affected Environment

The area encompassed by Crater Lake National Park is heavily influenced by Cascade Range volcanism and the cataclysmic eruption of Mt. Mazama approximately 7,700 years ago. Most park soils (90%) are volcanic in nature, with the exception of soils (10%) on the west and south near the park boundary that were not buried by ashflows and ash plumes and are derived from glacial deposits (USDA NRCS 2002). These remnant soils are the oldest in the park, consist of ash over glacial till, and are moderately deep and moderately well drained with moderate permeability (USDA NRCS 2002). The volcanically-derived soils are young with poor soil development, and are generally deep and well-drained with rapid permeability.

Soils in the north and east portions of the park contain thick layers of gravel-sized pumice with an area of finer, sand-sized pumice and ash on the eastern slope of Timber Crater. Soils in valleys and lower elevation lava plains are dominated by cobble-sized pumice. Soils around the caldera rim consist of ash and cinders with lesser amounts of pumice admixed with outcrops of andesitic or dacitic bedrock. The park's perennial streams are contained within deeply incised channels that expose layered ashflows (USDA NRCS 2002). Soils on the west side of the Cascade Crest have an udic or moist soil moisture regime, with a drier or xeric soil moisture regime east of the Cascade crest. The soils throughout the park experience primarily a cryic or very cold soil temperature regime, which slows soil development due to short growing seasons.

Soils in Crater Lake National Park contain diverse communities of fungi, bacteria, protozoa, nematodes, and arthropods that are essential to ecosystem health. The soil community is responsible for ecosystem functions such as nutrient cycling, mineral weathering, formation of soil organic matter, and creating new soils (Wolfe and Klironomos 2005). Invasive plants can release substances called allelochemicals into the soil that may inhibit growth of native plants through allelopathy and also alter the soil microbial community (Wolfe and Klironomos 2005). By changing the composition and structure of above-ground

vegetation communities, invasive vegetation can alter the structure, composition, and function of soil communities with cascading effects on nutrient cycles, ecosystem function, and biodiversity (Ehrenfield and Scott 2001). In some cases the changes to the soil environment by invasive plant species creates a positive feedback loop by creating conditions (e.g., altered soil biota; altered nutrient availability) that promote the persistence of the invasive species over native flora (Levine et al. 2006).

Alternative 1: Impacts on Soil Resources

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on soil resources through protecting and maintaining the integrity and biodiversity of native plant communities and soil communities. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual treatment methods. Manual removal of vegetation often requires ground disturbance to sever the main stem from the root, uproot the plant, or dig and remove rhizomes from perennial vegetation; this causes short-term, localized, negligible adverse impacts to soils.

Under Alternative 1, one herbicide (fluroxypyr) is permitted for use along roadsides to control St. John's wort. This herbicide has an average half-life in soils of 36 days, with decomposition accomplished primarily by microbial activity (DiTomaso et al. 2013). Spot-use of fluroxypyr results in short-term, localized, negligible to minor adverse impacts on soil resources by remaining on the soil surface until it degrades. Herbicide use Best Management Practices such as following label and MSDS instructions, requiring application by licensed applicators, and following proper application techniques help mitigate these adverse impacts. Herbicide use under Alternative 1 is limited and may hinder the park's ability to effectively control invasive plant populations using IPM techniques. This may cause long-term, localized, moderate to major adverse impacts to soils if large infestations of invasive plants are allowed to become established through reductions in biodiversity of vegetation and soil communities and potential changes in ecosystem function (e.g., nutrient cycling).

Cumulative Impacts

Analysis of cumulative impacts on soil resources is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Since the establishment of Crater Lake National Park, soils have been impacted by construction of roads and facilities to accommodate park visitors and operations. Soils have been damaged by trail construction and high concentrations of people causing compaction in visitor use areas. Soils have also been damaged by recurring maintenance of road and utility corridors and fuelbreaks. These impacts affect soil resources in many ways, including damaging soil ecosystems; altering the soil profile and removing soil organic matter; affecting soil structure; and affecting nutrient cycling processes. The control-related impacts of Alternative 1 to cumulative impacts on soil resources would be localized, short-term, negligible to minor, and adverse; with long-term

beneficial impacts attained through protecting and preserving the integrity of vegetation and soil communities.

Alternative 2: Impacts on Soil Resources

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on soil resources as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to the park by enabling a rapid and appropriate response to infestations of new-to-the-park invasive plant species using IPM methods. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on soil resources due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on soil resources through ground disturbance from hand-pulling and using hand tools to remove invasive plants. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicides instead of digging up the root mass associated with each plant yielding localized, short-term, negligible beneficial impacts to soils.

Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible adverse impacts to soil resources, as ground disturbance may result from off-target string trimmer applications.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on soil resources are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods proposed under Alternative 2 include ten herbicides with an average half-life in the environment ranging from 20 – 120 days (DiTomaso et al. 2013). Under the Treatment Selection Protocol, chemical treatments are used only after it has been determined that manual, mechanical, and cultural treatment methods would not lead to effective control of the targeted invasive plant species. The fate of herbicides in the environment is influenced by site-specific characteristics such as temperature, soil characteristics, precipitation, and amount of sunlight; which in turn influences the degradation, immobilization, and movement of herbicides post-application (DiTomaso et al. 2013). Herbicides degrade by sunlight, chemical decomposition, or microbial decomposition; and can bond with soil particles until they degrade, or move through the soil profile through leaching or runoff. Table 2 describes the primary soil degradation pathway and average half-life in the environment for each of the ten herbicides proposed for use under Alternative 2. When used according to label and MSDS

instructions, applied by licensed applicators, and applied using proper techniques, the impacts to soil resources from chemical treatments will be localized, short-term, negligible to minor, and adverse.

Table 2. Mechanisms of soil degradation for the ten herbicides proposed for use under Alternative 2. Information derived from DiTomaso et al. (2013).

Herbicide	Primary method for soil degradation	Average half-life in environment (days)
Aminopyralid	Microbial	35
Chlorsulfuron	Chemical	28-42
Clopyralid	Microbial	40
Glyphosate	Microbial	47
Imazapic	Microbial	120
Imazapyr	Microbial	90
Metsulfuron	Chemical	30
Rimsulfuron	Chemical	20
Sulfometuron	Chemical	24
Triclopyr	Microbial	30

Cumulative Impacts

The cumulative impacts to soil resources from Alternative 2 would be similar to those of Alternative 1.

Water Quality and Hydrology

Affected Environment

The climate at Crater Lake National Park is characterized by long, snowy winters and short, mild summers. Most of the precipitation (70%) is received between November-March in the form of snow, with less than 6% received from June-August often from thunderstorms. Average annual snowfall received at park headquarters is 524" with 66" of average annual precipitation (melted). Crater Lake National Park straddles the crest of the Cascade Range and contains many headwater streams, springs, and ponds in addition to Crater Lake. Waters originating within the park have four drainages: the Rogue River system to the southwest, west, and northwest; the Klamath Basin to the south and east; the Umpqua watershed to the north; and Crater Lake, which is generally considered a closed system with no inlets outside the caldera rim. Crater Lake occupies the caldera formed during the eruption and subsequent collapse of Mt. Mazama approximately 7,700 years ago. Over the years the caldera has filled with rain and snowmelt to a depth of approximately 1,943 feet, making it the deepest lake in the United States. It is world-renowned for its depth and clarity, and widely considered one of the purest bodies of water in the world.

The well-drained pumice soils within the park absorb much of the precipitation, which infiltrates into the water table and feeds numerous springs (Frank and Harris 1969). The park's main perennial streams include Annie, Sun, Sand, Castle, and Bybee Creeks. These originate high on the slopes of Mt. Mazama and form deeply incised canyons. The park contains important headwater springs such as Boundary

Springs, which is the origin of the Wild and Scenic Rogue River; and Annie Spring, which serves as the park's potable water source and flows into the Wood River and Upper Klamath Lake. Several small ephemeral and perennial ponds are present throughout the park, which are dependent upon and similar to precipitation in composition (Salinas et al. 1994).

Water quality within the park is considered excellent, with most surface and subsurface waters having low concentrations of minerals and organic contaminants. To protect the park's water quality and aquatic ecosystems, there is a ban on privately-owned vessels or motors on park waters. Additionally, Crater Lake is closed to snorkeling and underwater diving to prevent the introduction of non-native species. Developments that affect park waters include infrastructure related to the potable water supply at Annie Spring; bridges and/or culverts at road and trail crossings; two wastewater treatment plants in the Annie Creek drainage; the bulkhead at Cleetwood Cove; and the docks at Wizard Island.

The impacts of invasive vegetation on water quality and hydrology can differ based on species-specific impacts on ecosystems and level of invasion. Invasive plant species can change water use of an area by increasing or decreasing demands for water use; altering rooting zone depth as invasive species often have shallower root systems than native vegetation; and shifting the season of water use earlier in the season as is the case in displacement of perennial native species by annual invaders (Levine et al. 2002). Conversely, there may be no net impact on post-invasion water quality and hydrology if invasive plant species have similar morphologies and fill similar functional roles as native vegetation (Schmitz and Jacobs 2007).

Alternative 1: Impacts on Water Quality and Hydrology

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on water quality through protecting and maintaining the integrity of native plant communities. Native plant communities are adapted to the park's disturbance regimes and help stabilize soils and prevent erosion, which reduces sediment load to surface waters. Actions with the potential to cause adverse impacts to water quality are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance. This may lead to short-term, localized, negligible adverse impacts to water quality and hydrology through increased sedimentation.

Alternative 1 allows chemical control of roadside St. John's wort plants using the herbicide fluroxypyr. Fluroxypry is not labelled for aquatic use and is applied solely on upland, terrestrial habitats within road prisms of paved park roads. Fluroxypyr has a half-life in soils of 36 days and is generally not considered to have a high potential for contaminating ground or surface water (DiTomaso et al. 2013). Herbicide use Best Management Practices including adhering to label instructions, being applied by licensed

applicators, and using proper application techniques to help mitigate against adverse impacts to water quality and hydrology. Annual use of fluroxypyr has steadily decreased since its implementation in 2007 due to the effectiveness of this treatment. There would be short-term, localized, negligible adverse impacts to water quality and hydrology from chemical control under Alternative 1.

Cumulative Impacts

Analysis of cumulative impacts on water quality and hydrology is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to water quality and hydrology at Crater Lake National Park over the years have been in the form of atmospheric deposition of nutrients and pollutants; road and facility construction; maintenance of roads, utility corridors, and fuelbreaks; use of gas-powered boats on Crater Lake; trail construction and maintenance; wildland and prescribed fire and fire management actions; tree mortality caused by insects and pathogens; discharge from wastewater treatment facilities in the Annie Creek drainage; and invasive aquatic species. These impacts affect water quality and hydrology in many ways, including altering water chemistry; introducing environmental pollutants into stream ecosystems; increasing stream sediment load; altering stream temperature; and affecting coarse woody debris loading. Climate change has the potential to impact water quality and hydrology through changes in timing of peak stream flow, stream temperature, and frequency and duration of extreme precipitation events. The control-related impacts of Alternative 1 to cumulative impacts on water quality and hydrology would be localized, short-term, negligible and adverse with possible long-term beneficial impacts through protecting the cover and function of native vegetation communities.

Alternative 2: Impacts on Water Quality and Hydrology

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on water quality and hydrology as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to water quality by enabling effective rapid response to infestations of new-to-the-park invasive plant species using IPM methods and treating infestations at the smallest possible size. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on water quality and hydrology due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan. The annual work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed by park resource specialists (Aquatic Ecologist and/or Fisheries Biologist; Terrestrial Ecologist) and incorporate site-specific mitigations and recommendations to avoid and mitigate impacts to water quality and hydrology.

Under Alternative 2, implementation of manual control treatments would also cause short-term, localized, negligible impacts on water quality and hydrology through ground disturbance from hand-pulling and using hand tools to remove invasive plants. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicide instead of digging up the root mass associated with each plant yielding localized, short-term, negligible beneficial impacts to water quality and hydrology through reduced risk of sedimentation.

Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible adverse impacts to water quality and hydrology, as ground disturbance and sedimentation may result from off-target string trimmer applications.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on water quality and hydrology are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods proposed under Alternative 2 include ten herbicides with the potential to add additional herbicides as needed to treat new-to-the-park invasive plant species that are not effectively treated with existing methods, or use new herbicides with increased effectiveness and lesser or equivalent impacts to human health and the environment as they become available. Chemical treatments have the potential to impact water quality through off-target impacts from drift, runoff, leaching, and spills (DiTomaso et al. 2013). These impacts can be avoided through proper application techniques such as abiding by label instructions for appropriate wind speed and direction, temperature, and relative humidity and using backpack sprayers or wicks for precise treatment of target vegetation. Additionally, impacts from runoff and leaching can be avoided or mitigated by matching the rainfastness and potential mobility of the herbicide used with site-specific conditions and weather forecasts (Table 3). Impacts to water quality from spills can be avoided through Best Management Practices for herbicide use and storage. Only herbicides approved for use in and near aquatic habitats would be used near surface waters.

Table 3. Leaching potential and rainfastness information for the ten herbicides proposed for use under Alternative 2 (DiTomaso et al. 2013).

Herbicide	Habitat Use	Potential for leaching into ground & surface water	Rainfastness
Aminopyralid	Terrestrial	Limited; may leach into areas with permeable soils and shallow water table	2-6 hours
Chlorsulfuron	Terrestrial	Low potential to enter groundwater; has potential to enter surface waters from runoff	48 hours
Clopyralid	Terrestrial	Moderate potential for leaching, especially in areas with shallow water table	6 hours
Glyphosate	Terrestrial and Aquatic formulations	Very low	0.5-4 hours

Herbicide	Habitat Use	Potential for leaching into ground & surface water	Rainfastness
Imazapic	Terrestrial	Low potential to enter groundwater; has potential to enter surface waters from runoff	1 hour
Imazapyr	Terrestrial and Aquatic formulations	Low potential to enter groundwater; has potential to enter surface waters from runoff	1 hour
Metsulfuron	Terrestrial	Low potential to enter groundwater; has potential to enter surface waters from runoff	4 hours
Rimsulfuron	Terrestrial	Low potential to enter groundwater; has potential to enter surface waters from runoff	n/a – pre-emergent treatment
Sulfometuron	Terrestrial	Mobility increases with high soil pH and low soil organic matter	n/a – pre-emergent treatment
Triclopyr	Terrestrial and Aquatic formulations	Low potential	6-8 hours

When used according to label and MSDS instructions, applied by licensed applicators, and applied using proper techniques and Best Management Practices, the impacts to water quality and hydrology from chemical treatments under Alternative 2 will be localized, short-term, negligible to minor, and adverse.

Cumulative Impacts

The cumulative impacts to water quality and hydrology from Alternative 2 would be similar to those of Alternative 1.

Wetlands, Shorelines, and Riparian Areas

Affected Environment

As the transition zone between aquatic and terrestrial environments, wetlands including shorelines and riparian areas are often small but ecologically critical parts of forested landscapes (Gregory et al. 1991). Wetland environments at Crater Lake National Park occupy a diverse array of habitats including streamsides; pondshores; the lakeshore; springs; fens; groves of alder (*Alnus* sp.), cottonwood (*Populus trichocarpa*) and/or aspen (*Populus tremuloides*); montane and subalpine meadows; and snowmelt basins (Adamus and Bartlett 2008). These areas are often hotspots of biodiversity, supporting many rare or otherwise infrequently occurring species and providing habitat and sustenance for many species. The park's riparian areas have been shown to harbor significant floristic biodiversity that may be due to high elevation environments serving as refuges for species from cooler, wetter times (Smith and Sarr 2015). Wetland environments also play important functional roles such as nutrient cycling, carbon storage, soil and slope stabilization, water purification through filtering sediment and pollutants, and moderating temperatures (Richardson et al. 2007; Adamus and Bartlett 2008).

Wetland environments occupy less than one percent of the total land area contained within Crater Lake National Park (Adamus and Bartlett 2008). Some of the more unique wetland environments within the park include springs within the caldera; the shoreline of Crater Lake; Sphagnum Bog; Thousand Springs; the Whitehorse Ponds complex; Spruce Lake; and the Annie, Sun, and Sand Creek canyons. Sphagnum Bog was designated as a Research Natural Area in 1994, encompassing 170 acres of wetland habitat representing critical ecological elements designated in the West Cascades ecoregion (Oregon Natural Heritage Advisory Council 2010). A recent assessment of wetland environments within Crater Lake National Park concluded that park wetlands are relatively healthy (Adamus and Bartlett 2008).

Currently wetlands, shorelines, and riparian areas in Crater Lake National Park are only minimally impacted by non-native, invasive plant species. However, invasive plant infestations in these areas are high priorities for control. Wetland environments are at higher risk for invasion by non-native plants due to elevated availability of water and nutrients (Zedler and Kercher 2004). Invasive plants can cause changes in wetland environments such as altering habitat structure, biodiversity, nutrient cycling, and food webs (Zedler and Kercher 2004).

Alternative 1: Impacts on Wetlands, Shorelines, and Riparian Areas

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on wetlands, shorelines, and riparian areas through protecting and maintaining the health and integrity of native plant communities and the species dependent upon them. The process of early detection and rapid control would have long-term beneficial impacts to wetlands, shorelines, and riparian areas through catching plant invasions at small and manageable sizes. Actions with the potential to cause adverse impacts to wetlands, shorelines, and riparian areas are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance. This may lead to short-term, localized, negligible to minor adverse impacts to wetlands, shorelines, and riparian areas through creating areas of exposed soil that are devoid of vegetation. In areas with hard soils or rocky substrates such as shorelines, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas.

The limits on effective control under Alternative 1 do not permit chemical treatment of invasive plant species within the park's wetlands, shorelines, and riparian areas. This limits the ability of resource managers to use IPM techniques to control invasive plant species within these wetland environments, allowing them to spread further throughout the park.

Cumulative Impacts

Analysis of cumulative impacts on wetlands, shorelines, and riparian areas is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to wetlands, shorelines, and riparian areas at Crater Lake National Park over the years have been in the form of road, facility, and trail construction and maintenance; recreational use; wildland and prescribed fire and fire management actions; cattle trespass and grazing; and widespread tree mortality caused by insects and pathogens. These impacts have affected wetlands, shorelines, and riparian areas in many ways including changes in composition and structure of vegetation communities; altered hydrology and water flow patterns; altered nutrient cycling and water filtration processes; and altered temperature regimes from increases or decreases in canopy cover and insolation. Climate change has the potential to impact wetlands, shorelines, and riparian areas through changes in disturbance regimes; shifts in species' range and abundance; timing of peak stream flow; changes in precipitation and ground and surface water availability; earlier snowmelt and lengthened summer drought; and frequency and duration of extreme precipitation events. The control-related impacts of Alternative 1 to cumulative impacts on wetlands, shorelines, and riparian areas would be localized, short-term, negligible to minor and adverse with long-term beneficial impacts through protecting the integrity of native vegetation communities.

Alternative 2: Impacts on Wetlands, Shorelines, and Riparian Areas

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on wetlands, shorelines, and riparian areas as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to wetlands, shorelines, and riparian areas by enabling a rapid response to invasive plant species using IPM methods. This rapid response would treat infestations at the smallest possible size, and allow park staff to respond to new-to-the-park invasive plant species in a proactive manner. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on wetlands, shorelines, and riparian areas due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan. The annual work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed by park resource specialists (Botanist, Wildlife Biologist, Aquatic Ecologist and/or Fisheries Biologist, and Cultural Resource Specialist) and incorporate site-specific mitigations and recommendations to avoid and mitigate impacts to wetlands, shorelines, and riparian areas.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on wetlands, shorelines, and riparian areas through ground disturbance from hand-pulling and using hand tools to remove invasive plants. Ground disturbance under Alternative 2 would

be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicide instead of digging up the root mass associated with each plant.

Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible adverse impacts to wetlands, shorelines, and riparian areas, as ground disturbance and damage to neighboring vegetation may result from off-target string trimmer applications.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on wetlands, shorelines, and riparian areas are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods proposed under Alternative 2 include ten herbicides with the potential to add additional herbicides as needed to treat new-to-the-park invasive plant species that are not effectively treated with existing methods, or use new herbicides with increased effectiveness and lesser or equivalent impacts to human health and the environment as they become available. Compared with manual and mechanical control, the use of herbicides would reduce the extent and intensity of disturbance to wetland soils and would more effectively treat some invasive plant species, particularly rhizomatous perennials. Herbicide use in the park's wetland environments is expected to be very limited, and the total area treated is expected to decline sharply after five years as high-priority species are controlled.

Only herbicides approved for use in wetland environments would be used in and around the park's wetlands, shorelines, and riparian areas (Table 4). Any surfactants or dyes used in concert with these herbicide applications would be approved for use in aquatic environments. Chemical treatments have the potential to impact wetlands, shorelines, and riparian areas through off-target impacts from drift, runoff, and spills (DiTomaso et al. 2013). Impacts from drift can be avoided through proper application techniques such as abiding by label instructions for appropriate wind speed and direction, temperature, and relative humidity and using backpack sprayers or wicks for precise treatment of target vegetation. Additionally, impacts from runoff can be avoided or mitigated by matching the rainfastness and potential mobility of the herbicide used with site-specific conditions and weather forecasts (Table 3). Impacts to wetland environments from spills can be avoided through Best Management Practices for herbicide use and storage.

Table 4. Habitat use requirements for the ten herbicides proposed for use under Alternative 2 (DiTomaso et al. 2013).

Herbicide	Habitat Use	Use Considerations
Aminopyralid	Terrestrial	Can be used to water's edge
Chlorsulfuron	Terrestrial	Can be used near water
Clopryalid	Terrestrial	Cannot apply near water
Glyphosate	Terrestrial and Aquatic formulations	Terrestrial formulation contains surfactant that is toxic to fish and aquatic organisms (Tu and Randall 2005)

Herbicide	Habitat Use	Use Considerations
Imazapic	Terrestrial	Cannot apply near water
Imazapyr	Terrestrial and Aquatic formulations	Use only water soluble formations in aquatic areas
Metsulfuron	Terrestrial	Cannot apply near water
Rimsulfuron	Terrestrial	Cannot apply near water
Sulfometuron	Terrestrial	Cannot apply near water
Triclopyr	Terrestrial and Aquatic formulations	Use only water soluble formations in aquatic areas

When used according to label and MSDS instructions, applied by licensed applicators, and applied using proper techniques and Best Management Practices, the impacts to wetlands, shorelines, and riparian areas from chemical treatments under Alternative 2 will be localized, short-term, negligible to minor, and adverse.

Cumulative Impacts

The cumulative impacts to wetlands, shorelines, and riparian areas from Alternative 2 would be similar to those of Alternative 1.

Wildlife and Fish

Affected Environment

Crater Lake National Park supports a diversity of wildlife and fish species including approximately 74 mammal species, 174 bird species, 8 amphibian species, and 5 fish species. Much remains to be learned about many park species including invertebrates, which are currently not inventoried. The distribution and abundance of species in the park may fluctuate depending on time of year, elevation, habitat type, and recent disturbance events.

There is a vast diversity of mammalian species that occur in Crater Lake National Park. There are five ungulate species in the park, with the most abundant being black-tailed deer (*Odocoileus hemionus columbianus*) and elk (*Cervus canadensis*). Seventeen species of the Order Carnivora can be found in the park, including black bear (*Ursus americanus*) as the most dominant large carnivore and some rare mesocarnivores such as Sierra Nevada red fox (*Vulpes vulpes necator*) and fisher (*Pekania pennanti*), and the more common pine marten (*Martes martes*). Twelve bat species are suspected to occupy the park during portions of each year. There have been limited efforts to study the presence and/or distribution of the shrew community within the park, but it is assumed that 8 species of shrew are present. Approximately 32 species in the Orders Lagomorpha and Rodentia comprise the prey base in the park and include species such as snowshoe hare (*Lepus americanus*), American pika (*Ochotona princeps*), bushy-tailed woodrat (*Neotoma cinerea*), Northern flying squirrel (*Glaucomys sabrinus*), deer mouse (*Peromyscus maniculatus*), and yellow pine chipmunk (*Tamias amoenus*).

Of the 174 bird species that have been confirmed at Crater Lake National Park, the more common species include Oregon junco (*Junco hyemalis oregonus*), Audubon's warbler (*Setophaga coronata*

audubonii), golden-crowned kinglet (*Regulus satrapa*), red-breasted nuthatch (*Sitta canadensis*), pine siskin (*Spinus pinus*), mountain chickadee (*Poecile gambeli*), American robin (*Turdus migratorius*), brown creeper (*Certhia americana*), and hermit thrush (*Catharus guttatus*) (Stephens 2014). The brown creeper and hermit thrush are Partners in Flight focal species, which are species at the center of an international monitoring effort to conserve landbirds (Stephens 2014). Important habitat associations for these and other avian species at Crater Lake National Park include snags and large tree cover, along with diversity in elevation, vegetation type and structure, and disturbance size and severity that create and maintain foraging and nesting sites (Stephens et al. 2013).

The long, cold, snowy winters limit the diversity of amphibian and reptile species found at Crater Lake National Park. Early surveys within the park (Farner and Kezer 1953) documented eight amphibian species - rough-skinned newt (*Taricha granulosa*), northwestern salamander (*Ambystoma gracile*), long-toed salamander (*Ambystoma macrodactylum*), Oregon Ensatina (*Ensatina eschscholtzii oregonensis*), coastal tailed frog (*Ascaphus truei*), western toad (*Bufo borealis*), Pacific tree frog (*Pseudacris regilla*), and Cascades frog (*Rana cascadae*); and four reptiles – sagebrush lizard (*Sceloporus graciosus*), short-horned lizard (*Phrynosoma douglasii*), northern alligator lizard (*Elgaria coerulea*), and northwestern garter snake (*Thamnophis sirtalis*). While a partial survey of park amphibians and reptiles was conducted in 2003 (Bury and Wegner 2005), a comprehensive inventory for these species is still needed.

Crater Lake National Park contains only one native fish species, bull trout (*Salvelinus confluentus*). Non-native fish species were introduced throughout the park in the early years of park management to promote sport-fishing and tourism. Five species of non-native fish were introduced into Crater Lake from 1888-1941, with only two non-native species persisting to the present day: rainbow trout (*Oncorhyncus mykiss*) and kokanee (*O. nerka*) (Buktenica et al. 2007). Most park streams were stocked with brook trout (*Salvelinus fontinalis*), rainbow trout, and/or brown trout (*Salmo trutto*) from 1926-1971 (Wallace 1948; Dambacher et al. 1993).

Special Status Species

Crater Lake National Park contains three wildlife and fish species that are listed under the federal Endangered Species Act (ESA), and one park species of concern.

- The gray wolf (*Canus lupis*) is listed as endangered under the federal ESA. Gray wolves were extirpated from Oregon in the first half of the 20th century, but have slowly migrated back into the state. In 2011, a lone GPS-collared wolf (OR-7) wandered into southern Oregon and northern California, garnering much regional interest and media attention. In 2014-2015, OR-7 mated with another un-collared wolf in the southern Oregon Cascades and produced pups, earning the designation of the Rogue Pack (Mohren 2015b). The Rogue Pack and other wolves in the area are confirmed to have entered and used territory within Crater Lake National Park (Mohren 2015b).
- The northern spotted owl (*Strix occidentalis caurina*) is listed as threatened under the federal ESA. The main threats to this species are habitat loss and competition from the barred owl (*Strix varia*); at Crater Lake National Park barred owls pose the largest risk to the survival and

persistence of spotted owls (Mohren 2015a). In 2015, barred owls were detected at 30% of known spotted owl activity centers (Mohren 2015a). Spotted owls occupy mature mixed conifer forests comprised of Douglas-fir (*Pseduotsuga menziesii*), mountain hemlock (*Tsuga mertensiana*), white fir (*Abies concolor*), Shasta red fir (*Abies magnifica* x *procera*), and ponderosa pine (*Pinus ponderosa*) primarily on the west and southern sides of the park (Mohren 2015a).

- Bull trout is listed as threatened under the federal ESA. It has experienced population declines or extirpations throughout its range due to competition and hybridization with non-native brook trout (Buktenica et al. 2013). Critical habitat for bull trout is found within the southeast portion of Crater Lake National Park in Sun Creek and in Annie Creek below Annie Falls. An intensive restoration effort to remove brook trout and restore the Sun Creek bull trout population has been underway since the early 1990s (Buktenica et al. 2013), and has garnered national attention and recognition through being named one of the 2015 "Waters to Watch" by the National Fish Habitat Partnership.
- The fisher is a park species of concern. Fishers were extensively hunted in the 19th and 20th centuries and are threatened by habitat loss and fragmentation. Fishers utilize low- to mid-elevation areas with complex forest structure including large trees, snags, and logs that provide habitat for birthing, denning, and resting (Aubry and Raley 2006; Lofroth et al. 2010). Fishers have been recently documented within Crater Lake National Park, although much remains to be learned about their distribution and abundance throughout the park (Mohren 2015b).
- The Mazama newt (*Taricha granulosa mazamae*) is a park species of concern. This species is a genetically distinct population of the rough-skinned newt that occurs only within the Crater Lake caldera, and is less toxic and displays a darker ventral coloration than other rough-skinned newts, possibly due to lower predation pressure (Buktenica et al. 2015). The Mazama newt is threatened by predation and competition from the non-native signal crayfish (*Pacifastacus leniusculus*) that was introduced into Crater Lake in 1915 (Buktenica et al. 2015). Mazama newts occupy shoreline environments around Crater Lake and prey upon benthic aquatic invertebrates such as insects, worms, and snails (Buktenica et al. 2015).

Often the primary or secondary goal of invasive vegetation management is to protect and restore wildlife habitat (Cal-IPC 2015). Invasive vegetation can have long-term adverse impacts on wildlife and fish species through loss or alteration of the amount and quality of nesting, breeding, and/or foraging habitat. Invasive vegetation can alter food web dynamics by changing the abundance or nutrient quality of food, by changing the structure of vegetation and dynamics with predators, by changing access to food (Zedler and Kercher 2004); and by replacing native vegetation upon which species or their prey species depend (Wagner and Van Driesche 2010). Some invasive plant species contain allelochemicals or other phytochemicals that deter herbivory, and some invasive vegetation is toxic to wildlife species (Westbrooks 1998).

Alternative 1: Impacts on Wildlife and Fish

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on wildlife and fish through protecting and maintaining the health and integrity of native plant communities and the species dependent upon them. Actions with the potential to cause adverse impacts to wildlife and fish are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance. This may lead to short-term, localized, negligible to minor adverse impacts to ground-nesting birds, burrowing animals, and amphibians or their food sources. In areas with hard soils or rocky substrates, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas. Ground disturbance may result in slightly increased sedimentation to surface waters which could indirectly result in short-term, localized, negligible to minor adverse impacts on fish, amphibians, and invertebrates.

Chemical treatment of invasive plant species under Alternative 1 is limited to application of fluroxypyr to roadside St. John's wort populations. St. John's wort is mildly toxic to wildlife, so the likelihood that wildlife would ingest vegetation that was recently treated with herbicide is very low; and plants are generally treated when they are in bud stage (not yet flowering), which limits impacts to pollinators. Chemical treatment under Alternative 1 would have short-term, localized, negligible to minor adverse impacts upon wildlife and fish. The limited chemical treatments available under Alternative 1 may limit the ability of resource managers to use IPM techniques to control invasive plant species, allowing them to spread further throughout the park and negatively impact wildlife and fish through displacement of native plant habitats.

Impacts for Special Status Species and critical habitat include:

- Gray wolves and fishers are still relatively rare within Crater Lake National Park and chemical treatment may occur in areas used by these species. However, the small scale of this treatment would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to these species. Actions under Alternative 1 may affect but would not adversely affect gray wolves and fishers.
- Treatments would occur in spotted owl habitat but the small scale would have a low likelihood of causing more than negligible impacts to this species, as forest structure would not be impacted. Treatments in and around spotted owl nesting areas would be avoided during the breeding season. Actions under Alternative 1 may affect but would not adversely affect northern spotted owls.

- Bull trout critical habitat and habitat for the Mazama newt are located somewhat near roadside areas that may experience treatments with fluroxypyr. Due to the small scale of the treatments and large buffer between treated areas and habitat for bull trout and Mazama newt, chemical treatments would have short-term, localized, negligible adverse impacts upon these species. Actions under Alternative 1 may affect but would not adversely affect bull trout, Mazama newt, or their habitats.

Cumulative Impacts

Analysis of cumulative impacts on wildlife and fish is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to wildlife and fish at Crater Lake National Park over the years have been in the form of introduction and spread of invasive species; road, facility, and trail construction and maintenance; recreational use including angling and collisions with vehicles; wildland and prescribed fire and fire management actions; and widespread tree mortality caused by insects and pathogens. These impacts have affected wildlife and fish in many ways, including changes in species abundance and distribution; changes in availability and distribution of preferred habitat and food; and changes in predator-prey relationships and food web dynamics. Climate change has the potential to impact wildlife and fish through changes in disturbance regimes; shifts in species' range and abundance; shifts in vegetation composition, structure, and function; warmer stream temperatures; earlier snowmelt and lengthened summer drought; and frequency and duration of extreme precipitation events. The control-related impacts of Alternative 1 to cumulative impacts on wildlife and fish would be localized, short-term, negligible to minor, and adverse with long-term beneficial impacts through protecting the integrity of native vegetation communities.

Alternative 2: Impacts on Wildlife and Fish

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on wildlife and fish as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to wildlife and fish by enabling a rapid response to invasive plant species using IPM methods. This rapid response would treat infestations at the smallest possible size, and allow the park to respond to new-to-the-park invasive plant species in a proactive manner. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on wildlife and fish due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan. This work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed by the park's Wildlife Biologist and Aquatic Ecologist and/or Fisheries Biologist and incorporate site-specific recommendations to mitigate and avoid impacts to wildlife and fish. Such mitigation measures may include avoiding certain methods in habitat for sensitive wildlife and fish species; conducting

treatments outside of critical life history periods; and surveying a project area immediately before treatment to identify and avoid, if possible, wildlife species currently occupying the site (Cal-IPC 2015). Additional mitigation measures to protect wildlife species include: 1) avoiding treatments in the immediate proximity of burrows; and 2) placing a no-treatment buffer around any area where a ground nesting animal is flushed during treatment implementation.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on wildlife and fish through ground disturbance from hand-pulling and using hand tools to remove invasive plants. This may especially impact ground-nesting birds, burrowing animals, and amphibians or their food sources. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicide instead of digging up the root mass associated with each plant.

Mechanical treatment methods would affect wildlife species such as ground- nesting birds, burrowing animals, and amphibians through disturbances created by accessing sites and performing work. Additionally, noise from string trimmers or chainsaws could impact wildlife especially if conducted during breeding or nesting periods. Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible to minor adverse impacts to wildlife and fish, since the scope of this treatment would be very limited and since no mechanical treatment would occur in and around spotted owl nesting areas during the breeding season.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on wildlife and fish are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods may be used under Alternative 2 only if other IPM methods prove ineffective through use of the Treatment Selection Protocol. Many of the park's invasive plant species are unpalatable to wildlife species due to their morphology (e.g., spiny leaves) or phytochemical constitution (e.g., toxicity, unpalatability), so the chances of wildlife species ingesting herbicide applied to their foliage is very low. Herbicide labels direct the treatment of invasive plants while they are actively growing, which is usually prior to or while in bud stage, which also prevents seeding and further spread. This helps minimize impacts to pollinators and invertebrates through limiting herbicide contamination of pollen and nectar resources. All chemical treatments proposed under Alternative 2 would be applied through spot application of foliar spray using a backpack sprayer or hand-sprayer attached to a truck or UTV-mounted tank, or through direct application of wicking/wiping; this enables precise and accurate treatments of target vegetation and minimizes the amount of herbicide used.

When used according to label and MSDS instructions, applied by licensed applicators, applied using proper techniques and Best Management Practices such as avoiding impacts from drift and runoff, and incorporating site-specific mitigation measures recommended by park resource specialists, the impacts to wildlife and fish from chemical treatments under Alternative 2 will be localized, short-term, negligible

to minor, and adverse. Herbicide use mitigation measures to protect wildlife could include using an herbicide formulated for aquatic habitats and a low-toxicity surfactant in terrestrial settings that support a high diversity or abundance of amphibians (Cal-IPC 2015).

Impacts for Special Status Species and critical habitat include:

- The gray wolf is rare within Crater Lake National Park. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 2 may affect but would not adversely affect the gray wolf.
- The fisher is rare within Crater Lake National Park and uses dense, closed-canopy forests with complex forest structure. All treatments are unlikely to affect these habitat attributes, and few if any treatments would occur in dense forest types. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 2 may affect but would not adversely affect the fisher.
- The spotted owl uses closed-canopy, late-seral forests. All treatments are unlikely to affect these habitat attributes, and few if any treatments would occur in dense forest types. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species, especially when site-specific mitigation measures are used to avoid impacts to spotted owls in critical habitat. Additionally, treatments in and around spotted owl nesting areas would be avoided during the breeding season. Actions under Alternative 2 may affect but would not adversely affect the spotted owl.
- Bull trout are found in Sun Creek, with critical habitat in Sun Creek and Annie Creek below Annie Falls. Currently no invasive plant populations that would be treated with chemical methods are found in or immediately adjacent to Sun Creek. The scale of treatments near Annie Creek would cause no more than localized, short-term, negligible adverse impacts to critical habitat for this species. Actions under Alternative 2 may affect but would not adversely affect bull trout.
- The Mazama newt is restricted to the shoreline of Crater Lake. The scale of treatments near Mazama newt habitat would have a very low likelihood of causing more than localized, short-term, negligible adverse impacts to critical habitat for this species especially when site-specific mitigation measures (e.g., avoiding treatments in newt stronghold areas) are used to avoid impacts to the Mazama newt. Actions under Alternative 2 may affect but would not adversely affect the Mazama newt.

Cumulative Impacts

The cumulative impacts to wildlife and fish from Alternative 2 would be similar to those of Alternative 1.

Vegetation

Affected Environment

Crater Lake National Park protects a diversity of vegetation communities representative of the southern Oregon Cascade Range. Very little of the park has been logged, and minimal grazing has occurred since the park's establishment in 1902. While the park is dominated by forested habitats, non-forested areas

harbor high biodiversity including fens, montane and subalpine meadows, pumice meadows and deserts, rocky peaks and talus slopes, montane chaparral, and sharply dissected riparian canyons. Elevation within the park ranges from 3972' in the southwest corner to 8929' at the summit of Mt. Scott.

Vegetation within the park includes lower elevation mixed conifer forests of ponderosa pine, white fir, Douglas-fir, sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*). At middle elevations forests are composed of pure Shasta red fir or pure lodgepole pine (*Pinus contorta*), to an upper mixed conifer forest of Shasta red fir, western white pine (*Pinus monticola*), lodgepole pine, and mountain hemlock. At the park's higher elevations, mountain hemlock is the dominant species with whitebark pine (*Pinus albicaulis*) occupying the highest peaks. These subalpine forests are either pure mountain hemlock, pure whitebark pine, or a mixture of mountain hemlock, whitebark pine, lodgepole pine, Shasta red fir, and/or subalpine fir (*Abies lasiocarpa*). In riparian areas, Engelmann spruce (*Picea engelmannii*) is commonly found near creek margins and wetlands at lower elevations with subalpine fir occupying these habitats at low to high elevations. Small groves of aspen appear in wetlands, along riparian zones, and in montane meadows. Western hemlock (*Tsuga heterophylla*), Pacific madrone (*Arbutus menziesii*), and big leaf maple (*Acer macrophyllum*) are confined to the lowest elevations on the west and more mesic side of the park. Several large montane meadow systems (e.g., Sphagnum Bog, Thousand Springs, Poison Meadows, National Creek headwaters) are found on the slopes that drain into the Rogue River. Subalpine meadows often consist of well-drained ashy or pumice substrates dominated by forbs, sedges, and grasses with tree stringers and islands interspersed. Shrublands occur infrequently and are dominated by Fremont's silktassle (*Garrya fremontii*) in the southwest corner of the park, greenleaf manzanita (*Arctostaphylos patula*) and tobacco brush (*Ceanothus velutinus*) in montane forests, and Greene's goldenweed (*Ericameria greenei*) in the subalpine zone.

Special Status Species

Crater Lake National Park contains one plant species that is considered by the U.S. Fish and Wildlife Service as being a candidate for listing under the federal ESA, one plant species that is a federal Species of Concern, and one plant species listed as threatened by the state of Oregon.

- Whitebark pine is a candidate species for listing under the federal ESA. It is declining range-wide due to the introduction and spread of the fatal disease white pine blister rust, caused by the non-native fungal pathogen *Cronartium ribicola*; heavy mortality at higher elevations caused by the native mountain pine beetle (*Dendroctonous ponderosae*); increased competition and reduced habitat for regeneration from decades of fire suppression; and climate change. Whitebark pine grows at the park's highest elevations and supports a diversity of subalpine forb, grass, sedge, ands shrub associates in addition to providing shelter and food for many wildlife species (Beck and Holm 2014).
- The Crater Lake rockcress (*Boechera horizontalis*) is a federal Species of Concern. The Crater Lake rockcress is the park's only endemic plant species; it has been documented at two locations outside the park but recent efforts have been unable to relocate these populations in the field. The Crater Lake rockcress occupies high elevation habitat around the caldera rim and

surrounding peaks. Many populations occur in front-country settings including roadsides, along trails, overlooks, and pullouts with ongoing threats from visitor use and road rehabilitation and maintenance. Backcountry populations of the Crater Lake rockcress are threatened by recreational use. Climate change is another threat to the Crater Lake rockcress, as it occupies the park's highest elevations.

- The pumice grapefern (*Botrychium pumicola*) is listed as threatened by the state of Oregon. The pumice grapefern is endemic to the central and southern Cascade region and is found from South Sister in the north to Mt. Shasta in the south. At Crater Lake National Park, the pumice grapefern is found at high elevations near the caldera rim. Within the park, the pumice grapefern is threatened by recreational use and impacts from climate change.

The biggest threat to native plant communities is invasion by non-native plant species. Invasive plants ranked as the number one priority for monitoring of natural resources within the NPS Klamath Inventory and Monitoring Network (Odion et al. 2010), to which Crater Lake National Park belongs. High elevation areas such as Crater Lake National Park often serve as a "last stand" for native plant species and communities (Gray 2005). Areas of the Pacific Northwest have been less impacted by invasive plant species than other parts of the U.S. due to climatic factors related to short growing seasons, forested vegetation cover, shorter and less widespread settlement history, and fewer sources of invasive plant propagules (Parks et al. 2005). However, wilderness areas and national parks are at risk for plant invasions due to their high levels of visitor use and recreation (Parks et al. 2005). Additionally, natural areas such as Crater Lake National Park are even more at risk due to land management activities near park boundaries that may encourage and facilitate the introduction and spread of invasive plant species (Parks et al. 2005). Invasive plants may displace and replace native plant populations and communities, including populations of rare and sensitive species. Invasive plants can alter the structure, composition, and function of native plant communities and alter ecosystem health through changing nutrient cycling and disturbance regimes (Vitousek et al. 1997).

Alternative 1: Impacts on Vegetation

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on vegetation through protecting and maintaining the health and integrity of native plant communities. Actions with the potential to cause adverse impacts to vegetation are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance. This may lead to short-term, localized, negligible adverse impacts to vegetation through trampling of native vegetation. In areas with hard soils or rocky substrates, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes

and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas.

Chemical treatment of invasive plant species under Alternative 1 is limited to application of fluroxypyr to roadside St. John's wort populations. Chemical treatment under Alternative 1 would have short-term, localized, negligible adverse impacts upon vegetation through impacts to native vegetation caused by off-target herbicide application and/or drift. Applying herbicide by hand through foliar spray (backpack sprayers or truck/UTV-mounted tanks) or wicking/wiping methods would facilitate accurate and precise treatments that would minimize inadvertent impacts to native vegetation. Abiding by herbicide labels and following herbicide use Best Management Practices would reduce impacts to native vegetation from drift, runoff, or spills. The limited chemical treatments available under Alternative 1 may limit the ability of resource managers to use IPM techniques to control invasive plant species, allowing them to spread further throughout the park and negatively impact native vegetation through displacement of native plant habitats.

Impacts for Special Status Species and critical habitat include:

- Whitebark pine occurs in high elevation habitats that currently contain very few invasive plant populations. Within whitebark pine habitat, currently no treatments are proposed outside of roadsides or developed areas. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 1 may affect but would not adversely affect whitebark pine.
- The Crater Lake rockcress occurs in high elevation habitats that currently contain very few invasive plant populations. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 1 may affect but would not adversely affect the Crater Lake rockcress.
- The pumice grapefern occurs in high elevation habitats that currently contain very few invasive plant populations. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 1 may affect but would not adversely affect the pumice grapefern.

<u>Cumulative Impacts</u>

Analysis of cumulative impacts on vegetation is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to vegetation at Crater Lake National Park over the years have been in the form of introduction and spread of invasive plant species; road, facility, and trail construction and maintenance; recreational use and trampling in high visitor use areas; wildland and prescribed fire and fire management actions including fire exclusion; and widespread tree mortality caused by insects and pathogens. These impacts have affected vegetation in many ways, including altering the structure, composition, and function of vegetation communities and affecting overall plant species diversity. Climate change has the potential to impact vegetation through changes in disturbance regimes; shifts in species' range and abundance; shifts in vegetation composition, structure, and function; physiological changes based on CO_2 fertilization; and earlier snowmelt and lengthened

summer drought. The control-related impacts of Alternative 1 to cumulative impacts on vegetation would be localized, short-term, negligible to minor, and adverse with long-term beneficial impacts through protecting the integrity of native vegetation communities.

Alternative 2: Impacts on Vegetation

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on vegetation as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to native plant communities by enabling a rapid response to invasive plant species using IPM methods. This rapid response would treat infestations at the smallest possible size, and allow park staff to respond to new-to-the-park invasive plant species in a proactive manner. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on vegetation due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan. This work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed by the park's Botanist and incorporate site-specific recommendations to mitigate and avoid impacts to native vegetation, including rare and sensitive plant species. Such mitigation measures may include surveying project areas for rare and sensitive plant species and flagging population locations to avoid and mitigate impacts (Cal-IPC 2015).

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on vegetation through ground disturbance from hand-pulling and using hand tools to remove invasive plants. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicide instead of digging up the root mass associated with each plant.

Mechanical treatment methods could affect native vegetation through trampling and off-target impacts. Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible adverse impacts to vegetation, since the scope of this treatment would be very limited.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on vegetation are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods may be used under Alternative 2 only if other IPM methods prove ineffective through use of the Treatment Selection Protocol. Herbicide treatments would be applied

through spot application of foliar spray using a backpack sprayer or hand-sprayer attached to a truck or UTV-mounted tank or through direct application of wicking/wiping; this enables precise and accurate treatments of target vegetation and minimizes the amount of herbicide used. Mitigations for protecting rare and sensitive plant species would be employed, such as applying foliar spray to invasive plants in the early morning during calm winds to avoid drift, and using low herbicide application rates (Watts 2015). Additionally, if native plants are inadvertently treated with herbicide while controlling invasive vegetation, impacts may be reduced by washing the herbicide from the plant with water, or breaking off affected parts of the plant so herbicide will not spread throughout the vascular system to unaffected parts of the plant (Cal-IPC 2015).

When used according to label and MSDS instructions, applied by licensed applicators, applied using proper techniques and Best Management Practices such as avoiding impacts from drift or runoff, and incorporating site-specific mitigation measures recommended by park resource specialists, the impacts to vegetation from chemical treatments under Alternative 2 will be localized, short-term, negligible to minor, and adverse.

Impacts for Special Status Species and critical habitat include:

- Whitebark pine occurs in high elevation habitats that currently contain very few invasive plant populations. Within whitebark pine habitat, currently no treatments are proposed outside of roadsides or developed areas. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 2 may affect but would not adversely affect whitebark pine.
- The Crater Lake rockcress occurs in high elevation habitats that currently contain very few invasive plant populations. Within Crater Lake rockcress habitat, currently no treatments are proposed outside of roadsides or developed areas. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 2 may affect but would not adversely affect the Crater Lake rockcress.
- The pumice grapefern occurs in high elevation habitats that currently contain very few invasive plant populations. Within pumice grapefern habitat, currently no treatments are proposed outside of roadsides or developed areas. The scale of treatments would have a low likelihood of causing more than localized, short-term, negligible adverse impacts to this species. Actions under Alternative 2 may affect but would not adversely affect the pumice grapefern.

Cumulative Impacts

The cumulative impacts to vegetation from Alternative 2 would be similar to those of Alternative 1.

Cultural Resources

Affected Environment

Cultural resources at Crater Lake National Park include archaeological resources, culturally significant plants, cultural landscapes, historic districts, historic structures and other sites. Presently there are 43 contributing resources listed on the National Register of Historic Places, most of which are included

within three historic districts. Other historic properties are eligible for listing, while still others are potentially eligible, so they are subject to review under Section 106 of the NHPA when undertakings might affect their potential listing on the National Register.

Humans have had a long history with the landscape surrounding and encompassed by Crater Lake National Park. The earliest peoples known to use the area now encompassed by Crater Lake National Park are the ancestors and members of the Klamath Tribes (a confederation that includes the southern Molalla) as well as the Cow Creek Band of the Umpqua Tribe of Indians (Deur 2008). Crater Lake and its surrounding high peaks and caldera rim are considered sacred lands possessing great power; traditional use of the area was primarily spiritual, consisting of vision quests, ceremonies, healing, and other religious purposes (Deur 2008). Traditional resource use of the area encompassed by Crater Lake National Park involves gathering food, medicine, and materials such as berries – especially thin-leaved huckleberries (*Vaccinium membranaceum*), bulbs such as great camas (*Camassia leichtlinii* var. *leichtlinii*), and shoots from bear grass (*Xerophllum tenax*) and hazel (*Corylus cornuta* ssp. *californica*). Archeological artifacts found within the park consist of cairns and rock stack features, lithic scatter, and tools and projectile points (Mairs et al. 1994).

With the increased use of the area by European Americans, many buildings, facilities, travel routes, and artifacts became part of the Crater Lake National Park landscape and most are associated with the creation of the national park. Four historic properties are listed on the National Register of Historic Places: the Rim Village Historic District, Munson Valley Historic District, Rim Drive Historic District, and Watchman Lookout. One historic property is eligible for listing on the National Register of Historic Places: the west half of the Fort Klamath – Rogue River Wagon Road that includes historic routes between Whitehorse Creek and Annie Spring, and between park headquarters and Rim Village. Potentially eligible historic structures include the south half of the Fort Klamath – Rogue River Wagon Road; the Old Rim Road; remnant sections of abandoned approach roads, such as Pinnacles Road; Garfield Peak Trail; Mt. Scott Lookout; and Mission 66 properties including the Annie Creek Bridge, Goodbye Creek Bridge, and Mazama Amphitheater. Many of the park's historic structures were constructed in the 1920s – 1940s and exemplify rustic architecture characteristic of the National Park Service. As the nation's sixth oldest national park, Crater Lake National Park preserves and protects many structures and features with significant historical value. Additional areas within the park are considered as cultural landscapes, including Annie Spring, Castle Crest Wildflower Garden, Grayback Road, the Mt. Scott trail, Lost Creek Campground, and Wizard Island (DOI NPS 2005).

Invasive vegetation threatens cultural resources by displacing culturally significant plant species and by altering cultural landscapes. Many of the park's cultural landscapes and historic districts contain historic plantings and vegetation assemblages designed by landscape architects to serve as the interface between visitor use and the natural environment. Many of the park's historic districts and cultural landscapes experience high levels of visitor use, and are in need of restoration efforts to protect and rehabilitate fragile vegetation while providing for and accommodating use by park visitors. Trampled and barren areas facilitate invasion by non-native plant species, further compromising the integrity and visual quality of historic districts and cultural landscapes. Invasive vegetation also threatens culturally significant plant species through competition for resources and possible displacement.

Alternative 1: Impacts on Cultural Resources

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on cultural resources through protecting and maintaining the integrity of native vegetation communities, including culturally significant plant species and cultural landscapes. The process of early detection and rapid control would have long-term beneficial impacts to cultural resources through catching plant invasions at small and manageable sizes and minimizing the need for control efforts. Actions with the potential to cause adverse impacts to cultural resources are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance and may affect archeological resources. This may cause short-term, localized, negligible to minor adverse impacts to cultural resources through inadvertent damage or exposure. In areas with hard soils or rocky substrates, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas that could displace culturally significant plant species and/or alter the appearance of cultural landscapes.

Effective control under Alternative 1 allows treatment of roadside St. John's wort with fluroxypyr. This may limit the ability of resource managers to use IPM techniques to control invasive plant species. This could facilitate the spread of invasive plants throughout the park with potential to displace culturally significant plant species and/or alter the appearance and integrity of cultural landscapes.

Cumulative Impacts

Analysis of cumulative impacts on cultural resources is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to cultural resources at Crater Lake National Park over the years have been in the form of road, facility, and trail construction and maintenance; recreational use; fire exclusion; introduction of non-native species; wildland fire and fire management actions; looting or theft; lack of maintenance and upkeep; and acts of nature such as falling trees. Additionally, the winter use (e.g., year-round use of facilities designed for summer use only) of historic properties has caused adverse impacts to cultural resources through such mechanisms as changing circulation patterns to accommodate snow removal. Climate change has the potential to impact cultural resources through changes in vegetation composition, structure, and function; altered disturbance regimes especially an increase in fire frequency, intensity, and size; deterioration caused by changes in temperature and moisture; and lengthening the period of summer recreation and increasing the amount of visitor use. The control-related impacts of Alternative 1 to cumulative impacts on cultural resources would be localized, short-term, negligible to minor and adverse with long-term beneficial impacts through protecting native vegetation communities and their ethnographic resources, and also protecting cultural landscapes and their unique vegetation assemblages.

Alternative 2: Impacts on Cultural Resources

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on cultural resources as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to cultural resources by enabling a rapid response to infestations of new-to-the-park invasive plant species using IPM methods; this rapid response would control infestations at the smallest possible size. Under Alternative 2, educational and collaborative actions would have short- and long-term, indirect beneficial actions on cultural resources due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan. The annual work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed by cultural resource specialists and incorporate site-specific mitigations and recommendations to avoid and mitigate impacts to cultural resources. The review would be conducted through the process mandated by Section 106 of the National Historic Preservation Act. Consultation with park associated and federally recognized tribes will be conducted to ensure that current information about the use of culturally significant plant species is incorporated into annual work plans.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on cultural resources through ground disturbance with the potential for inadvertent damage and exposure of archeological resources. Consultation with cultural resource specialists would occur to avoid sensitive areas and to choose appropriate treatment methods to ensure protection of cultural resources. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicides instead of digging up the root mass associated with each plant yielding localized, short-term, negligible beneficial impacts to cultural resources.

Mechanical treatment options proposed under Alternative 2 would cause localized, short-term, negligible adverse impacts to cultural resources, as ground disturbance and damage to neighboring vegetation may result from off-target string trimmer applications. If mechanical treatments are proposed for use in areas with ethnobotanical species and/or cultural landscapes, precautions would be taken to minimize off-target impacts to neighboring vegetation.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on cultural resources are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods may be used under Alternative 2 only if other IPM methods prove ineffective through use of the Treatment Selection Protocol. Herbicide treatments would be applied through spot application of foliar spray using a backpack sprayer or hand-sprayer attached to a truck or UTV-mounted tank or through direct application of wicking/wiping; this enables precise and accurate treatments of target vegetation and minimizes the amount of herbicide used. Mitigations for protecting ethnobotanical species and native vegetation within cultural landscapes would be employed, such as applying foliar spray to invasive plants in the early morning during calm winds to avoid drift, and using low herbicide application rates (Watts 2015). Additionally, if ethnobotanical species or native vegetation within cultural landscapes are inadvertently treated with herbicide while controlling invasive vegetation, impacts may be reduced by washing the herbicide from the plant with water, or breaking off affected parts of the plant so herbicide will not spread throughout the vascular system to unaffected parts of the plant (Cal-IPC 2015).

When used according to label and MSDS instructions, applied by licensed applicators, applied using proper techniques and Best Management Practices such as avoiding impacts from drift or runoff, and incorporating site-specific mitigation measures recommended by park resource specialists, the impacts to cultural resources from chemical treatments under Alternative 2 will be localized, short-term, negligible to minor, and adverse.

Under Alternative 2, managing invasive vegetation would have long-term beneficial impacts on cultural resources by avoiding the displacement of ethnobotanical species and maintaining the character of cultural landscapes. There would be short-term, localized, negligible to minor adverse impacts on the cultural resources from control efforts proposed for use under Alternative 2.

Cumulative Impacts:

The cumulative impacts to cultural resources from Alternative 2 would be similar to those of Alternative 1.

Recommended Wilderness

Affected Environment

Crater Lake National Park contains 122,400 acres of recommended wilderness that was identified in a 1974 NPS wilderness proposal (USDI NPS 1974). This proposal was brought forward to Congress by the President, but the legislative process was never completed and this area remains as recommended wilderness. Park staff is mandated by NPS policy to manage recommended wilderness as if it were designated wilderness.

Management of recommended wilderness abides by requirements of the 1964 Wilderness Act to uphold wilderness character. The central qualities of wilderness character are the untrammeled nature of area; the undeveloped state of an area; the naturalness of an area; the outstanding opportunities for solitude or primitive recreation; and the area's scientific, educational, scenic, or historical values (USDI NPS 2013).

Visitor use within the park's recommended wilderness includes hiking, fishing, birding, backcountry camping, backpacking, and horseback riding along with cross country skiing, snowshoeing, and winter camping. The park's recommended wilderness contains many popular trails including the Pacific Crest Trail (PCT). Stock use is allowed on designated trails within the recommended wilderness, including the PCT.

Invasive vegetation threatens ecosystem health, which is the foundation for wilderness character (Asher and Harmon 1995). Protecting and maintaining the naturalness and scientific values of wilderness while minimizing any trammeling caused by managing invasive vegetation is accomplished by performing a Minimum Tool analysis. In considering the Minimum Tool approach to meeting natural resource management objectives in wilderness, project impacts are limited to the smallest extent possible using the least intrusive techniques, equipment, and processes. This helps protect and uphold wilderness character while also protecting and maintaining native vegetation communities and overall ecosystem health.

Alternative 1: Impacts on Recommended Wilderness

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on the recommended wilderness through protecting and maintaining the naturalness of backcountry environs and reducing the amount of trammeled vegetation communities. The process of early detection and rapid control would have long-term beneficial impacts to the recommended wilderness through catching plant invasions at small and manageable sizes and minimizing the need for control efforts. Actions with the potential to cause adverse impacts to the recommended wilderness are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance and may disrupt opportunities for solitude by inserting a small field crew into the recommended wilderness. This may cause short-term, localized, negligible to minor adverse impacts to the recommended wilderness through diminishing the wilderness experience for park visitors. In areas with hard soils or rocky substrates, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas.

The limits on effective control under Alternative 1 do not permit chemical treatment of invasive plant species within the park's recommended wilderness. This may limit the ability of resource managers to use IPM techniques to control invasive plant species within the recommended wilderness, allowing them to spread further throughout the park and diminish the naturalness, untrammeled nature, and scientific values of backcountry vegetation communities.

Cumulative Impacts

Analysis of cumulative impacts on the recommended wilderness is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to the recommended wilderness at Crater Lake National Park over the years have been in the form of trail construction and maintenance; recreational use; fire exclusion; introduction of non-native species; wildland fire and fire management actions; and widespread tree mortality caused by insects and pathogens. Climate change has the potential to impact the recommended wilderness through changes in vegetation composition, structure, and function; altered disturbance regimes especially an increase in fire frequency, intensity, and size; and lengthening the period of summer recreation and increasing the amount of wilderness users. The control-related impacts of Alternative 1 to cumulative impacts on the recommended wilderness would be localized, short-term, negligible to minor and adverse with long-term beneficial impacts through protecting the naturalness and scientific values of the recommended wilderness and reducing the amount of trammeled areas.

Alternative 2: Impacts on Recommended Wilderness

Impact Analysis:

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on the recommended wilderness as Alternative 1. An adaptive management approach to managing invasive vegetation would yield short- and long-term major beneficial impacts to the recommended wilderness by enabling a rapid response to infestations of new-to-the-park invasive plant species using IPM methods; this rapid response would control infestations at the smallest possible size. Under Alternative 2, educational, preventative, and collaborative actions would have short- and long-term, indirect beneficial actions on the recommended wilderness due to the increase in preventative measures that would reduce the need for invasive vegetation treatments. Actions with the potential to cause adverse impacts are discussed below.

Effective control of invasive vegetation under Alternative 2 would be guided each year by the development of an annual Invasive Vegetation Management work plan and Minimum Tool Analysis. The annual work plan would outline proposed treatment methods by invasive plant species and location. This work plan would be reviewed and approved by park resource specialists including the park's Wilderness Coordinator and incorporate site-specific mitigations and recommendations to avoid and mitigate impacts to the recommended wilderness.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on the recommended wilderness through ground disturbance from the presence of a small field crew to hand-pull and use hand tools to remove invasive plants. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicides instead of digging up the root mass associated with each plant yielding localized, short-term, negligible beneficial impacts to the recommended wilderness through use of a Minimum Tool approach.

Mechanical treatment options proposed under Alternative 2 would not occur in the recommended wilderness, as Minimum Tool analysis would favor the use of hand tools and non-mechanized equipment.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on the recommended wilderness are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods proposed under Alternative 2 include ten herbicides with the potential to add additional herbicides as needed to treat new-to-the-park invasive plant species that are not effectively treated with existing methods, or use new herbicides with increased effectiveness and lesser or equivalent impacts to human health and the environment as they become available. Under the Treatment Selection Protocol, chemical treatments are used only after it has been determined that manual, mechanical, and cultural treatment methods would not lead to effective control of the targeted invasive plant species. Compared with manual control, the use of herbicides would reduce the extent and intensity of disturbance to soils and would more effectively treat some invasive plant species, particularly rhizomatous perennials. The increased effectiveness of chemical control would reduce the repeated disturbance to wilderness visitors by reducing the number of staff and volunteer hours spent removing vegetation by hand.

Under Alternative 2, managing invasive vegetation in the recommended wilderness would have long-term beneficial impacts on wilderness character by improving naturalness, scientific and educational values, and the experiential aspect of wilderness recreation by maintaining, promoting, and protecting ecosystem health. There would be short-term, localized, negligible to minor adverse impacts on the trammeling aspect of wilderness character through implementing invasive vegetation control actions and inserting a field crew into the recommended wilderness.

Cumulative Impacts:

The cumulative impacts to the recommended wilderness from Alternative 2 would be similar to those of Alternative 1.

Visitor Experience

Affected Environment

Visitation to Crater Lake National Park has been steadily rising over the past several years with a record 756,000 visitors received in 2016 (average is 500,000 visitors/year). This was partially due to the 2016 National Park Service Centennial; increased use of national parks was promoted by the “Find Your Park” advertising campaign. Park visitors enjoy viewing Crater Lake, hiking, photography, driving the scenic Rim Drive, camping, swimming, skiing, and snowshoeing. During the peak season, the park’s campgrounds and overnight accommodations are used at or beyond capacity. Heavy visitation and

related recreational activities can damage native vegetation and soils and facilitate invasion by non-native plant species.

Managing invasive vegetation helps protect and preserve the park's native ecosystems for future generations to experience and enjoy. Some aspects of controlling invasive vegetation could affect visitor experience through temporary closures, short-term visual quality of treated areas, encounters with park staff controlling invasive plants, and opportunities for solitude. Other aspects of visitor experience would largely be unaffected by the proposed actions.

Alternative 1: Impacts on Visitor Experience

Impact Analysis

Under Alternative 1, Invasive Vegetation Management actions would have short- and long-term beneficial impacts on visitor experience through protecting and maintaining the native ecosystems of Crater Lake National Park. Actions with the potential to cause adverse impacts to visitor experience are related to manual and chemical treatments and are discussed below.

Effective control of invasive vegetation under Alternative 1 would be achieved primarily through manual control. The process of controlling invasive plants through hand pulling and using hand tools to uproot plants and remove root structures of rhizomatous species would cause ground disturbance and may be visually unappealing. This may cause short-term, localized, negligible to minor adverse impacts to visitor experience. In areas with hard soils or rocky substrates, manual control of rhizomatous, perennial invasive vegetation would be marginally effective since park staff would be unable to dig out rhizomes and root systems that resprout when left behind in the soil. This may lead to the persistence and spread of invasive vegetation in these areas, which could diminish visitors' opportunities to experience and enjoy native vegetation communities.

Chemical control under Alternative 1 occurs along park roadsides, and may cause short-term, localized, negligible impacts to visitor experience. Visitors may witness ODA or park staff hand-spraying St. John's wort with herbicide. The limits on effective control under Alternative 1 may hinder the ability of resource managers to use IPM techniques to control invasive plant species within the park, allowing them to spread further throughout the park and diminish visitor experience through alteration of native plant communities.

Cumulative Impacts

Analysis of cumulative impacts on visitor experience is based on past, present, and foreseeable future impacts combined with impacts from Alternative 1. Impacts to visitor experience at Crater Lake National Park over the years have been in the form of road construction or traffic delays; congested areas and facilities; and facility repair and maintenance. Climate change has the potential to impact visitor experience through changes in vegetation composition, structure, and function; altered disturbance regimes especially an increase in fire frequency, intensity, and size; decreasing the period of winter recreation; and lengthening the period of summer recreation and increasing the amount of park

visitors. The control-related impacts of Alternative 1 to cumulative impacts on visitor experience would be localized, short-term, negligible to minor, and adverse with long-term beneficial impacts through protecting and preserving the park's native ecosystems.

Alternative 2: Impacts on Visitor Experience

Impact Analysis

Under Alternative 2, Invasive Vegetation Management actions would have similar short- and long-term beneficial impacts on visitor experience as Alternative 1. Actions with the potential to cause adverse impacts are discussed below.

Under Alternative 2, implementation of manual control treatments would cause short-term, localized, negligible impacts on visitor experience through ground disturbance from hand-removal of invasive plants. Ground disturbance under Alternative 2 would be reduced, as rhizomatous perennial invasive vegetation would be treated with herbicides instead of digging up the root mass associated with each plant yielding localized, short-term, negligible beneficial impacts to visitor experience.

Mechanical treatment options proposed under Alternative 2 would cause short-term, localized, negligible to minor impacts on visitor experience primarily by increasing the noise level present during treatments. No mechanical treatments would occur within the park's recommended wilderness.

Biological methods may be used under Alternative 2 only if other IPM methods prove ineffective, and only after a comprehensive technical review and consultation with NPS and ODA specialists have been completed through the implementation of the Treatment Selection Protocol. In this review process, if any impacts of biological methods on visitor experience are deemed to exceed minor, then additional compliance will be pursued.

Chemical treatment methods proposed under Alternative 2 would cause short-term, localized, negligible to minor adverse impacts on visitor experience. Some areas may be temporarily closed to visitors after herbicide treatments for public safety. Park visitors may observe park staff hand-spraying invasive vegetation and may observe temporary marker dye on vegetation or the ground delineating treated plants. Mitigations to reduce impacts on visitor experience would be employed such as conducting herbicide treatments in high visitor use areas in off-peak times or seasons when possible; and placing interpretive material with closure signs to explain the purpose of the closures. Helping visitors understand the need for controlling invasive vegetation may lessen the adverse impacts on visitor experience.

Under Alternative 2, managing invasive vegetation would have long-term beneficial impacts on visitor experience by improving opportunities for photography, scenic viewing, and enjoying native wildflower blooms and ensuring that future generations can enjoy these activities.

Cumulative Impacts

The cumulative impacts to visitor experience from Alternative 2 would be similar to those of Alternative 1.

Park Operations

Affected Environment

Park Operations at Crater Lake National Park consist of NPS, concessionaire, and contractor staffs that work together to fulfill the mission of the National Park Service. The Superintendent retains overall responsibility for safety, operations, and management of the park. Park operations are focused on providing for visitor experience and enjoyment; protecting the park's natural and cultural resources; and maintaining roads, trails, buildings, and facilities within the park. Crater Lake National Park is organized into six divisions that have responsibilities for and play important roles in invasive vegetation management:

- The Division of Resource Preservation and Research (RP&R) is responsible for natural resource management, wildland fire management, wilderness management, and has overall responsibility for the Invasive Vegetation Management program. The Fire Management program works closely with the park's Resource Advisors to reduce the introduction and spread of invasive plant species during fire operations. The RP&R division does most of the work related to invasive vegetation management, including implementation of planning, prevention, early detection and rapid response, control, monitoring, outreach, collaboration, and reporting components.
- The Division of Facility Management maintains the park infrastructure including all roads, trails, buildings, and facilities. The biggest role this division plays in invasive vegetation management is preventing the introduction and spread of invasive plant species. This is done through using clean, weed-free equipment, tools, supplies, vehicles, and materials in their operations and also communicating with the Invasive Vegetation Management program to ensure their operations include mitigations to avoid the introduction and spread of invasive plant species. This division also plays an important role in early detection of invasive plant species and communicating new observations to the Invasive Vegetation Management program.
- The Division of Interpretation and Cultural Resources communicates Invasive Vegetation Management goals to the public, and helps educate and inform the public about ways they can help protect the park through preventing the introduction and spread of invasive plant species. This division oversees citizen science and volunteer efforts, and links the public with the Invasive Vegetation Management program. This division also plays an important role in early detection of invasive plant species and communicating new observations to the Invasive Vegetation Management program.
- The Division of Visitor and Resource Protection oversees law enforcement, search and rescue, the structural fire program, the ski patrol, dispatch and communications, and backcountry use. This division also enforces park regulations, such as use of pelletized weed-free forage for stock.

This division also plays an important role in early detection of invasive plant species and communicating new observations to the Invasive Vegetation Management program.

- The Division of Park Management, Planning, and Compliance assists the Invasive Vegetation Management program by ensuring park projects and contractor operations have completed the environmental compliance process, which include incorporating mitigations and actions that do not cause the introduction and spread of non-native plant species.
- The Division of Administration performs important functions for the Invasive Vegetation Management program including providing human resources, budget, payroll, procurement, travel, and information technology support.

The Invasive Vegetation Management program would affect park operations primarily through needs for office and storage space, rental vehicles, seasonal employee housing, PPE and field equipment, and administrative support.

Alternative 1: Impacts on Park Operations

Impact Analysis

Under Alternative 1, current invasive vegetation management would continue at Crater Lake National Park. Park management already allocates office and storage space, seasonal housing, and administrative support to the Invasive Vegetation Management program. Controlling invasive plant populations at small and manageable sizes would have long-term beneficial cost-saving impacts to park operations. Impacts to park operations under Alternative 1 would be long term, minor, and adverse.

Cumulative Impacts

Actions proposed under Alternative 1 would cause long-term negligible impacts to park operations by continuing to use office space and administrative resources. Incorporating Invasive Vegetation Management prevention measures into park operations, and continuing early detection and rapid response efforts would keep invasive plant populations at low and manageable levels, reducing the need for invasive plant treatments.

Alternative 2: Impacts on Park Operations

Impact Analysis

Under Alternative 2, impacts to park operations would be similar to those of Alternative 1. The ability to use more efficient control methods under Alternative 2 would have long-term beneficial cost-saving impacts to park operations by reducing the need for follow-up treatments and keeping the overall level of plant invasions throughout the park at low and manageable levels.

Cumulative Impacts

The cumulative impacts to park operations from Alternative 2 would be similar to those of Alternative 1. The increased efficiency of control methods proposed under Alternative 2 would have long-term beneficial impacts upon park operations by reducing the need for and intensity of treatments.

Consultation and Coordination

A public scoping period on the problem statement for the Invasive Vegetation Management Plan Environmental Assessment was open from February 3, 2016 to March 9, 2016. Park management announced the public scoping period with a press release to local media outlets, as well as electronically on the NPS Planning, Environment, and Public Comment (PEPC) website. No comments were received during the public scoping period.

Agency consultation will take place on this environmental assessment and the proposed 2017 work plan, including with the U.S. Fish and Wildlife Service and the State Historic Preservation Office. Local tribes will be solicited for their feedback and comments. Neighboring national and state forests are important collaborators with the park on invasive vegetation management. Collaboration is essential for meeting mutual invasive vegetation management goals while abiding by common best management practices and mitigations to protect sensitive species, habitats, and resources.

This environmental assessment will be released for a 30 day public review period. An NPS letter or press release will be distributed to various agencies, tribes, institutions, organizations, and members of the public on the park's mailing list and posted on the NPS PEPC website. Copies of the document will be sent to the Grants Pass, Klamath Falls, Medford, and Roseburg public libraries. Copies of the document will also be provided to interested individuals upon request. Comments may be submitted through the PEPC website: http://parkplanning.nps.gov/IVMP or by mail to:

Superintendent, Crater Lake National Park
Attn: Invasive Vegetation Management Plan
P.O. Box 7
Crater Lake, Oregon 97604

For a copy of this document, please call (541) 594-3072 or email crla_public_affairs@nps.gov

This Environmental Assessment is subject to a 30-day public comment period, during which the public is encouraged to provide feedback through written comments. The comments will be considered and analyzed prior to the release of a decision document. Crater Lake National Park will respond to substantive comments received during the public comment period, and will amend the environmental assessment as needed.

List of Contributors (all Crater Lake National Park unless otherwise specified):

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Appendix A: Crater Lake National Park Non-Native Plant Species List

Crater Lake National Park has assigned all of its 86 non-native plant species a control priority of Low, Medium, High, or Watch (Table 1). All high priority species are actively targeted for control efforts whenever possible using manual, mechanical, and chemical methods. Medium priority species are targeted as time and resources allow, with backcountry occurrences given a higher priority than those found along roadsides. Low priority species are usually not targeted for management, either because populations of those species are not aggressively spreading, population locations are presently unknown, or populations are beyond control. Watch-listed species are those that either have not been documented within the Park but have been found in surrounding areas, or that have been documented within the Park, but have not been observed in some time (> 10 years) and are believed to be eradicated from within Park boundaries. If any watch species are found within the Park, they will receive a management priority of high.

Control priorities may change depending upon situation and location. For example, a low priority species may be controlled if found in a pristine wilderness environment and its control is feasible. A high priority species may not be treated in a specific region where its population is beyond control. Low priority species may be controlled concurrently at sites where high priority species are being treated when cost-efficient.

General control strategies for invasive plant species are *containment* – preventing new infestations and spread; *reduction* – reducing the size and extent of existing infestations; and *eradication* – extirpating the invasive plant species from the Park.

Table A1. Non-native, invasive plant species at Crater Lake National Park by management priority and control strategy. Watch-listed species not presently found within the park are also included.

Scientific Name	Common Name	Control Priority	Control Strategy	Comments
Anthoxanthum oderatum	Sweet vernalgrass	High	Eradication	Recently discovered small populations
Arrhenatherum elatius var. *elatius*	Tall oatgrass	High	Eradication	Recently discovered small populations
Bromus diandrus	Ripgut brome	High	Eradication	Recently discovered small populations
Bromus hordeaceus	Soft chess	High	Eradication	Recently discovered small populations
Bromus inermis	Smooth brome	High	Reduction	Limited distribution
Bromus tectorum	Cheatgrass	High	Eradication	Limited distribution
Centaurea stoebe ssp. *micranthos*	Spotted knapweed	High	Eradication	Limited distribution
Chondrilla juncea	Rush skeletonweed	High	Eradication	Limited distribution
Cirsium arvense	Canada thistle	High	Reduction	Becoming more widespread

Scientific Name	Common Name	Control Priority	Control Strategy	Comments
Cirsium vulgare	Bull thistle	High	Reduction	Becoming more widespread, some areas beyond treatment
Convolvulus arvensis	Field bindweed	High	Eradication	Recently discovered small populations
Dysphania botrys	Jerusalem oak	High	Eradication	Limited distribution
Hypericum perforatum	St. John's wort	High	Containment	Trying to contain, finding new infestations
Isatis tinctoria	Dyer's woad	High	Eradication	Limited distribution
Leucanthemum vulgare	Oxeye daisy	High	Reduction	Contained, needs annual treatment
Phalaris arundinacea	Reed canarygrass	High	Eradication	Limited distribution
Poa bulbosa	Bulbous bluegrass	High	Containment	Trying to contain, finding new infestations
Rumex acetosella	Sheep sorrel	High	Containment	Trying to contain, finding new infestations
Senecio jabobaea	Tansy ragwort	High	Eradication	Recently discovered small populations
Tragopogon dubius	Yellow salsify	High	Reduction	Problem at Poison Meadows especially
Tripleurospermum inodorum	Scentless mayweed	High	Eradication	Limited distribution
Verbascum thapsus	Flannel mullein	High	Containment	Becoming more widespread
Arctium minus	Common burdock	Medium	Eradication	Recently discovered small populations
Barbarea vulgaris	Yellow rocket	Medium	Reduction	Contained, needs annual treatment
Brassica napus	Canola	Medium	Eradication	Recently discovered small populations
Brassica rapa	Field mustard	Medium	Eradication	Recently discovered small populations
Capsella bursa-pastoris	Shepherd's purse	Medium	Eradication	Recently discovered small populations
Cerastium fontanum ssp. *vulgare*	Big chickweed	Medium	Eradication	Recently discovered small populations
Chenopodium album	Lambs quarters	Medium	Reduction	Contained, needs annual treatment
Cichorium intybus	Common chicory	Medium	Eradication	Limited distribution
Dactylis glomerata	Orchard grass	Medium	Reduction	Occurs infrequently
Descurainia sophia	Flixweed	Medium	Eradication	Recently discovered small populations
Elymus repens	Quackgrass	Medium	Eradication	Recently discovered small populations
Erodium cicutarium	African filaree	Medium	Eradication	Recently discovered small

Scientific Name	Common Name	Control Priority	Control Strategy	Comments
				populations
Fallopia convolvulus	Ivy bindweed	Medium	Eradication	Recently discovered small populations
Filago pyramidata var. *pyramidata*	Broadleaf cottonrose	Medium	Eradication	Recently discovered small populations
Holcus lanatus	Common velvetgrass	Medium	Eradication	No known distribution
Hypochaeris radicata	Rough cat's ear	Medium	Reduction	Occurs infrequently
Lactuca canadensis	Tall lettuce	Medium	Reduction	Limited distribution
Lactuca serriola	Prickly lettuce	Medium	Containment	Becoming more widespread; beyond control in some places
Lepidium campestre	Field pepperweed	Medium	Eradication	Recently discovered small populations
Lepidium heterophyllum	Purple anther field pepperweed	Medium	Eradication	Recently discovered small populations
Lepidium ruderale	Stinking pepperweed	Medium	Eradication	Recently discovered small populations
Lotus corniculatus	Birdsfoot trefoil	Medium	Eradication	Recently discovered small populations
Matricaria discoidea	Pineapple weed	Medium	Eradication	Limited distribution
Melilotus albus	White sweetclover	Medium	Reduction	Contained, needs annual treatment
Melilotus officinalis	Common yellow sweetclover	Medium	Reduction	Contained, needs annual treatment
Mycelis muralis	Wall lettuce	Medium	Eradication	Limited distribution
Oenothera laciniata	Cutleaf evening primrose	Medium	Eradication	Recently discovered small populations
Phleum pratense	Timothy	Medium	Reduction	Occurs infrequently
Plantago lanceolata	English plantain	Medium	Reduction	Occurs infrequently
Plantago major	Common plantain	Medium	Reduction	Occurs infrequently
Poa annua	Annual bluegrass	Medium	Eradication	Limited distribution
Polygonum aviculare ssp. *depressum*	Common knotweed	Medium	Reduction	Limited distribution; higher priority around rare plants
Rosa canina	Dog rose	Medium	Eradication	Recently discovered small populations
Rumex crispus	Curly dock	Medium	Reduction	Limited distribution
Salsola kali ssp. *pontica*	Russian thistle	Medium	Eradication	Recently discovered small populations
Senecio sylvaticus	Woodland groundsel	Medium	Containment	Becoming more widespread, some areas beyond control. Higher priority at higher

Scientific Name	Common Name	Control Priority	Control Strategy	Comments
				elevations.
Sonchus asper	Prickly sow thistle	Medium	Eradication	Limited distribution
Taraxacum officinale	Common dandelion	Medium	Containment	Becoming more widespread, some areas beyond treatment. Higher priority at higher elevations.
Thinopyrum intermedium	Intermediate wheatgrass	Medium	Eradication	Recently discovered small populations
Trifolium aureum	Golden clover	Medium	Eradication	Recently discovered small populations
Trifolium pratense	Red clover	Medium	Eradication	Recently discovered small populations
Trifolium repens	White clover	Medium	Containment	Becoming more widespread
Triticum aestivum	Wheat	Medium	Eradication	Recently discovered small populations
Agrostis capillaris	Colonial bentgrass	Low	None	
Agrostis gigantea	Redtop	Low	None	
Alopecurus pratensis	Meadow foxtail	Low	None	
Festuca rubra ssp. *commutata*	Rock red fescue	Low	None	
Festuca rubra ssp. *rubra*	Red fescue	Low	None	
Festuca trachyphylla	Sheep fescue	Low	None	
Lolium perenne	Perennial ryegrass	Low	None	
Luzula multiflora	Common woodrush	Low	None	
Persicaria lapathifolia	Willow weed	Low	None	At Spruce Lake, probably beyond treatment
Persicaria pensylvanica	Pinkweed	Low	None	
Poa compressa	Canada bluegrass	Low	Containment	Limited distribution
Poa pratensis	Kentucky bluegrass	Low	Containment	Most areas beyond treatment
Potentilla norvegica	Norwegian cinquefoil	Low	Containment	At Spruce Lake beyond treatment
Sagina procumbens	Procumbent pearlwort	Low	None	
Schedonorus arundinaceus	Tall fescue	Low	None	
Spergularia rubra	Red sandspurry	Low	Containment	Most areas beyond treatment; higher priority around rare plants and at higher elevations.
Adonis aestivalis	Pheasant's eye	Watch	n/a	Found locally but not yet in park
Carduus	Plumeless thistle	Watch	n/a	Found locally but not yet in park

Scientific Name	Common Name	Control Priority	Control Strategy	Comments
acanthoides				
Carduus nutans	Musk thistle	Watch	n/a	Found locally but not yet in park
Centaurea diffusa	Diffuse knapweed	Watch	Eradicated	No known distribution
Centaurea solstitialis	Yellow star thistle	Watch	n/a	Found locally but not yet in park
Centaurea x moncktonii	Meadow knapweed	Watch	n/a	Found locally but not yet in park
Cynoglossum officinale	Houndstongue	Watch	n/a	Found locally but not yet in park
Cytisus scoparius	Scotch broom	Watch	Eradicated	No known distribution; eradicated in 1998
Dipsacus fullonum	Common teasel	Watch	n/a	Found locally but not yet in park
Euphorbia esula	Leafy spurge	Watch	n/a	Found locally but not yet in park
Hieracium aurantiacum	Orange hawkweed	Watch	n/a	Found locally but not yet in park
Hieracium caespitosum	Meadow hawkweed	Watch	n/a	Found locally but not yet in park
Iris pseudacorus	Yellow flag iris	Watch	n/a	Found locally but not yet in park
Lamium amplexicaule	Henbit	Watch	Eradicated	No known distribution
Lepidium draba ssp. draba	Whitetop	Watch	n/a	Found locally but not yet in park
Lepidium latifolium	Perennial pepperweed	Watch	n/a	Found locally but not yet in park
Linaria dalmatica ssp. *dalmatica*	Dalmatian toadflax	Watch	Eradicated	No known distribution
Linaria vulgaris	Yellow toadflax	Watch	n/a	Found locally but not yet in park
Myriophyllum spicatum	Eurasian watermilfoil	Watch	n/a	Found locally but not yet in park
Nardus stricta	Matgrass	Watch	n/a	Found locally but not yet in park
Nymphoides peltata	Yellow floating heart	Watch	n/a	Found locally but not yet in park
Potentilla recta	Sulfur cinquefoil	Watch	n/a	Found locally but not yet in park
Rubus bifrons	Himalayan blackberry	Watch	n/a	Found locally but not yet in park
Salvia aethiopsis	Mediterranean sage	Watch	n/a	Found locally but not yet in park
Silene coronaria	Rose campion	Watch	n/a	Found locally but not yet in park
Silybum marianum	Milk thistle	Watch	n/a	Found locally but not yet in park
Taeniatherum caput-medusae	Medusahead	Watch	n/a	Found locally but not yet in park
Tribulus terrestris	Puncturevine	Watch	n/a	Found locally but not yet in park
Trifolium hybridum	Alsike clover	Watch	Eradicated	No known distribution
Ventenata dubia	North Africa grass	Watch	n/a	Found locally but not yet in park

Appendix B: Crater Lake National Park 2017 Invasive Vegetation Work Plan

Introduction

This work plan outlines projects that could begin in, but not necessarily be completed in, 2017. The Invasive Vegetation Management program has received funding to focus on the following projects in 2017 that have potential to exacerbate the invasive plant situation at Crater Lake National Park:

- Rim Drive Rehabilitation Project: Invasive plant survey and control efforts will be directed at all areas affected by this project, including West Rim Drive, East Rim Drive, Rim Village, the Cleetwood Cove parking lot, Roundtop Quarry, Pole Bridge Creek Quarry, and the Ball Diamond.

- 2014 Pavement Preservation Project: Invasive plant survey and control efforts will be targeted on roadways and staging areas affected by this chip-seal project that used contaminated earthen materials. Roadways affected include Munson Valley Road, North Entrance Road, Highway 62, Pinnacles Road, Cloudcap Spur Road, and access roads through park headquarters. Staging areas used in this project will also be subject to invasive plant survey and control including: South Yard, the Pumice Desert Overlook, North Junction parking area, and the junction of East Rim Drive with Pinnacles Road. Areas with dense infestations of invasive plants will be restored by seeding with locally-sourced native plant materials.

- Bybee Creek Fire Burned Area Rehabilitation (BAR): The area impacted by the 2016 Bybee Creek fire will be subject to invasive plant survey and control efforts (first year of funding). Invasive plant survey and control efforts will focus on areas impacted by fire suppression operations including firelines, spike camps, helispots, and just south of the southern control line where over 61,000 gallons of fire retardant chemical was applied.

- National Creek Complex BAR: This will continue (second year of funding) invasive plant survey and control efforts in areas affected by the 2015 National Creek Complex of wildfires, which includes the largest fire (Crescent Fire) in the park's recorded history. Invasive plant survey and control efforts will center on areas impacted by fire suppression operations including firelines, spike camps, areas near the park boundary that were impacted by dozerlines, areas where fire retardant was applied, helispots, secondary control lines, and safety zones. Additionally, areas that burned with high intensity and areas of special floristic diversity (e.g., Boundary Springs, wetlands, riparian areas) will be given a high priority for invasive plant survey and control. No previously known invasive plant populations had been documented within the fire perimeter prior to 2016, so efforts will focus on maintaining the integrity of this relatively pristine area.

- Pumice Complex BAR: Invasive plant survey and control efforts will continue (third and last year of funding) within the areas affected by the 2014 Pumice Complex of wildfires. Areas impacted by firelines, access routes, helispots, and spike camps will be the primary focus.

- High Visitor Use Areas: Invasive plant survey and control efforts will target areas experiencing high concentrations of visitors, including developed areas, popular trails, scenic overlooks and vistas, campgrounds, backcountry campsites and horse camps, parking lots, and recreational sites such as the Cleetwood Cove swimming area, Wizard Island boat docks, and Annie Creek fishing access points.

A crew of nine Biological Science Technicians (Plants) will comprise the 2017 IVM field crew, which will be the largest seasonal crew in the IVM program's history.

Methods

The park has been divided into IVM Regions where survey and control efforts are targeted. Each region is a "problem area" where invasive plants are known to be concentrated or have recently been detected. The control strategy for each region varies depending upon which species it contains. Prior to the field season, IVM data are queried by region and maps of invasive plant species distribution created. Packets are made for the IVM crew containing the following information per region: maps of the region in relation to the park, including directions on best access to the site (if applicable); spatial data on which species are found in each region provided on maps and also digitally for import to a GPS unit; and abundance (number) and size of each invasive plant population per spatial coordinate set.

Invasive vegetation survey consists of visually searching a region, typically on foot but sometimes via boat, automobile, or bicycle, for invasive plant species. The IVM crew navigates to known invasive plant locations with a GPS unit and searches a broad grid around that coordinate point using transects (width determined by terrain and vegetation structure). In previously un-surveyed areas with no record of invasive plant species, surveys are concentrated on the most likely establishment points such as open habitats, areas with moist soils or close to water, and recently disturbed habitats. It is unlikely to find invasive plant species in dense, closed canopy forests at CRLA.

Control methods available to CRLA's IVM program in past years have been limited to manual methods. With the implementation of the Invasive Vegetation Management Plan Environmental Assessment, it is hoped that the 2017 season will see the implementation of a wider scope of treatment methods through the Treatment Selection Protocol, including chemical control through herbicide use. Manual control typically involves invasive plants being pulled or severed from the root below the ground surface using a digging knife. Additional tools including cultivator mattocks, pitchforks, and long-handled spades are also used as appropriate. Many of CRLA's invasive plant species are capable of vegetative reproduction through an extensive system of underground roots called rhizomes. It is very difficult to remove all the rhizomes through manual control, especially in areas with hard or rocky substrates. Additionally, the intense ground disturbance required for rhizome removal often creates excessive disturbance that may facilitate invasive plant establishment along with causing potentially deleterious impacts on cultural resources, water quality, and soil resources.

Chemical control in this phase of the work plan would focus on treating the following perennial, rhizomatous invasive plant species that are not effectively treated using manual or mechanical methods:

- Smooth brome (*Bromus inermis*): limited distribution along roadsides
- Cheat grass (*Bromus tectorum*): limited distribution along roadsides; two recently discovered backcountry populations
- Spotted knapweed (*Centaurea stoebe* ssp. *micranthos*): limited distribution along roadsides
- Rush skeletonweed (*Chondrilla juncea*): one very small roadside population
- Canada thistle (*Cirsium arvense*): becoming more widespread in backcountry areas especially on the west and south sides of park; occasional along roadsides
- Bull thistle (*Cirsium vulgare*): reserved for areas where hand pulling is ineffective due to large population size or fragile soils
- Field bindweed (*Convolvulus arvensis*): very limited distribution Jerusalem oak (*Dysphania botrys*): very limited distribution along roadsides
- St. John's wort (*Hypericum perforatum*): widespread distribution mostly along Highway 62; backcountry populations have recently been found
- Oxeye daisy (*Leucanthemum vulgare*): very limited distribution along roadside
- Reed canarygrass (*Phalaris arundinacea*): very limited distribution
- Bulbous bluegrass (*Poa bulbosa*): limited distribution along roadsides
- Sheep sorrel (*Rumex acetosella*): widespread distribution mostly along roadsides. Treatment priority would be higher elevation sites where sheep sorrel is invading subalpine meadows and rare plant populations, and small populations elsewhere.
- Tansy ragwort (*Senecio jacobaea*): very limited distribution
- White clover (*Trifolium repens*): distribution along roadsides and developed areas

Herbicides proposed for use in 2017 are outlined in Table 2.

Table B1. Proposed herbicides for chemical control of rhizomatous invasive plant species.

Invasive Plant Species	Proposed Herbicide	Proposed Herbicide (aquatic habitats)
Smooth brome	Glyphosate	Glyphosate
Cheat grass	Glyphosate	n/a
Spotted knapweed	Aminopyralid	n/a
Rush skeletonweed	Aminopyralid	n/a
Canada thistle	Aminopyralid	Glyphosate
Bull thistle	Aminopyralid	
Field bindweed	Aminopyralid/Glyphosate	Glyphosate
Jerusalem oak	Aminopyralid/Glyphosate	n/a
St. John's wort	Aminopyralid	n/a
Oxeye daisy	Aminopyralid	n/a
Reed canarygrass	Glyphosate	Glyphosate
Bulbous bluegrass	Glyphosate	n/a
Sheep sorrel	Aminopyralid/ Clopyralid (roadside only)	Glyphosate
Tansy ragwort	Aminopyralid	n/a
White clover	Aminopyralid	Glyphosate

Herbicide applications would be made with a backpack sprayer to spot-spray invasive plants. This technique not only minimizes drift, but also specifically targets non-native vegetation and protects native plants. While implementing chemical treatment methods, the following Standard Operating Protocol and mitigations would be employed to protect native ecosystems and natural and cultural resources of Crater Lake National Park:

1. All herbicide applications will be made by licensed Oregon state pesticide applicators.
2. All label requirements will be adhered to.
3. Precautions will be taken to minimize drift.
4. Herbicide applications will be made after checking weather forecasts to ensure winds, probability of precipitation, atmospheric stability, etc. are favorable. If rain is expected in the near term, the rainfastness of the herbicide will match the weather forecast for expected precipitation.
5. Site-specific sensitive resources will be recognized and mitigations to protect special-status species will be in place.
6. No activities will occur within current or historic northern spotted owl nesting areas unless they have been surveyed following the USFWS northern spotted owl survey protocol and nesting status has been determined. If nesting status is active, no activities will occur until after August 15.
7. Aquatic resources will be protected by using herbicides and surfactants approved for use in riparian, lakeshore, and pondshore habitats.
8. Whenever possible, herbicide applications will be timed to minimize impact or risk of impact to non-target species.
9. Prior to treatment, area will be surveyed for wildlife species, rare plant species, and culturally significant plant species. If such species are found, the affected area will be flagged and appropriate no-treatment buffers will be used to protect wildlife and plant species:
    a. A 50’ buffer will be placed around any ground-nesting birds and invertebrates
    b. A 100’ buffer will be placed around active mammal dens
    c. A 20’ buffer will be placed around rare plant populations
    d. A 50’ buffer will be placed around culturally significant plant species (e.g., huckleberries – *Vaccinium* sp., bear grass – *Xerophyllum tenax*)
    e. In terrestrial areas known to harbor an abundance or diversity of amphibians, aquatic-formulated herbicides and surfactants will be used to minimize impacts to amphibians
10. Herbicide applications in areas where park visitors may enter will be signed and marked to keep visitors out of treated area until it is safe for re-entry as per label requirements.
11. Herbicide applications made within the park’s recommended wilderness will be subject to a Minimum Tool Analysis.
12. Steps in the adaptive management process as outlined in the Treatment Selection Protocol will be documented to allow refinements and improvements to the IVM program in subsequent phases of the work plan.

Other invasive plant species encountered during the 2017 Invasive Vegetation Management field season would be controlled using manual treatment methods. No mechanical or biological treatments are proposed for use in this phase of the Invasive Vegetation Management work plan.

Planning Maps by Invasive Vegetation Management Zones

The park is divided into several zones where IVM work is focused:

1. Backcountry Zone: all areas away from roads, trails, developed areas, staging areas, and facilities. This includes the park's recommended wilderness.
2. Developed Zone: all areas where park buildings and facilities are concentrated to support park visitors and operations. This includes park headquarters, Rim Village, Mazama Village, Mazama Dorms, Mazama Campground, Lost Creek Campground, and the park's two sewage lagoons.
3. Lakeshore Zone: all areas within the Crater Lake caldera but primarily focused on the shore of Crater Lake and Wizard Island.
4. Roadside Zone: all park roads, including Highway 62, Munson Valley Road, West and East Rim Drives, the North Entrance Road, Highway 138, Pinnacles Road, Cloudcap Spur Road, and Grayback Road.
5. Staging Zones: all staging areas used by park operations including South Yard, Pole Bridge Creek Quarry, Anderson Quarry, Roundtop Quarry, and the Ball Diamond.

Detailed planning maps are included in the following figures (Figures 1-15) that outline the proposed work for the 2017 IVM field crew. These maps are based on findings of the 2016 IVM field crew. The most abundant or noxious invasive plant species are indicated on each map; less abundant or noxious species are lumped together as "other species" to facilitate interpretation. Species targeted for manual control are indicated by circles; species with the potential for chemical control are indicated by squares.

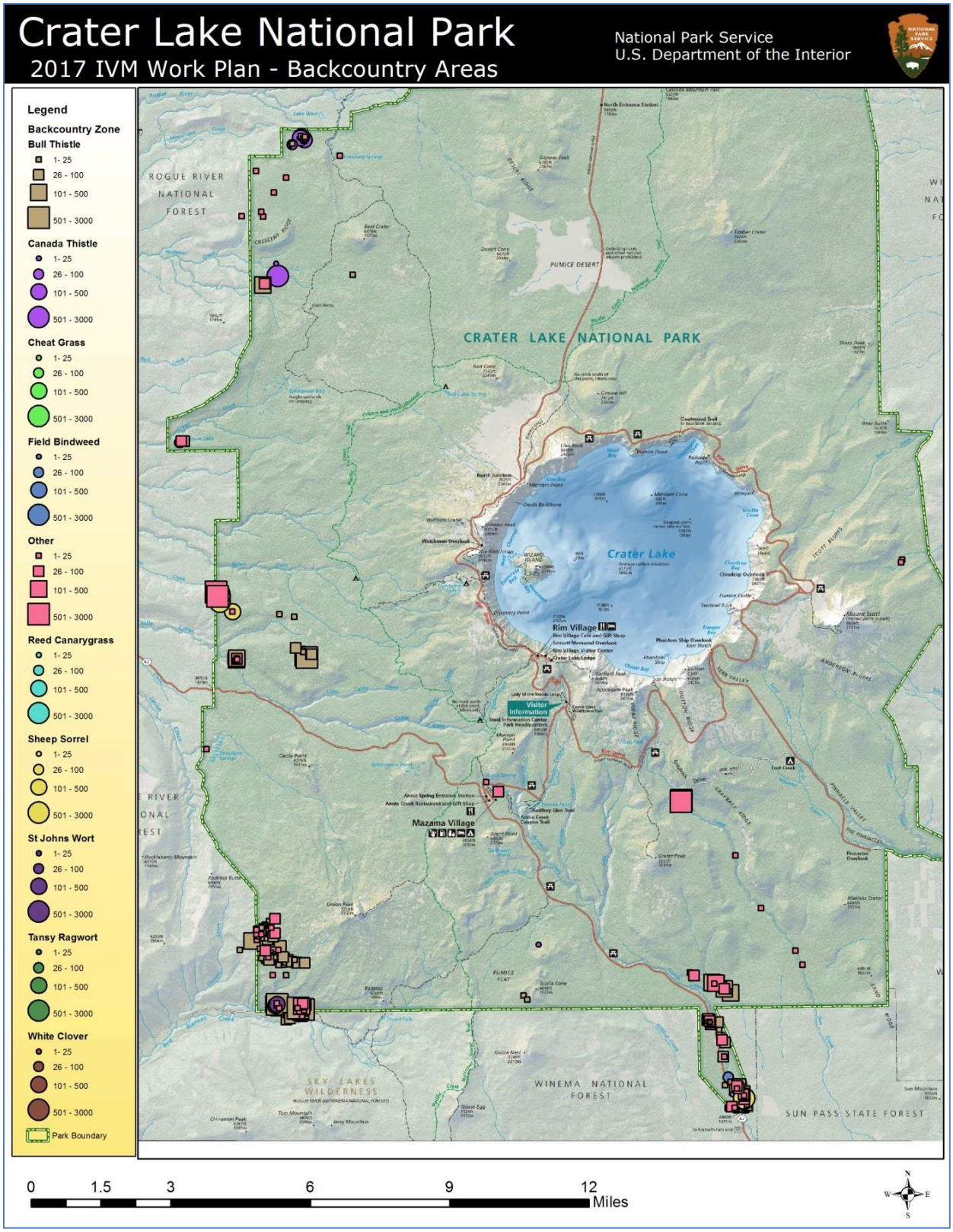
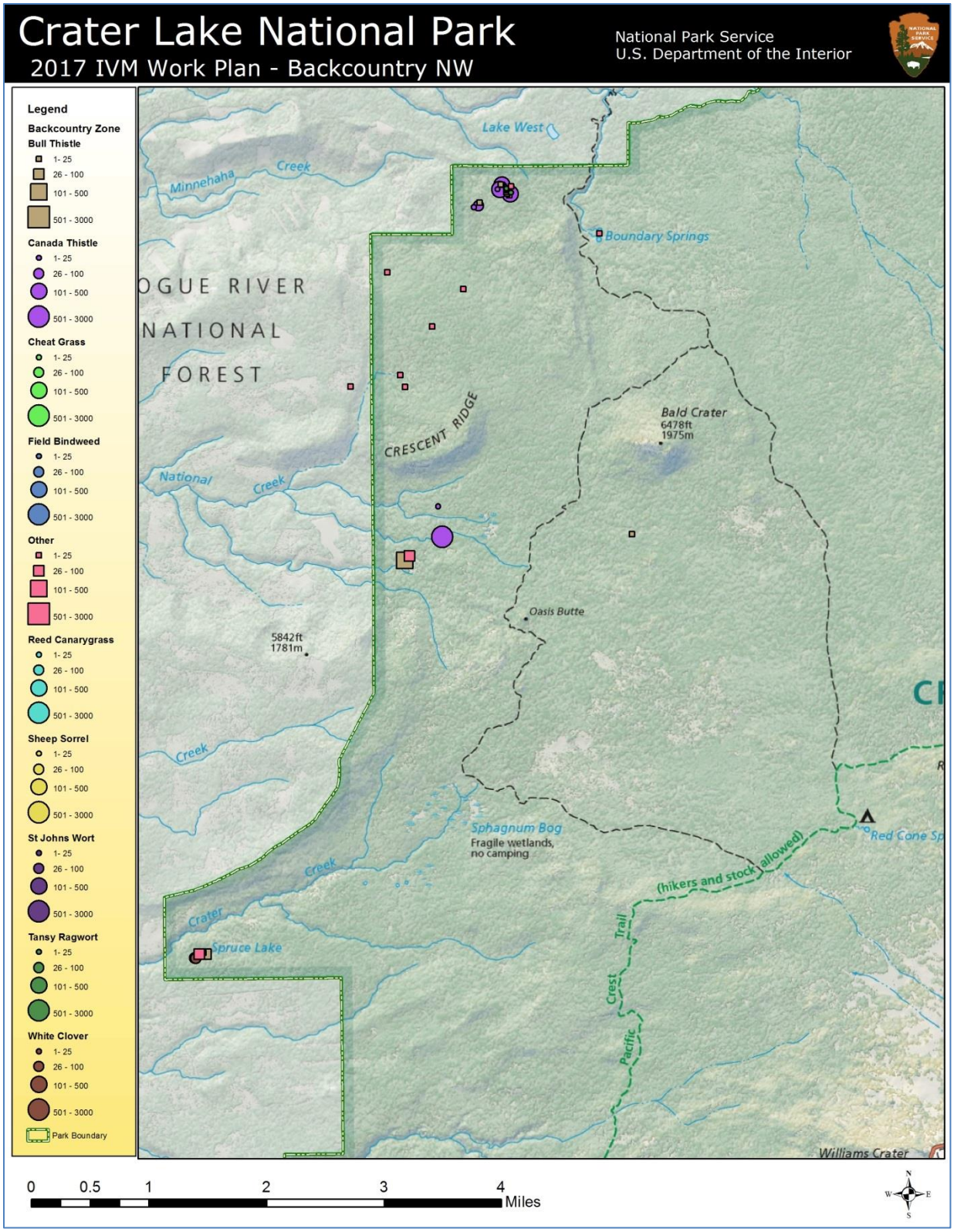


Figure B1. 2017 IVM work in the Backcountry zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.



FigureB 2. 2017 IVM work in the Backcountry zone NW based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

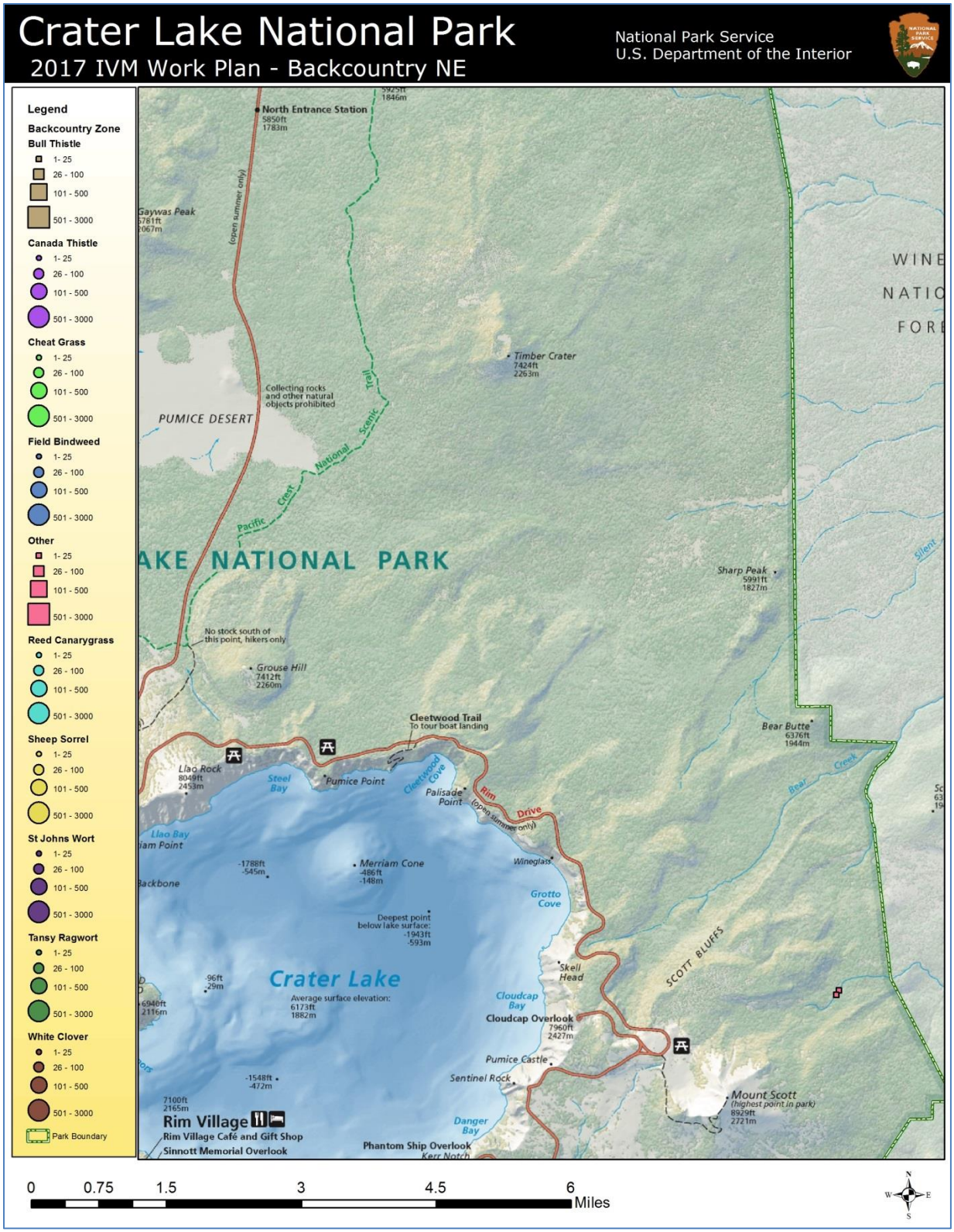


Figure B3. 2017 IVM work in Backcountry zone NE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

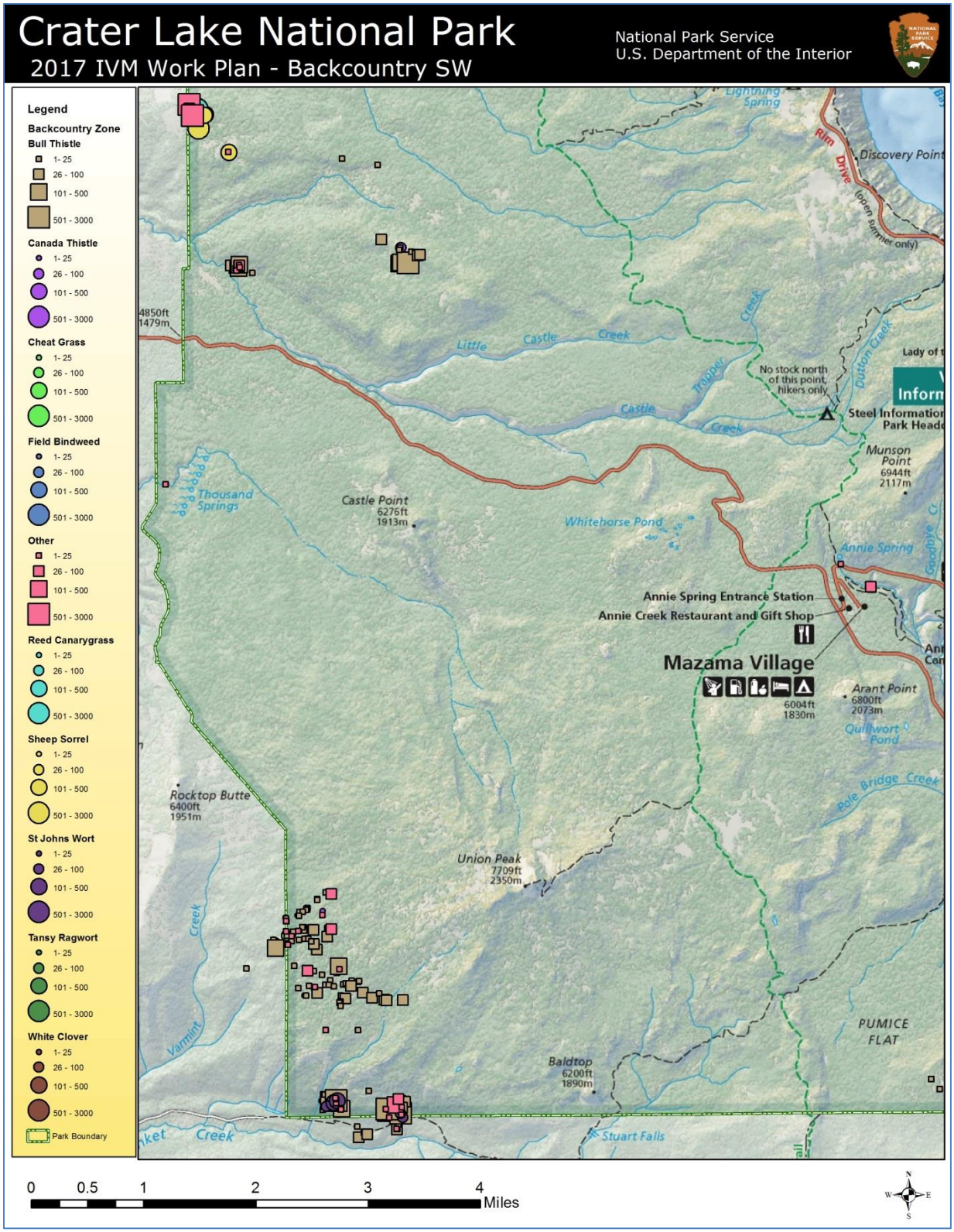


Figure B4. 2017 IVM work in the Backcountry zone SW based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

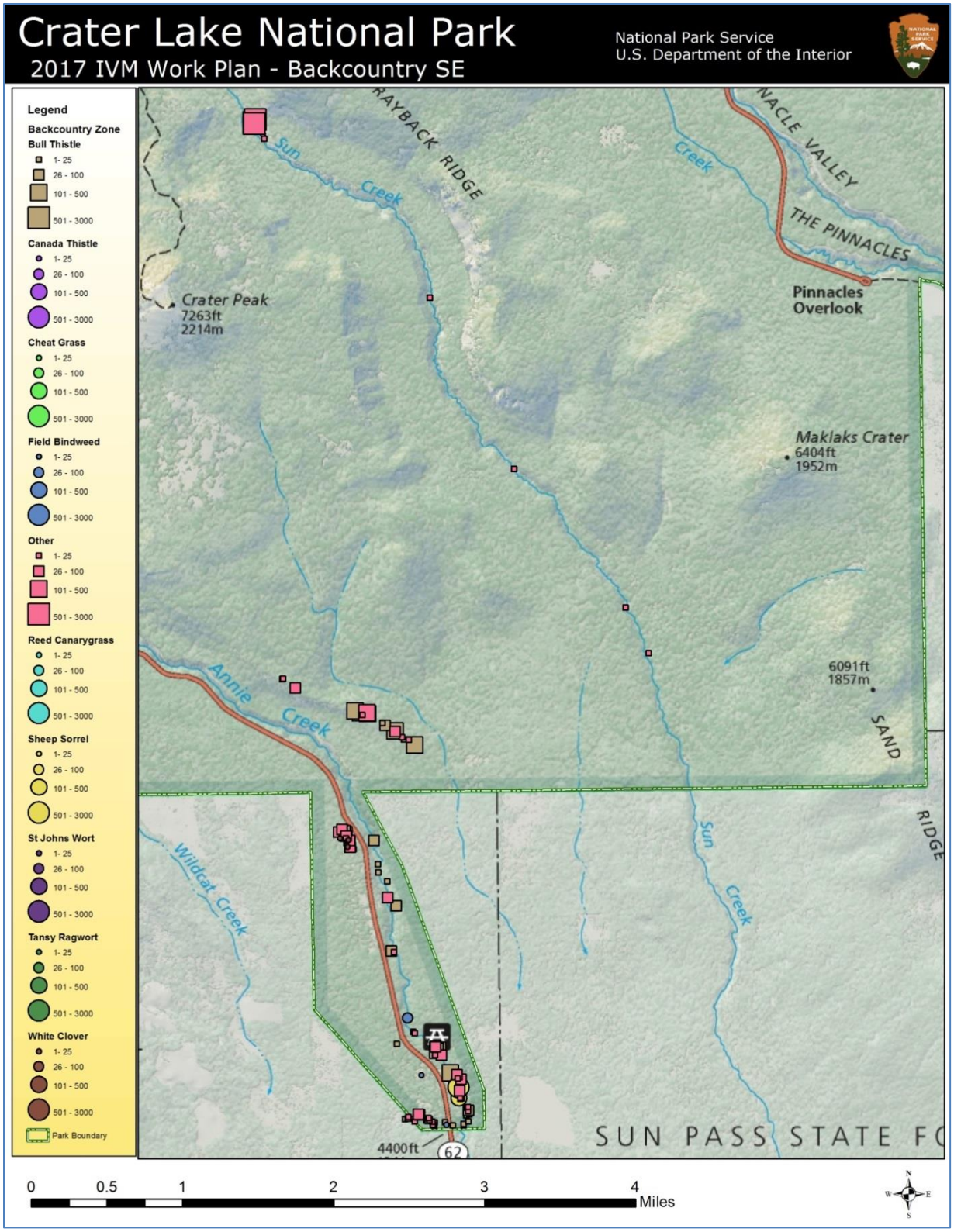


Figure B5. 2017 work in Backcountry zone SE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

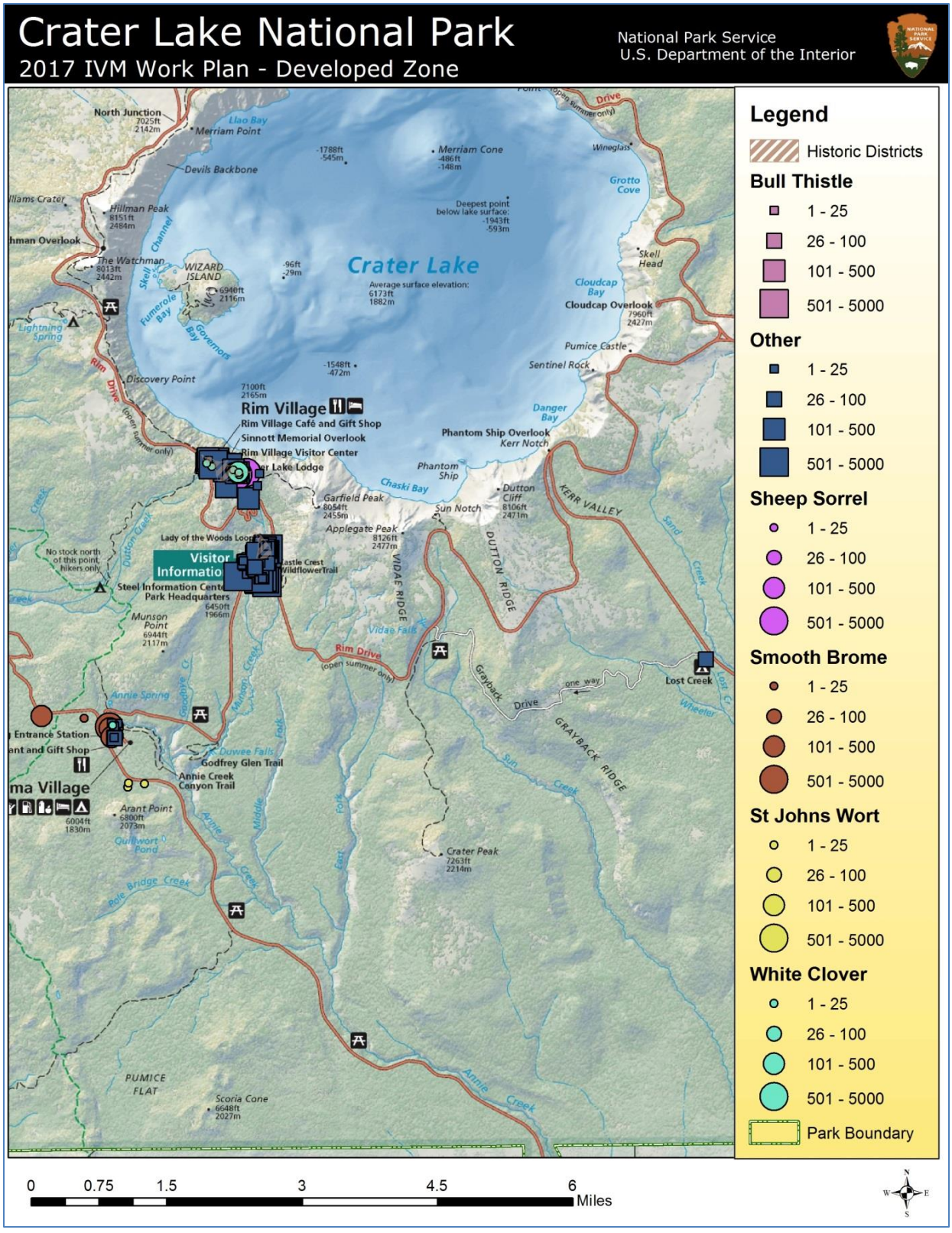


Figure B6. 2017 work in the Developed zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

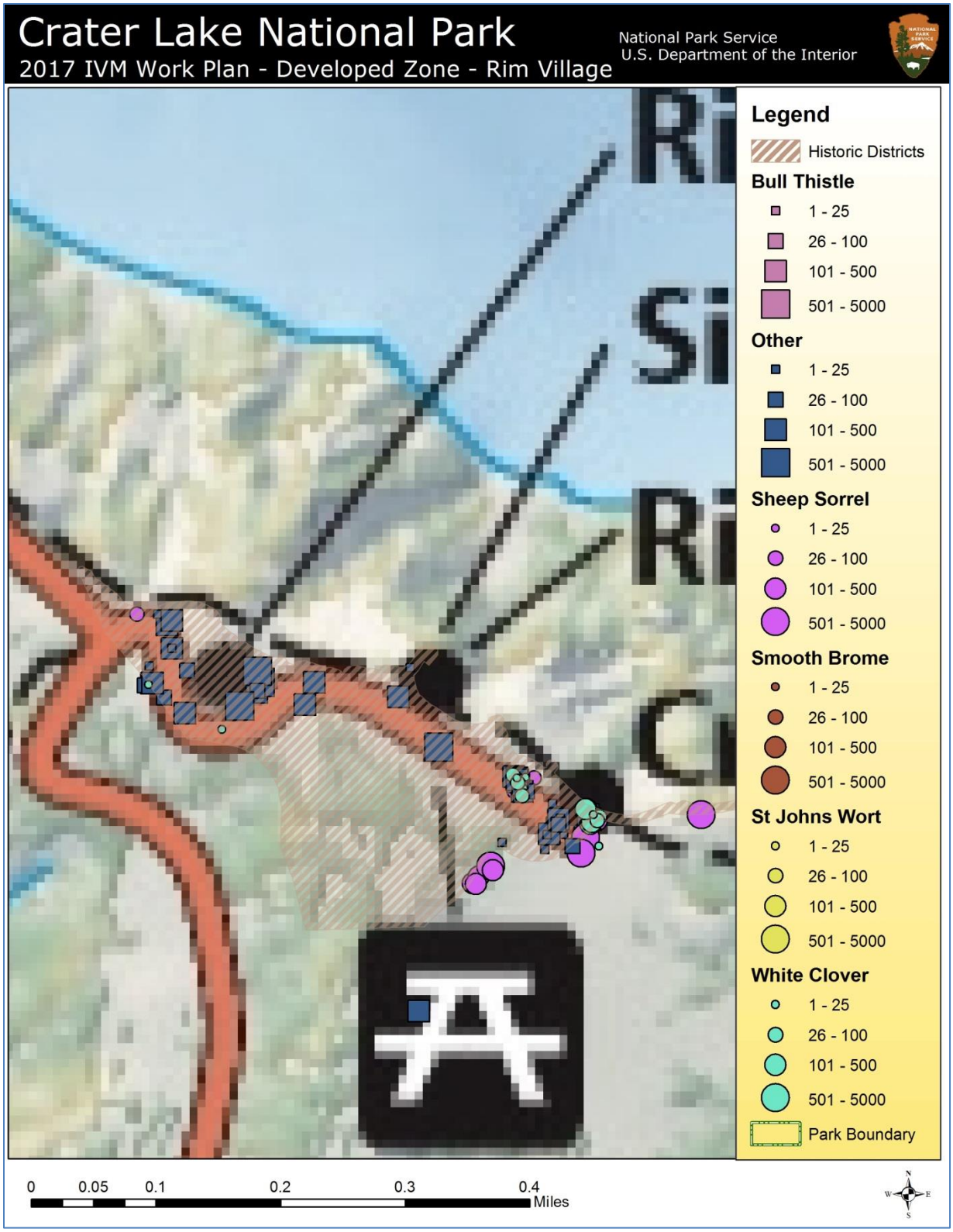


Figure B7. 2017 IVM work in the Developed zone – Rim Village area based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

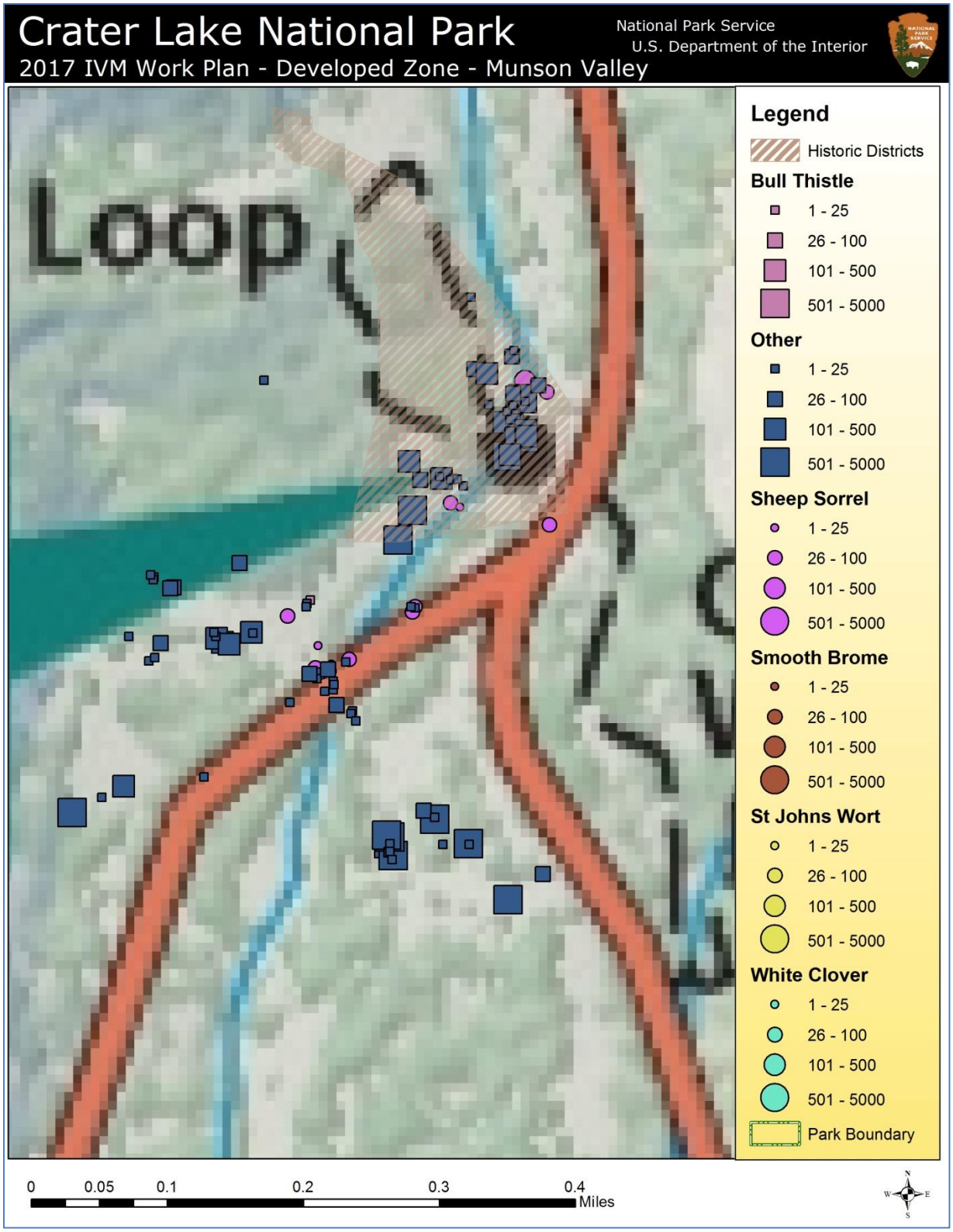


Figure B8. 2017 IVM work in the Developed zone – Munson Valley area based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

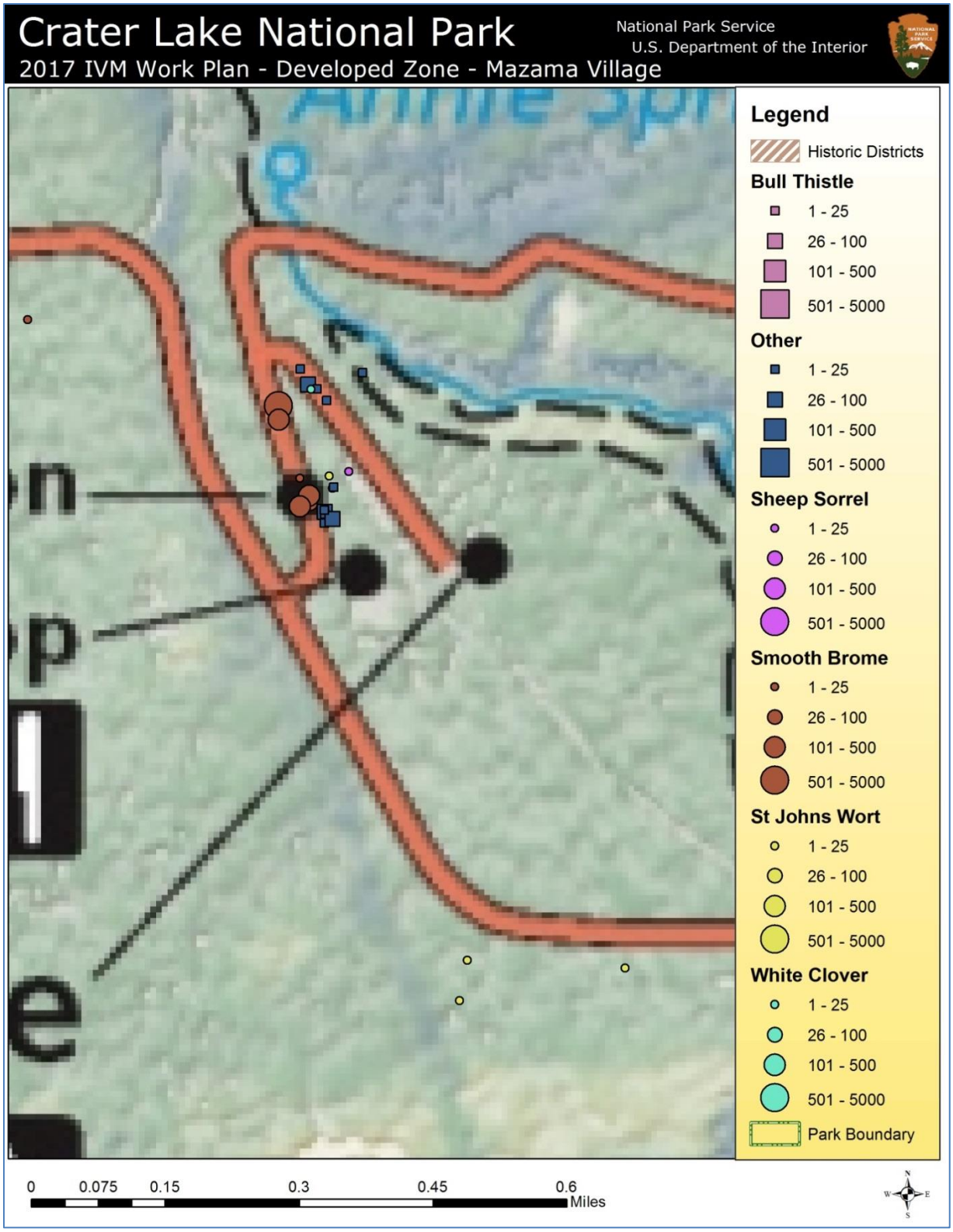


Figure B9. 2017 IVM work in the Developed zone – Mazama Village area based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

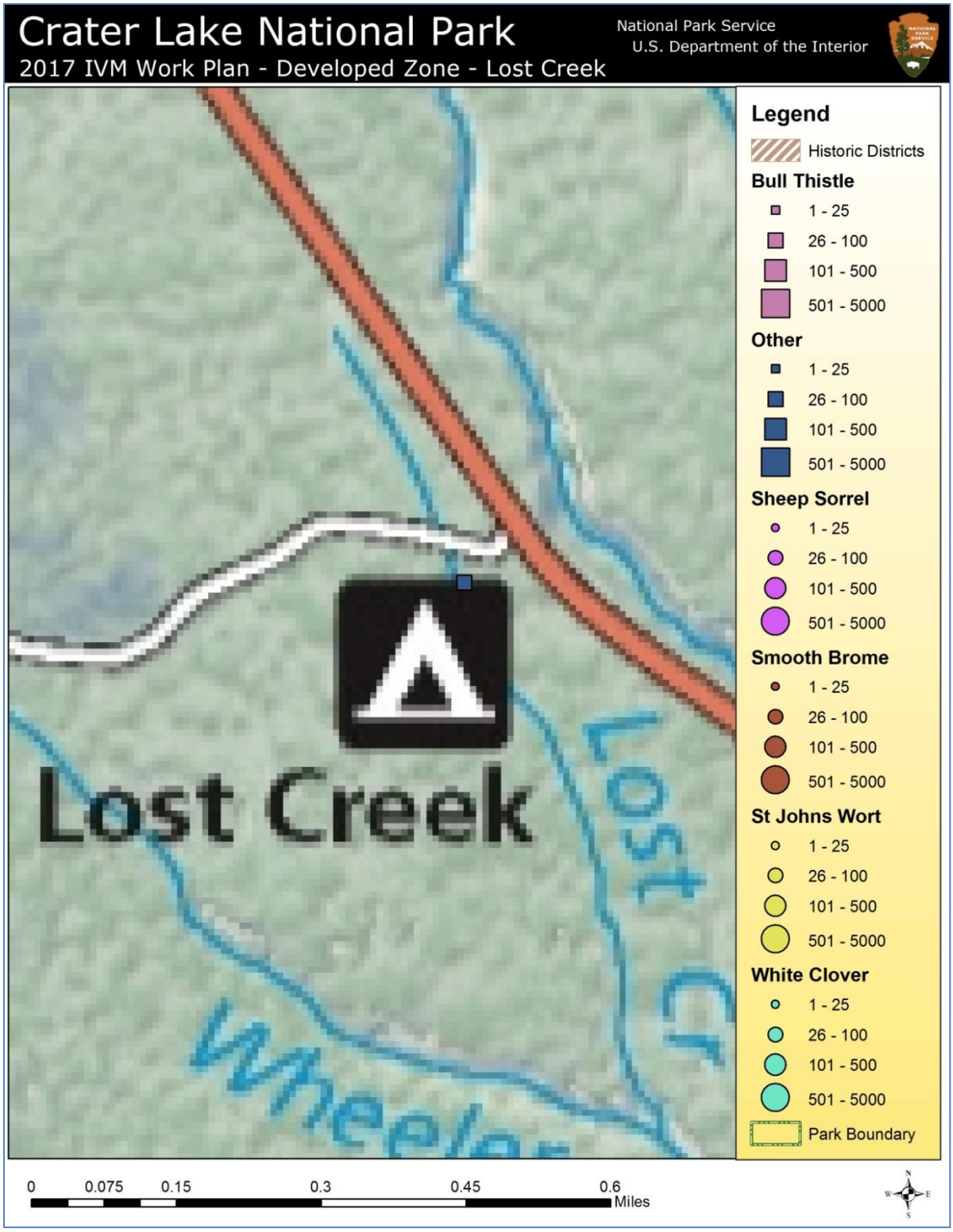


Figure B10. 20017 IVM work in the Developed zone – Lost Creek Campground area based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

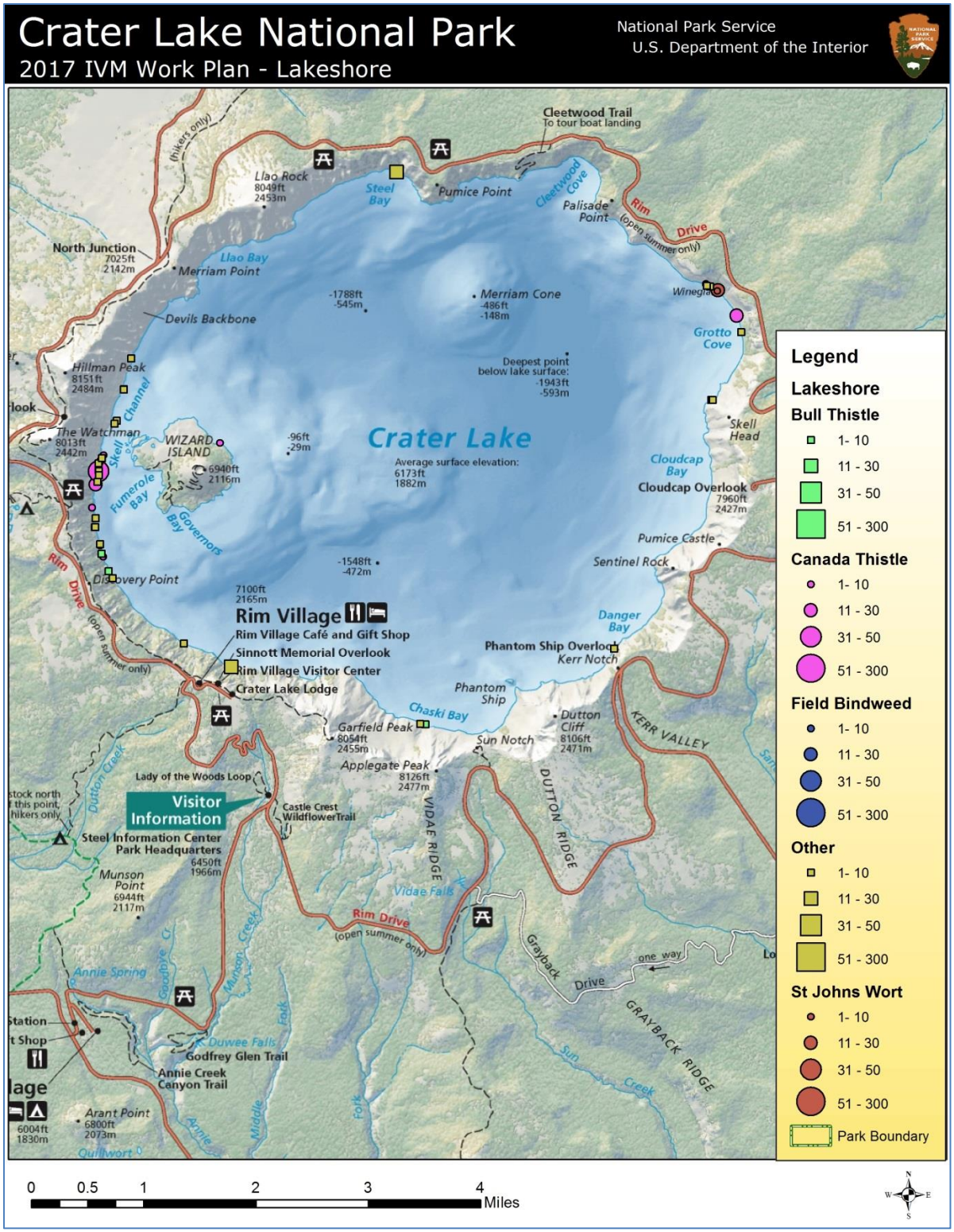


Figure B11. 2017 IVM work in the Lakeshore zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments. No chemical treatment would occur to invasive plants growing in Crater Lake or in stronghold areas for the Mazama newt.

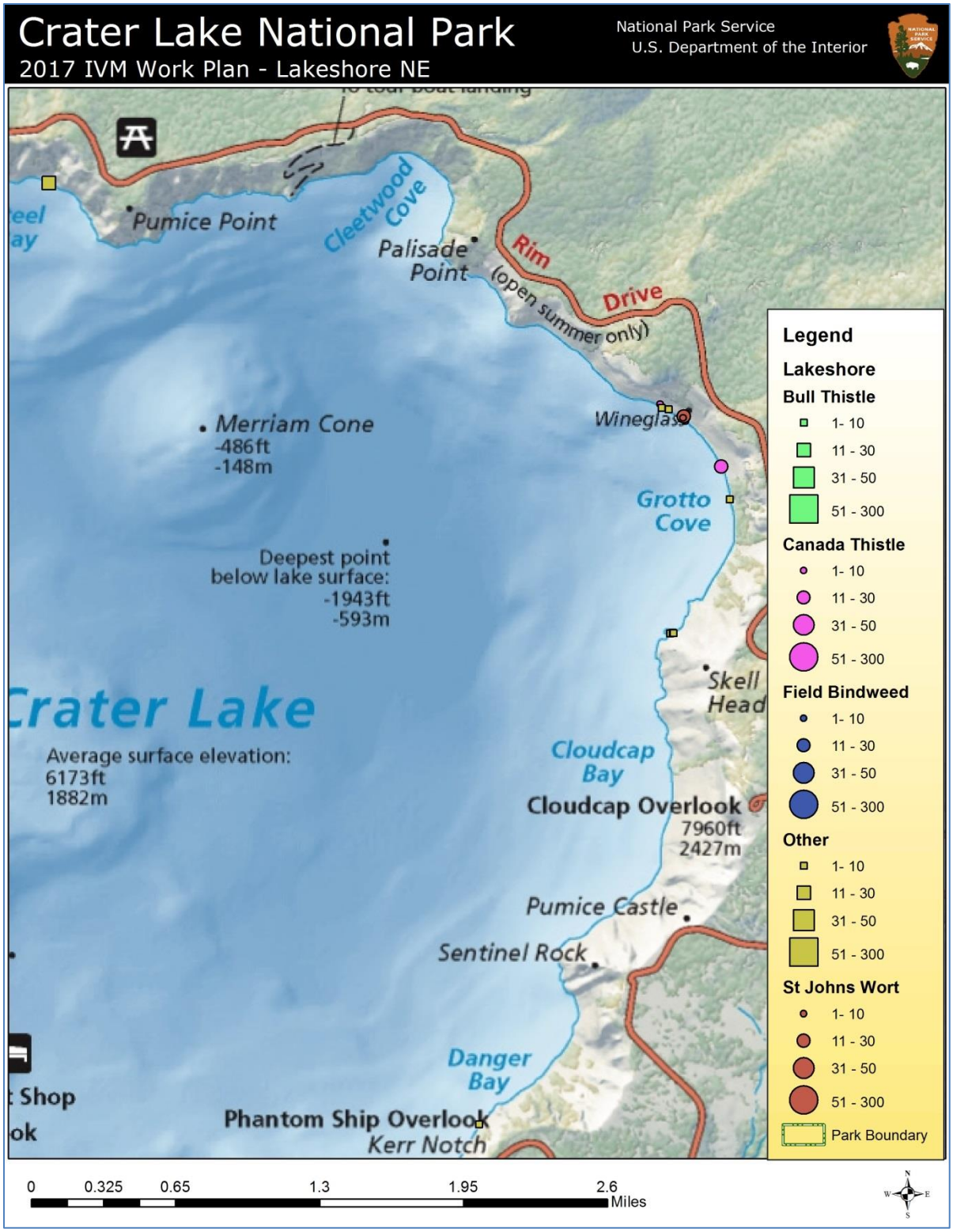


Figure B12. 2017 work in the Lakeshore zone NE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments. No chemical treatment would occur to invasive plants growing in Crater Lake or in stronghold areas for the Mazama newt.

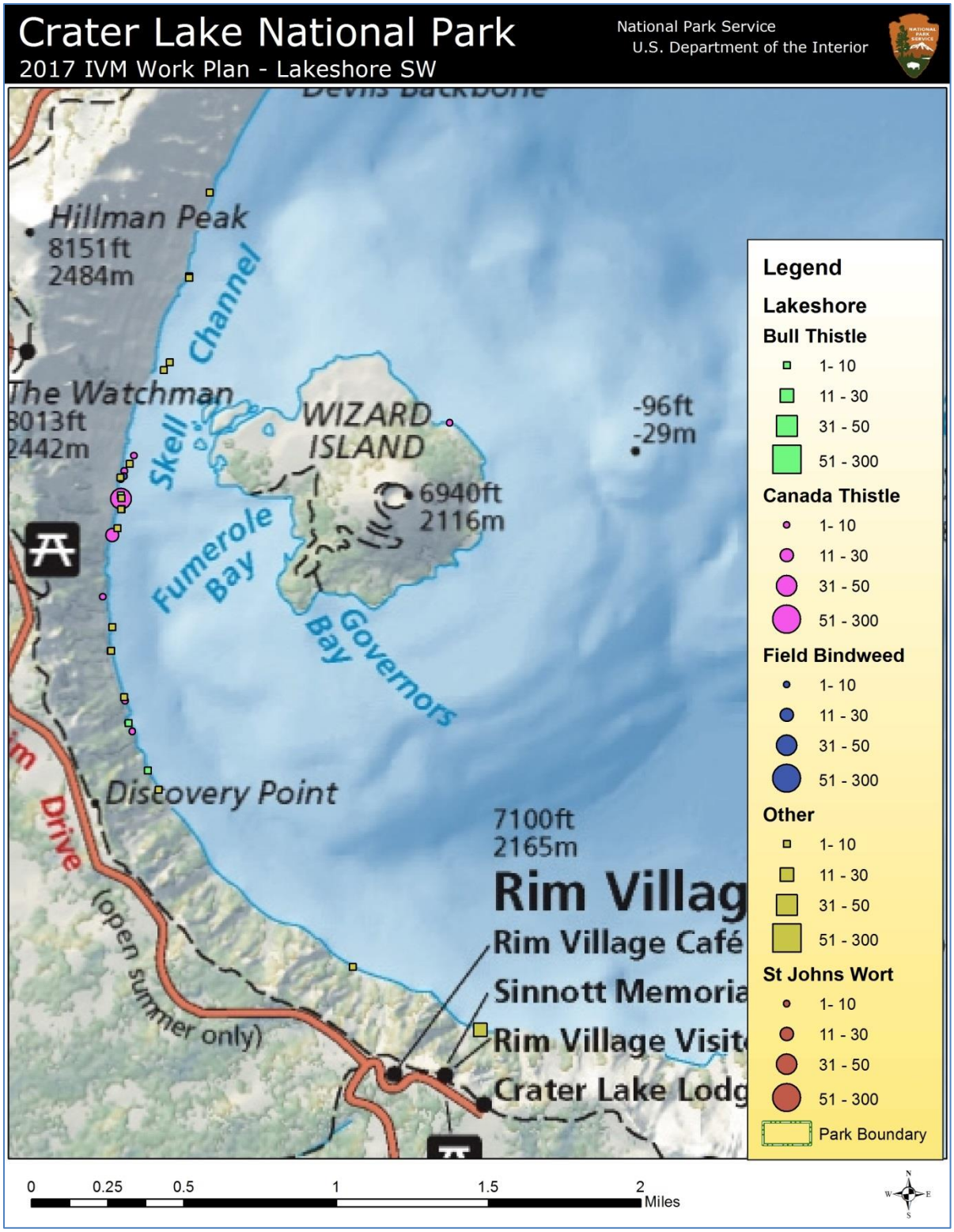


Figure B13. 2017 IVM work in the Lakeshore zone SW based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments. No chemical treatment would occur to invasive plants growing in Crater Lake or in stronghold areas for the Mazama newt.

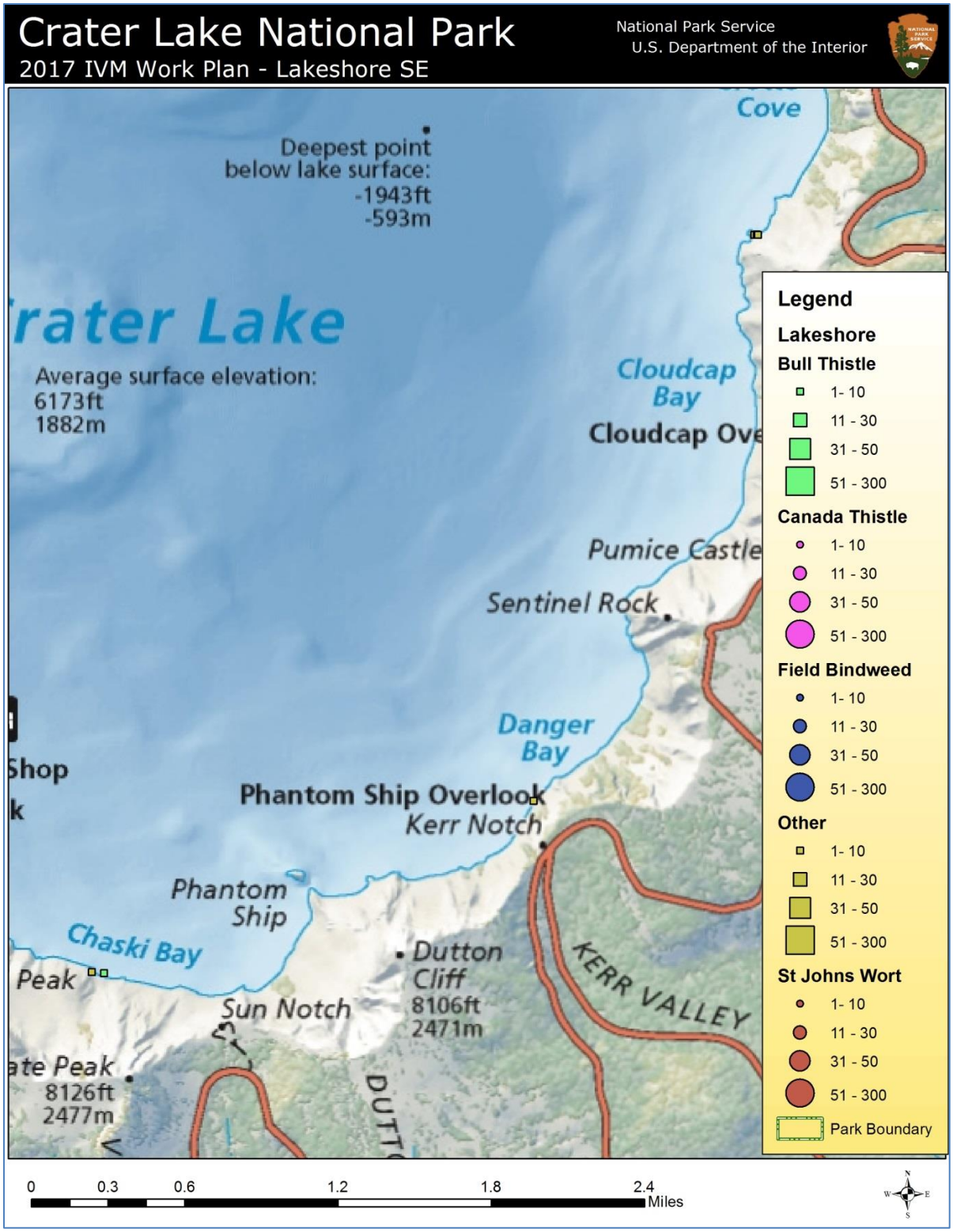


Figure B14. 2017 IVM work in the Lakeshore zone SE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments. No chemical treatment would occur to invasive plants growing in Crater Lake or in stronghold areas for the Mazama newt.

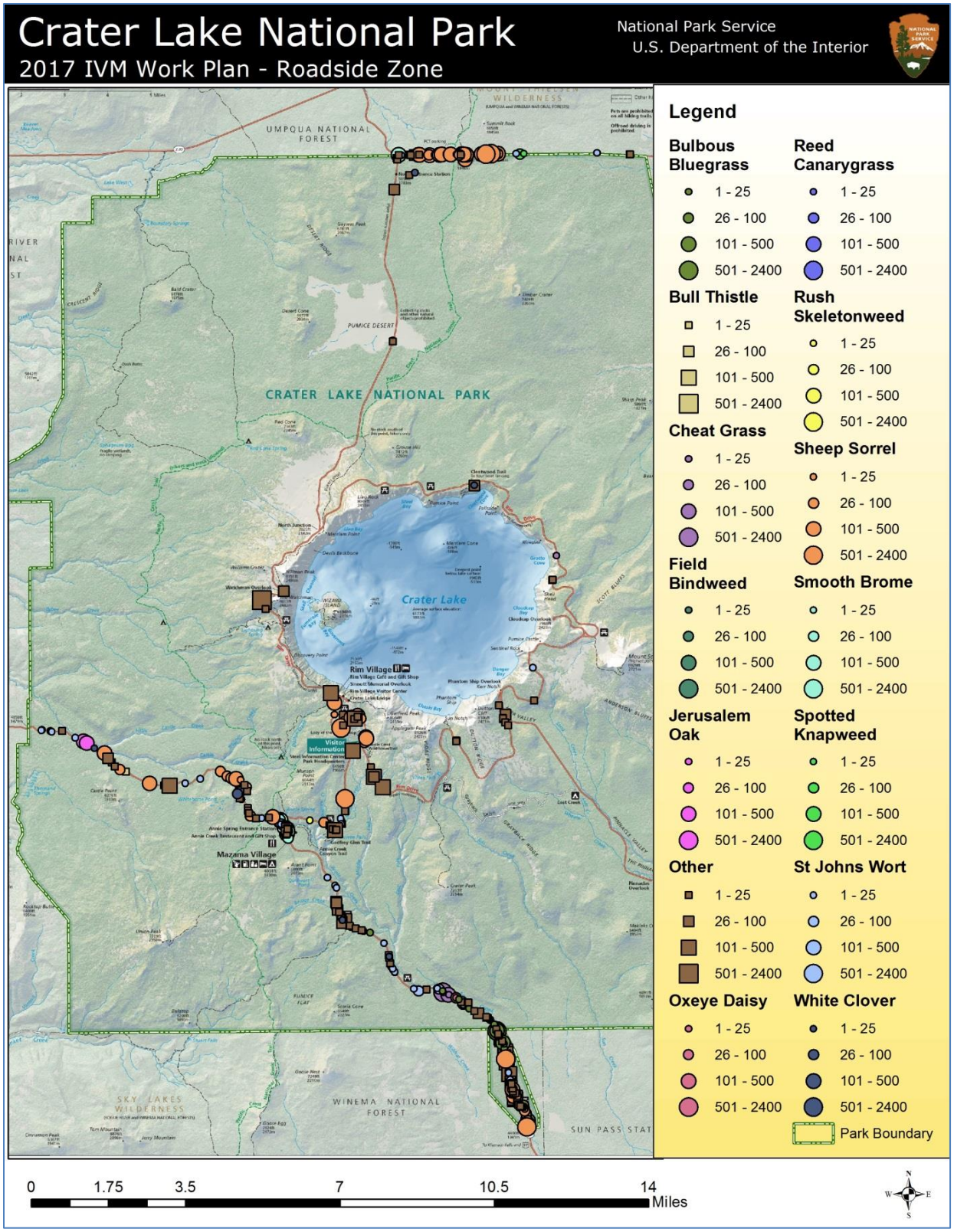


Figure B15. 2017 IVM work in the Roadside zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

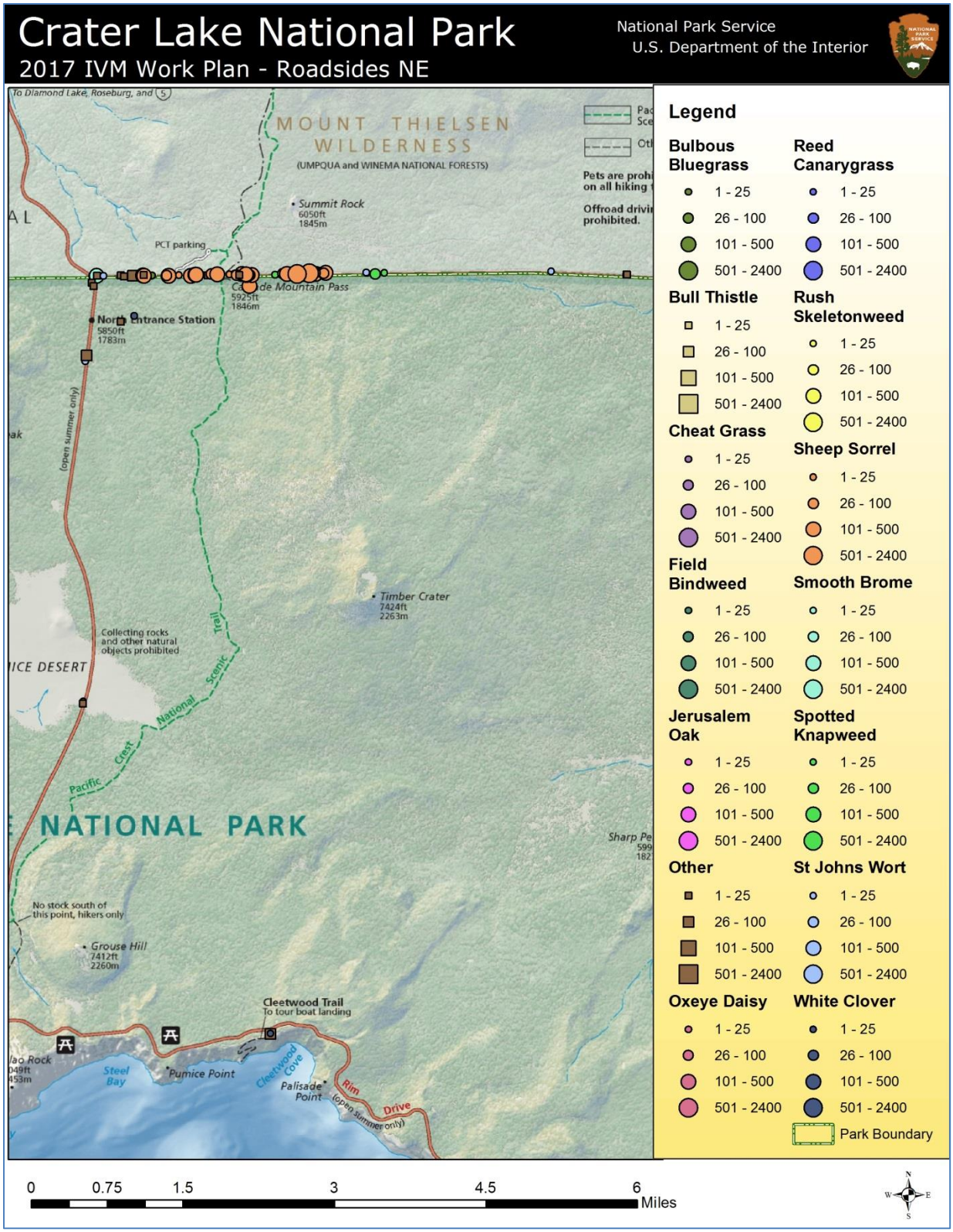


Figure B16. 2017 work in the Roadside zone NE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

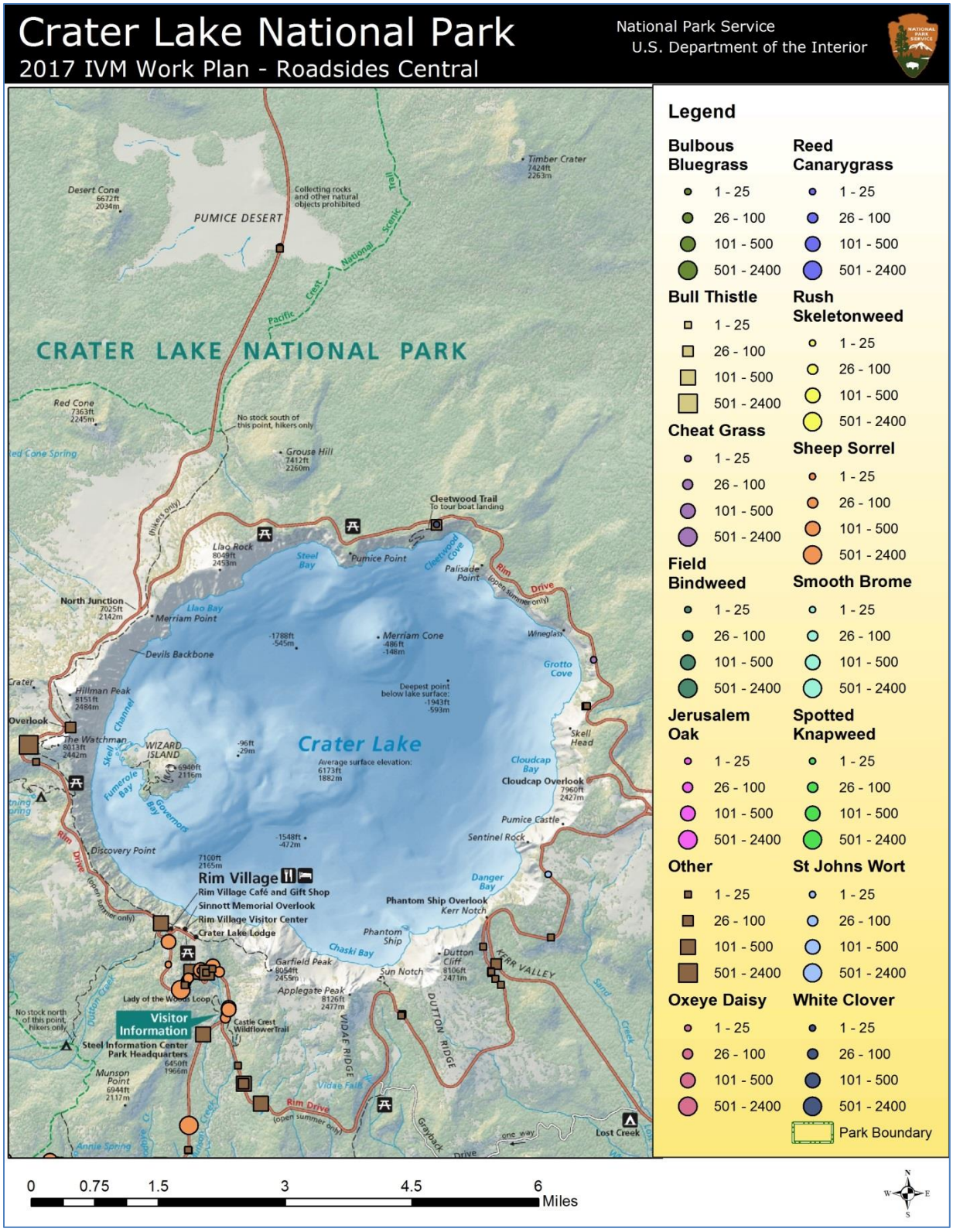


Figure B17. 2017 IVM work in the central Roadside zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

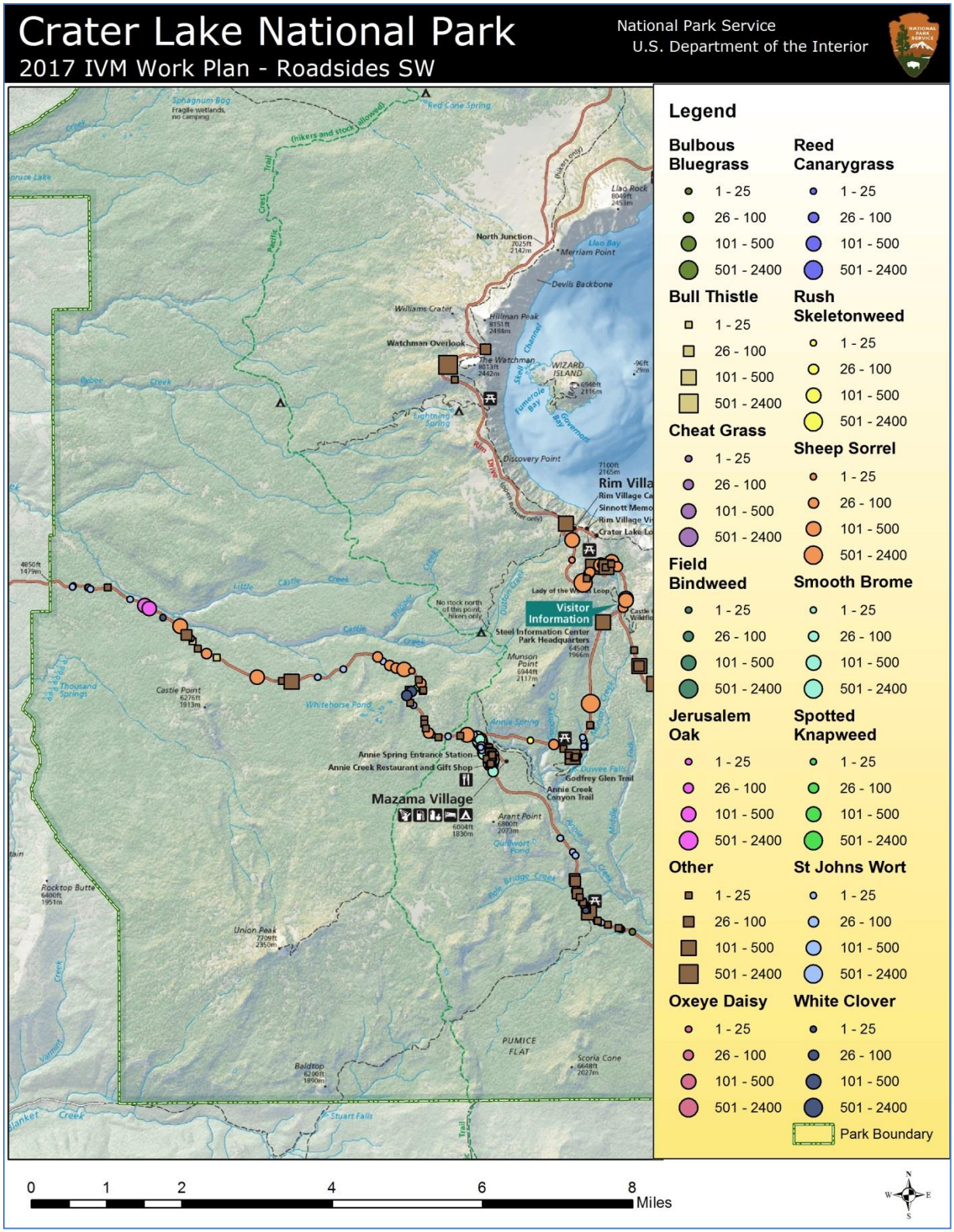


Figure B18. 2017 IVM work in the Roadside zone SW based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

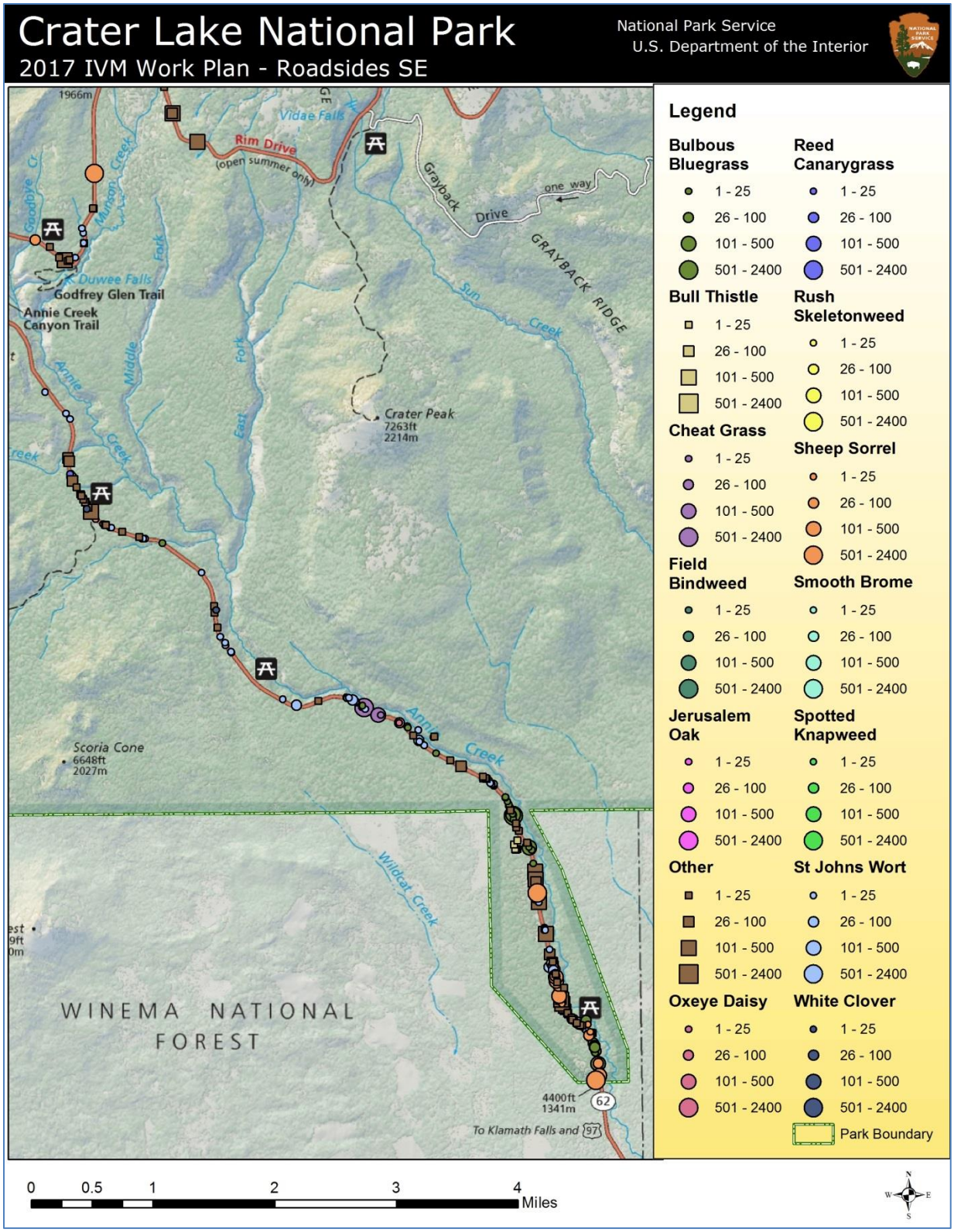
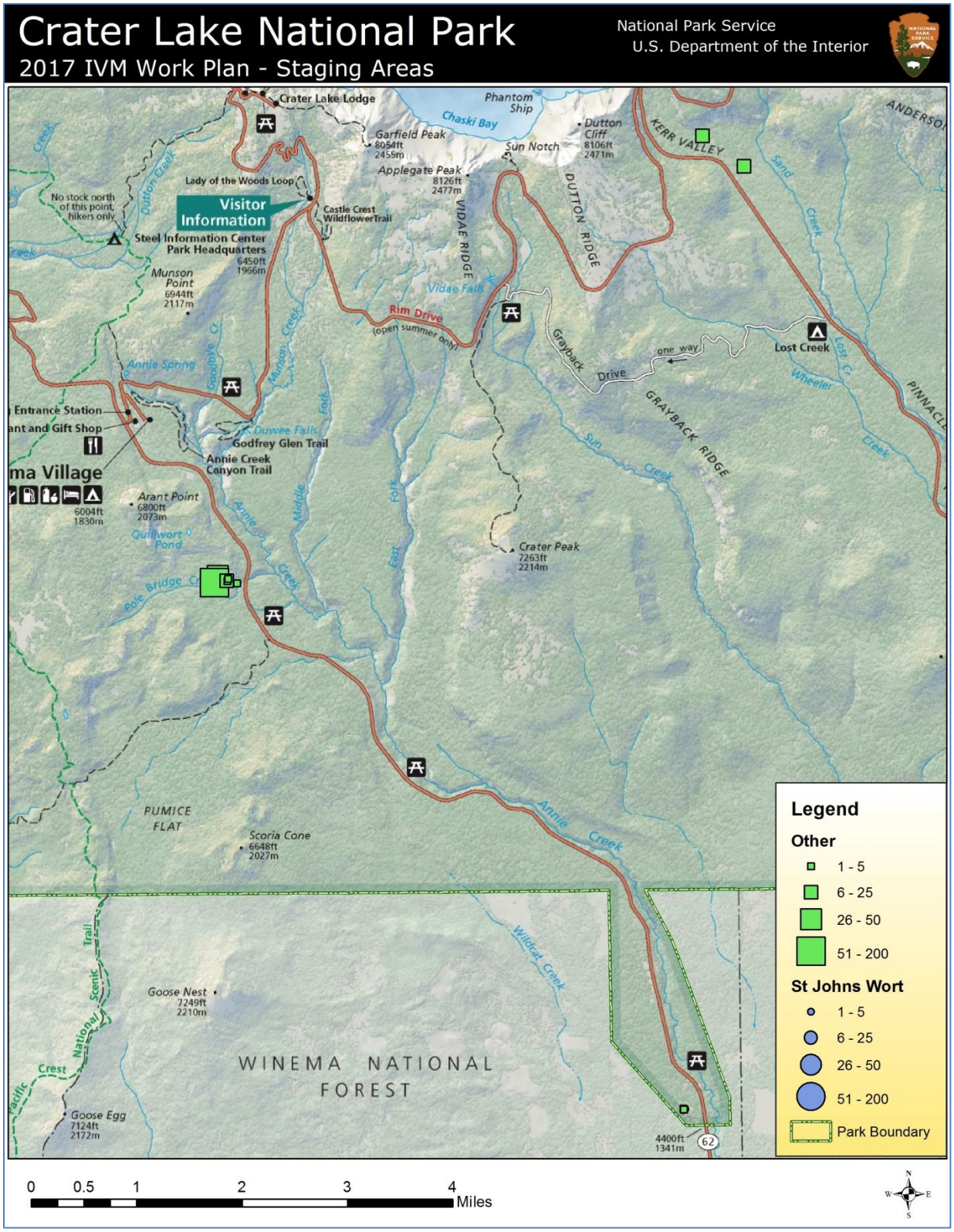


Figure B19. 2017 IVM work in the Roadside zone SE based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.



FigureB 20. 2017 IVM work in the Staging Areas zone based on 2016 IVM data. Circles depict species with potential for chemical treatment methods; squares denote species slated for manual treatments.

Appendix C: Minimum Requirements Analysis

Work proposed under the Invasive Vegetation Management Plan occurring in the park's recommended wilderness will be subject to a Minimum Requirements Analysis to ensure the protection of wilderness character and resources. The most efficient way to protect the recommended wilderness from degradation by invasive plant colonization is to prevent invasion in the first place, and to catch infestations at small and manageable sizes. This is achieved through employing measures to keep invasive plant seeds out of the recommended wilderness, and through early detection surveys and rapid response to any invasive plant populations encountered.

The steps to complete a Minimum Requirements Analysis for Invasive Vegetation Management work to be conducted in the park's recommended wilderness are outlined below.

1. Determine if the Proposed Action includes areas in recommended wilderness.
2. Determine whether the Proposed Action is required for the management of the park's recommended wilderness.
3. Determine whether the goals and objectives of the Invasive Vegetation Management Plan can be achieved through actions outside the park's recommended wilderness
4. Develop a list of options to meet the objectives of actions proposed by the Invasive Vegetation Management Plan occurring within the park's recommended wilderness. Outline methods to reduce or mitigate the impact of each option upon the park's recommended wilderness.
5. Determine the effects of each option on wilderness character.
6. Determine and assess the management concerns of each option.
7. Evaluate the options and determine the options that best meet the goals of the Proposed Action while simultaneously protecting and upholding wilderness character.

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