Pacific Northwest Region Invasive Plant Program

Preventing and Managing Invasive Plants Draft Environmental Impact Statement

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USDA Forest Service
Pacific Northwest Region

States of Oregon and Washington, Including Portions of Del Norte and Siskiyou Counties in California, and Portions of Nez Perce, Salmon, Idaho, and Adams Counties in Idaho

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Comments must be postmarked by November 24, 2004.

Note to Reviewers:

Reviewers should provide their comments during the DEIS review period so that the agencies may respond to all comments at one time and to use information acquired in the preparation of the final environmental impact statement, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act process so that it is meaningful and alerts the agency to the reviewers' position and contentions. Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 553 (1978). Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement. City of Angoon v. Hodel (9th Circuit, l986) and Wisconsin Heritages, Inc. v. Harris, 490 F. Supp. 1334, 1338 (E.D. Wis. 1980). Comments on the draft environmental impact statement should be specific and should address the adequacy of the statement and the merits of the alternatives discussed (40 CFR 1503.3).

Abstract: The Forest Service proposes to add management direction to all existing National Forest Land and Resource Management Plans in the Pacific Northwest Region (Region Six). This direction would increase invasive plant prevention, and make a new, and expanded set of invasive plant treatment tools available to the Forests.

Four alternatives are considered: No Action (Alternative A), the Proposed Action (Alternative C), Alternative B and Alternative D. No Action would continue current invasive plant management direction. The Proposed Action would provide increased consistency in prevention, new treatment tools, and increased flexibility in treatment. Alternative B represents a more "precautionary" approach, which proposes increasing the avoidance of invasive plant introduction and spread by further constraining current land management practices, such as road building, road maintenance, and off-highway vehicle use. Alternative D, proposes the use of additional, less expensive herbicides (2,4-D and Dicamba), and allows local land managers more discretion in how and when invasive plant prevention measures are implemented.

Implementation of any of the action alternatives is expected to reduce the rate of spread of invasive plants across Region Six. All of the action alternatives would increase the costs and effectiveness of invasive plant management. All of the action alternatives protect human health and the environment.

The Forest Service preferred alternative is the Proposed Action.

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SUMMARY

This environmental impact statement (EIS) documents the analysis of the potential environmental consequences of amending all Pacific Northwest Region (Region Six) Land and Resource Management Plans (Forest Plans) to improve the ability of the National Forests to prevent and manage invasive plants. Existing direction would be replaced with new, updated and more comprehensive direction for the prevention and management of invasive plants.

This EIS has been prepared in compliance with the National Environmental Policy Act (NEPA) guidelines as set by the Council of Environmental Quality in 40 CFR 1500-1508 and Forest Service Handbook 1909.15. The four main chapters of this document describe the purpose and need for action, the alternatives including the Proposed Action, the affected environment, and the effects of the alternatives.

The Proposed Action

The Proposed Action amends all Forest Plans within Region Six[1] to increase the emphasis on consistency of invasive plant prevention across the Region and allows the use of a new and expanded set of invasive plant treatment tools (see Figure S-1). The Proposed Action also includes restoration requirements and an inventory and monitoring plan framework.

Proposed prevention measures focus on reducing ground disturbances that promote invasive plants and on limiting the introduction and spread of invasive plants. Treatment measures expand and modernize the toolbox of available treatment methods[2], while clarifying processes related to the use of these methods, and adding flexibility for unforeseen future needs. Restoration measures standardize requirements for recovery of native flora and represent the important link between treatment and prevention. The inventory and monitoring plan framework provides a consistent blueprint for more detailed future monitoring plans.

The prevention of further invasive plant spread and treatment/restoration of infested sites will promote desirable vegetation and healthy native plant communities.

The selected alternative would become part of the amended Forest Plans, and provide management direction for site-specific (project-level) decisions, which will require additional NEPA analysis before being implemented.

[1] Region Six is 24.9 million acres of National Forest system land in Oregon, Washington, and small portions of Western Idaho (Hell's Canyon) and Northern California.

Purpose and Need

Invasive plants are damaging the biological diversity and ecosystem integrity of the Pacific Northwest. Invasive plants create a host of adverse environmental effects, include displacement of native plants; reduction in habitat and forage for wildlife and livestock; loss of threatened, endangered, and sensitive species; increased soil erosion and reduced water quality; reduced soil productivity; and changes in the intensity and frequency of fires.

An estimated 420,000 acres of National Forest system lands in the Region are currently infested with invasive plants (Chapter 3.1). Invasive plants continue to increase and invade previously uninfested areas. Collectively, the current National Forest land and Resource Management Plans (Forest Plans) in the Region do not provide adequate direction and tools to the Forests to protect these areas. This action is proposed to meet the underlying need on National Forests for: (1) Forest Plan direction that will better assure prevention or reduction of the spread of invasive plants; (2) Release from the Forest Plan direction established by the 1988 ROD and 1989 Mediated Agreement so that new practices, technologies, and chemical formulations of herbicides are available for use; (3) A new, updated list of herbicides available for use by the Forests (Chapter 1.2).

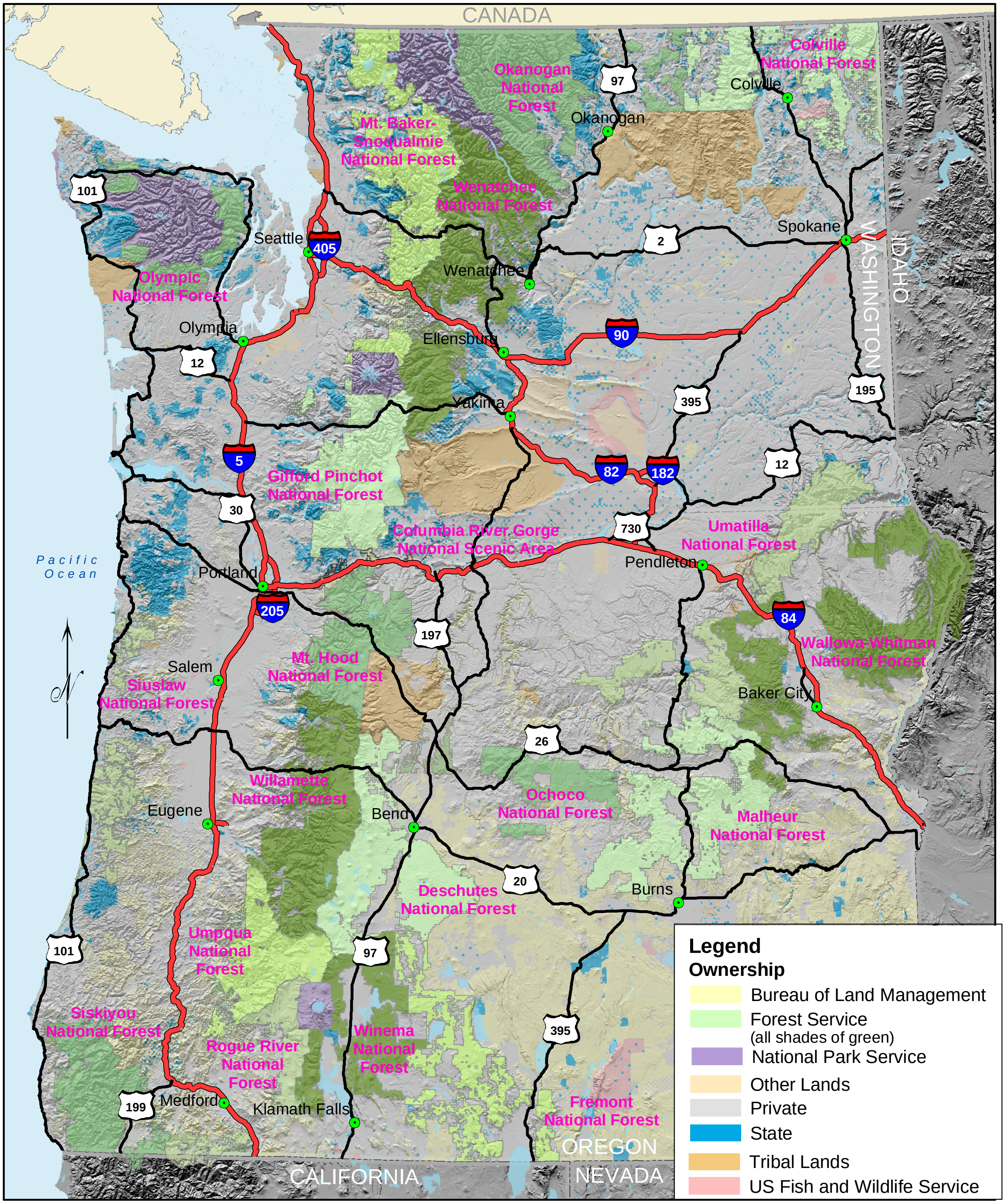
Not meeting this underlying need would mean invasive plant populations would continue to increase on National Forest system land, compromising our ability to manage the Forests and Grasslands for healthy native ecosystems, and the National Forests would become a continuing source of invasive plants spreading to neighboring lands.

Decision to be Made

The Region Six Regional Forester is the responsible official for this EIS. The Regional Forester will decide whether to implement the Proposed Action, another action alternative, or to implement no change at all (No Action). Factors influencing the Regional Forester's decision on selection of an alternative include: (1) how well the alternative meets the underlying need for action, (2) the potential effects to human health and the environment, (3) the effects on existing uses/management activities on the National Forest system land, and (4) the associated costs (Chapter 1.3).

[2] Treatment methods include manual, mechanical, biological, cultural, herbicide, and prescribed fire methods

Figure S-1 USDA Forest Service Pacific Northwest Region



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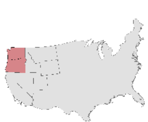

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Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

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Scoping

Members of the public have provided us extensive help to successfully move forward with this EIS. Scoping outreach was conducted to elicit participation from the general public, interest groups, government agencies, and Forest Service employees. Methods used to solicit comment included: Notice of Intent filed in the Federal Register (August 28, 2002); a project website; a direct mailing to approximately 3,000 interested members of the public, organizations, governments, and tribes. Public meetings were held in Oregon and Washington. Outreach yielded 275 letters of comment and a compendium of input from the public meetings. The letters were reviewed and significant issues were identified. For NEPA purposes an issue is a point of discussion, debate, or dispute about the environmental effects of a proposed action. Public concerns generated through scoping were evaluated based on their relevance to invasive plant management and the scope of this EIS. Concerns that could be addressed were consolidated into five key issues approved by the Regional Forester (Chapter 1.6).

Key Issues

Issue 1: Strategies to prevent and control invasive plants can vary in effectiveness.

The alternatives vary in their potential to prevent or reduce the spread of invasive plants. A combination of prevention, treatment and restoration activities is needed to deter the introduction, establishment and spread of invasives. Each action alternative adds a unique set of invasive weed management standards to Forest Plans in Region Six. The analysis in Chapter 4 focuses on characteristics of the standards and how they influence the introduction, establishment and spread of invasive plants.

The standards vary by degree of emphasis on prevention, treatment, and/or restoration. An emphasis on prevention effectiveness will result in reduced introduction and spread rates of invasive plants. An emphasis on treatment effectiveness will result in reductions in current infestations.

The social acceptability of the alternatives also factors into their effectiveness. The ability of the Forest Service to meet the purpose and need for action, achieve desired future conditions, and contribute to cooperative efforts throughout Oregon and Washington are directly correlated to the effectiveness of invasive plant prevention and control strategies.

Issue 2: Invasive plant treatments may harm non-target plants and native plant communities.

Invasive plant treatments, especially herbicides, may harm non-target plants, including culturally significant, and threatened, endangered and sensitive species. Different herbicides have varying degrees of potency and selectivity (e.g. some herbicides affect certain plant families more readily than others) and application methods vary in the potential for off-site drift. Shifts in species composition and diversity in native plant communities could occur as less herbicide-tolerant species are replaced by more tolerant species.

Certain herbicides and the methods by which they are applied could also harm plant pollinators. If reduction or shift in pollinators occurs, changes to species composition or diversity could follow.

Issue 3: Application of certain herbicides may harm some vegetation-eating or insect-eating birds and mammals and/or amphibians.

The use of herbicides to treat invasive plants may harm free-ranging wildlife. Certain herbicides have the potential, for example, to affect the vital organs of some wildlife species, change body weight, reduce the number of healthy offspring, increase susceptibility to predation, or cause direct mortality. Birds and mammals may ingest vegetation or insects that have been sprayed with some herbicides and potentially experience these types of effects. There is also concern that herbicides may cause some malformations or mortality to amphibians, which are exposed when herbicides enter water.

Issue 4: Invasive plant treatments may result in risks to human health, including contamination of drinking water.

The health and safety of forestry workers and the public may be at risk from exposure to herbicides, working on uneven/broken terrain, use of hand tools, inhalation of smoke, driving vehicles, exposure to fire, exposure to falling/rolling debris, and the other accidents. The public expressed particular concern about human health effects related to herbicide and fertilizer treatments in municipal watersheds, small watersheds with individual drinking water systems, or other areas where forest visitors may consume forest water.

To respond to this issue, toxicity data for various chemicals was analyzed for a variety of worker and public exposure scenarios.

Issue 5: Cost of Treatments and Effects on Land Uses.

The prevention and management of invasive plants can be costly and fiscal resources are always limited. Increased operating costs due to expanded invasive plant management may result in direct or indirect transfer of costs to users of National Forest lands. Also, invasive plant management may compete with other important land management needs, resulting in opportunity-cost tradeoffs.

Certain standards may have significant costs and potential to affect programs and users. Costs of conducting land management activities may be increased, potentially resulting in direct or indirect transfers to users of National Forest lands. Public access may be restricted from closing or decommissioning roads or off-road vehicle use areas.

Adjustments to range management such as grazing locations, intensity, timing, or outputs may occur. Recreation users may be required to supply weed free feed on some or all National Forest lands, which may increase the cost of using pack stock or restrict recreationists' ability to enter certain federal lands.

The No Action Alternative (Alternative A)

The No Action alternative represents no change from the current direction as established by the 1988 EIS and 1988 ROD for Managing Competing and Unwanted Vegetation and an accompanying 1989 Mediated Agreement, the individual Forest Plans for the nineteen National Forests in Region 6, the FSM, and letters of Regional policy (Chapter 2.3).

The Action Alternatives

The three "action alternatives" (Proposed Action, Alternatives B and D) were developed to meet the underlying need for action and address the identified issues. The action alternatives would amend Forest Plans within the Region by approving four kinds of invasive plant management direction (DFC, Goals, Objectives, and Standards), along with an inventory and monitoring framework.

The Proposed Action (Alternative C)

Invasive plant prevention, early detection, early treatment, and restoration of affected habitat, monitoring, and long-term site management are emphasized in the Proposed Action. A key feature of the Proposed Action is the requirement to develop long-term site goals for all invasive plant sites prior to treatment. Long-term site goals provide the mechanism to link treatment to prevention, revegetation/restoration and monitoring in an integrated and adaptive process. This alternative is the Forest Service Preferred Alternative.

Alternative B

Alternative B builds on the Proposed Action by increasing the emphasis on preventing invasive plants, and reducing the conditions that contribute to the introduction, establishment and spread of invasive plants, while taking a "precautionary" approach to treatment methods. Alternative B further restricts land management practices, such as road building, road maintenance, and off-highway vehicle use. Under Alternative B, the use of herbicides for treatment of invasive plants is a tool of "last resort."

Alternative D

Alternative D is similar to the Proposed Action, but it is designed to maintain greater planning and operational flexibility at the Forest/Ranger District level. It is the least prescriptive of the action alternatives. Greater flexibility is intended to reduce the treatment costs and impacts on land uses and user groups. In addition, Alternative D includes the use of two, less expensive and more risky herbicides (2,4-D and Dicamba).

Inventory and Monitoring

The action alternatives include specific inventory and monitoring requirements to be added to Forest Plans, and provide a blueprint for future, more detailed monitoring plans (Chapter 2.4 and Appendix M).

Effects of the Alternatives

The effects of the No Action, the Proposed Action, Alternative B, and Alternative D are disclosed in Chapter 4 and compared in Chapter 2.6.

No Action

Under No Action, invasive plant prevention would remain inconsistently applied across the Region and the treatment tools available to land managers would remain out-of-date. Under this alternative the underlying need for action would not be met. Continued invasive plant spread would compromise land managers' ability to manage the Forests for healthy native ecosystems and limit the ability of the Forest Service to reach one of its high priority goals (invasive species management).

No Action would also mean that National Forest System land would be a source of invasive plants spreading to neighboring lands.

Action Alternatives

All of the action alternatives are expected to decrease the rate of spread for invasive plants as compared to No Action. The Proposed Action and Alternative B are predicted to reduce the rate of spread most effectively. Alternative B is the most restrictive of current land management and land use activities. Alternative D has the highest treatment effectiveness, with the greatest reliance in the use of herbicides. Alternative B is least effective in treatment, as it emphasizes the use of non-herbicide treatment methods over herbicides, and considers herbicides "tools of last resort".

All action alternatives would comply with environmental standards to protect soils and water, native plant communities, fish and wildlife and human health. There is a higher degree of risk and uncertainty associated with the use of herbicides under Alternative D.

All action alternatives have the potential to increase costs and/or reduce program accomplishments due to consistent application of prevention standards.

The Forest Service Preferred Alternative is the Proposed Action

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CHAPTER 1 PURPOSE AND NEED FOR ACTION

1.1 Introduction

The Regional Forester proposes to amend all Forest Plans within Region Six[3] to improve the ability of the National Forests to prevent and manage invasive plants. Updated and more comprehensive direction would replace existing direction for the prevention and control of invasive plants.

Invasive plants threaten the biological diversity and ecosystem integrity of the Pacific Northwest. They can displace native plants and out-compete rare plants; reduce habitat and forage value for wildlife and livestock; increase soil erosion and reduce water quality; reduce soil productivity; and change the intensity and frequency of fires. The economic impact of invasive species is substantial. A study conducted for the Oregon Department of Agriculture estimated that invasive plants are costing Oregon citizens about $100 million per year (2000). Chapter 2 provides details about the widespread impacts of invasive plants on National Forest values.

An estimated 420,000 acres of National Forest system lands in the Region are currently infested with invasive plants[4]. Despite current management efforts, invasive plants continue to increase and invade previously uninfested areas, such as Wilderness areas, Research Natural Areas, and Hell's Canyon National Recreation Area.

The good news is we still have an opportunity. The Pacific Northwest and National Forest system land in particular, have not yet been invaded to the degree that other Western States (Montana, Idaho) have been affected. If we act now, and act effectively, we can still protect our most unique and valuable areas of uninfested native plant communities.

The Proposed Action was developed to address the growing threat posed by invasive plants. The Regional Forester proposes to amend all Forest Plans within Region Six to give National Forests the tools and the flexibility they need to better manage invasive plants. The Proposed Action (along with other alternatives considered) is presented in detail in Chapter 2.

[3]Region Six is 24.9 million acres of National Forest system land in Oregon, Washington, and small portions of Western Idaho (Hell's Canyon) and Northern California.

[4] Invasive plant surveys on National Forests in Region Six are not yet complete, and existing inventories vary from one National Forest to another. The estimate of 420,000 acres of invasive plants are based on the best information available from the 19 National Forests in the Region Six.

1.2 Need for Action

Invasive plants are spreading at an estimated rate of 4,600 acres per day on all federal lands in the West, outside of Alaska (Asher, 2001). This equates to adding approximately 1.7 million acres (an area the size of the Willamette National Forest), of new invasive plants every year. The spread of invasive plants within Region Six approximates this broader regional trend, particularly on National Forest System lands east of the Cascade crest (ICBEMP, 2000). Currently, 107 different species of invasive plants have been identified on National Forest System land in Region Six (Appendix B). Undoubtedly, this number will increase as other new invaders arrive and are discovered. Umatilla County, in northeast Oregon, has reported that despite cooperative management efforts, populations of yellow starthistle (*Centaurea solstitialis*), an aggressive, adaptable rangeland invasive plant has doubled in the past ten years (Asher, 2001).[5]

Collectively, these invasive plant species disrupt natural ecosystems, and increase the potential loss of native plant communities, wildlife, and ecosystem functions. Invasive plants can have adverse effects on rare or endemic species, which could result in listing under state or federal endangered species laws. Invasive plants threaten all land ownerships (private, corporate, tribal, and government), they have the potential to spread from one piece of property to the next.

Current direction for the prevention and management of invasive plants on National Forests in Region Six comes to a large degree, but not exclusively, from the 1988 Environmental Impact Statement (EIS) and 1988 Record of Decision (ROD) for Competing and Unwanted Vegetation, and the associated 1989 Mediated Agreement.[6] These documents require consideration of invasive plant prevention, but specific direction on how to actually prevent the spread of invasive plants is not provided.[7] The 1988 ROD specified and limited the tools available for the treatment of competing and unwanted vegetation, but did not provide administrative mechanisms for adapting their requirements and adopting new technologies. For example, herbicides approved for use by the Forest Service in the 1988 ROD were developed before 1980. Since that time new herbicides have been developed and registered for use. The new herbicides have advantages for invasive plant control, such as greater selectivity, less harm to desired vegetation, reduced application rates, and lower toxicity to animals and people.

[5] Asher also reported that star thistle has increased in Jackson County in southern Oregon.
[6] These documents have been incorporated into the Forest Plans within the Region.
[7] A few National Forests, most notably the Mt. Baker-Snoqualmie, have moved forward in recent years to amend their Forest Plan to include specific direction for the prevention of invasive plants; most Forests have not.

Collectively, the Forest Plans, as they are currently written, do not provide sufficient direction, nor do they provide adequate tools for effectively responding to the invasive plant threat.

This EIS responds to three underlying needs that currently exist on all National Forest system land in Region Six for:

1. Forest Plan direction that will prevent or reduce the spread of invasive plants.
2. Release from the Forest Plan direction established by the 1988 ROD and 1989 Mediated Agreement so that new practices, technologies, and chemical formulations of herbicides are available for use.
3. An updated list of herbicides available for use by the Forests.

The purpose of this project is to reduce or prevent the spread of invasive plants so that the desired future condition of lands can be attained (refer to Chapter 2.4 for more information on Desired Future Condition (DFC)), to maintain federal land managers' ability to provide goods and services from the National Forest system lands, and to improve the Forest Service's ability to cooperate with efforts to reduce or prevent spread of invasive plants outside of National Forest lands.

1.3 Decision to be Made

The Regional Forester is the Responsible Official for this EIS. The analyses and findings described in this EIS will help the Responsible Official make a reasoned decision, whether to:

1. Select No Action (Alternative A) and continue with current invasive plant management direction, or
2. Meet the underlying need for action by adopting an action alternative (Proposed Action, Alternatives B or D), or
3. Select a modified action that meets the underlying need.

Factors influencing the Regional Forester's decision on selection of an alternative include: (1) how well the alternative meets the underlying need for action, (2) the potential effects to human health and the environment, (3) the effects on existing uses/management activities on the National Forest system land, and (4) the associated costs.

The Record of Decision for this Environmental Impact Statement would add new Forest Plan direction relating to invasive plants, and delete existing Forest Plan direction for invasive plants incorporated from the 1988 EIS, 1988 ROD, and the 1989 Mediated Agreement. The selected alternative would become part of the amended Forest Plans, and provide management direction for project level decisions.

Management direction provided by the selected alternative would apply to future projects and activities. A selected alternative will not by itself change any permitted or authorized activity on National Forest system land. Any subsequent site-specific federal action that may change the environment, and applies management direction adopted through this action, would be subject to applicable NEPA and other planning regulations.

Over time, decision makers for individual National Forests will likely modify the decisions that result from this EIS as per 36 CFR 219. The Proposed Action will not be retained as a Regional-scale decision.

1.4 Project Location

The Forest Service proposes to modify management direction for all National Forest system lands administered by Region Six, which includes the following nineteen National Forests: Colville, Gifford Pinchot, Mt. Baker-Snoqualmie, Okanogan, Olympic, and Wenatchee National Forests in Washington, and the Deschutes, Fremont, Malheur, Mt. Hood, Ochoco (which encompasses the Crooked River National Grassland), Rogue River, Siskiyou, Siuslaw, Umatilla, Umpqua, Wallowa-Whitman, Willamette, and Winema National Forests in Oregon (see Figure 1-1). The Columbia River Gorge National Scenic Area is also included, as are portions of the Payette and Nez Perce National Forests (Hell's Canyon National Recreation Area) in Idaho, managed by the Wallowa-Whitman National Forest, and portions of the Rogue River and Siskiyou National Forests that extend into California.

The National Forest system lands administered by Region Six, total about 24.9 million acres, and include approximately 15.5 million acres in Oregon, 9.2 million acres in Washington, 142,000 acres in Idaho, and 87,000 acres in California.

1.5 What is Not Included

This action does not include invasive plants floating on or submerged in water. Floating and submerged invasive plants (aquatic invasives) are currently being addressed through other federal actions in cooperation with the states. Nor does it include experimental trials of herbicides conducted by the U.S. Environmental Protection Agency (EPA) to test new products.

The action would revise only that portion of existing management direction that addresses prevention, and management of invasive plants, as well as restoration activities associated with the removal of invasive plants. It will not alter current management direction for competing and unwanted vegetation other than invasive plants, or other restoration not associated with invasive plant treatment.

Under the Wyden Amendment, Section 323 of the Fiscal Year 1999 Department of the Interior and Related Agencies Appropriations Act, and the Secure Rural Schools and Community Self-determination Act of 2000, federal funding can be authorized for treatment of invasive plants on non-federal lands. The Forest Plan amendments proposed in this document apply only to the identified National Forest system land.

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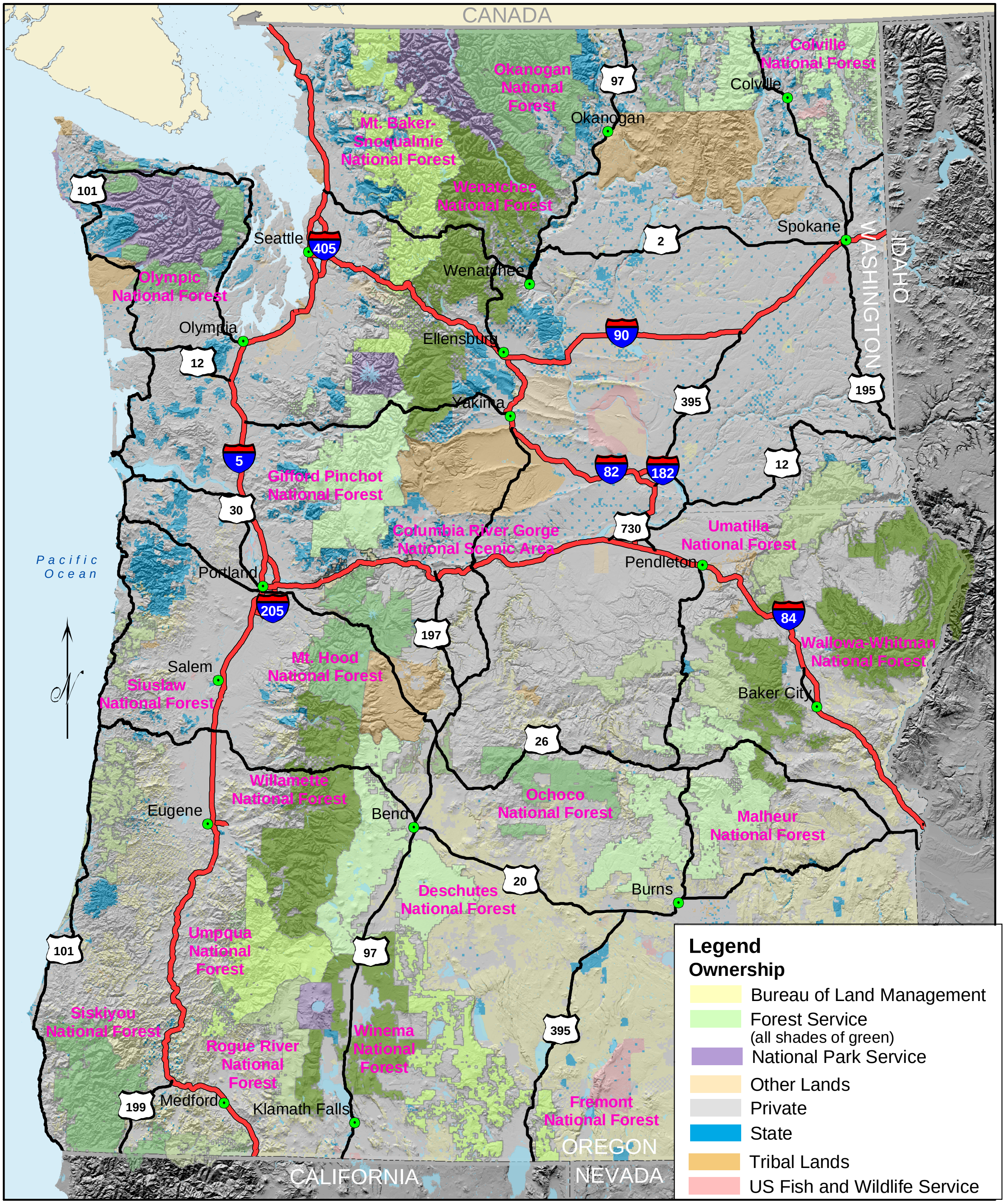
Figure 1-1 USDA Forest Service Pacific Northwest Region



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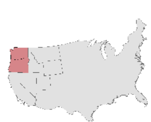

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1.6 Public Participation, Scoping and Issues

Scoping outreach was conducted to elicit participation from the general public, interest groups, government agencies, and Forest Service employees. Methods used to solicit comment included: the Notice of Intent filed in the *Federal Register* (August 28, 2002); a project website; a direct mailing to approximately 3,000 interested members of the public, organizations, governments, and tribes. Public meetings were held in Oregon and Washington.

Public participation was extensive; scoping outreach yielded 275 letters of comment and additional input from the public meetings. Many concerns identified in the scoping input did not fall within the scope of this analysis, were re-statements of legal or procedural requirements, or were already covered by a prior decision. These were dismissed from full analysis (see Appendix A describing how all scoping concerns were addressed).

Scoping input was used to develop the management direction common to all action alternatives (including the Proposed Action). Key issues (points of discussion, debate, or dispute about the environmental effects of an action) were identified where public concerns could only be resolved through substantial change to the Proposed Action. Alternatives were developed to address key issues. The five key issues identified for this analysis are:

Issue 1: Strategies to prevent and control invasive plants can vary in effectiveness.

Issue 2: Invasive plant treatments may harm non-target plant species.

Issue 3: Application of certain herbicides may harm some vegetation-eating or insect-eating birds and mammals and/or amphibians.

Issue 4: Invasive plant treatments may result in risks to human health, including contamination of drinking water.

Issue 5: Cost of Treatments and Effects on Land Uses.

This EIS analyzes the physical, biological and social impacts that may result from proposed new invasive plant treatment and prevention methods and standards. In many cases, these impacts are inherent to invasive plant management in general and do not vary between alternatives. The environmental consequences related to potential soil contamination and soil productivity; harm to aquatic organisms from herbicides; potential impacts to threatened, endangered, sensitive and management indicator species; tribal/treaty rights; and environmental justice are similar for all alternatives. Effects on these environmental components are also disclosed in Chapter 4.

Key Issues

Issue 1: Strategies to prevent and control invasive plants can vary in effectiveness.

The alternatives vary in their potential to prevent or reduce the spread of invasive plants. A combination of prevention, treatment and restoration activities is needed to deter the introduction, establishment and spread of invasives. Each action alternative adds a unique set of invasive weed management standards to Forest Plans in Region Six. The analysis in Chapter 4 focuses on characteristics of the standards and how they influence the introduction, establishment and spread of invasive plants.

The standards vary by degree of emphasis on prevention, treatment, and/or restoration. An emphasis on prevention effectiveness will result in reduced introduction and spread rates of invasive plants. An emphasis on treatment effectiveness will result in reductions in current infestations.

The social acceptability of the alternatives also factors into their effectiveness. The ability of the Forest Service to meet the purpose and need for action, achieve desired future conditions, and contribute to cooperative efforts throughout Oregon and Washington are directly correlated to the effectiveness of invasive plant prevention and control strategies.

Factors for Comparison of Alternatives

- Estimated annual rate of invasive plant spread
- Estimated acreage of invasive plants treated annually based on mix of treatments approved
- Number of years until invasive plants may be controlled

Issue 2: Invasive plant treatments may harm non-target plants and native plant communities.

Invasive plant treatments, especially herbicides, may harm non-target plants, including culturally significant, and threatened, endangered and sensitive species. Different herbicides have varying degrees of potency and selectivity (e.g. some herbicides affect certain plant families more readily than others), and application methods vary in the potential for off-site drift. Shifts in species composition and diversity in native plant communities could occur as less herbicide tolerant species are replaced by more tolerant species.

Certain herbicides and the methods by which they are applied could also harm plant pollinators. If reduction or shift in pollinators occurs, changes to species composition or diversity could follow.

Factors for Comparison of Alternatives

- Number of herbicides included in each alternative that have a relatively higher potential to harm non-target plants
- Number of herbicides included in each alternative that have known potential to cause toxic effects to honey bees
- Acres of annual herbicide treatment with these herbicides that have a relatively higher potential to harm non-target plants

Issue 3: Application of certain herbicides may harm some vegetation-eating or insect-eating birds and mammals and/or amphibians.

The use of herbicides to treat invasive plants may harm free-ranging wildlife. Certain herbicides have the potential, for example, to affect the vital organs of some wildlife species, change body weight, reduce the number of healthy offspring, increase susceptibility to predation, or cause direct mortality. Birds and mammals may ingest vegetation or insects that have been sprayed with some herbicides and potentially experience these types of effects. There is also concern that herbicides may cause some malformations or mortality to amphibians, which are exposed in the event herbicides enter water.

Factors for Comparison of Alternatives

- The number of plausible exposure scenarios in each alternative that could result in harmful doses to birds and mammals
- Acres of annual herbicide treatment for each alternative where a plausible scenario could occur
- Number of herbicides approved that may harm amphibians

Issue 4: Invasive plant treatments may result in risks to human health, including contamination of drinking water.

The health and safety of forestry workers and the public may be at risk from exposure to herbicides, working on uneven/broken terrain, use of hand tools, inhalation of smoke, driving vehicles, exposure to fire, exposure to falling/rolling debris, and the other accidents. The public expressed particular concern about human health effects related to herbicide and fertilizer treatments in municipal watersheds, small watersheds with individual drinking water systems, or other areas where forest visitors may consume forest water.

To respond to this issue, toxicity data for various chemicals was analyzed for a variety of worker and public exposure scenarios.

Factors for Comparison of Alternatives

- Number of worker days of exposure to manual treatment hazards
- Number of herbicide and NPE[8] worker scenarios exceeding reference dose (RfD)[9]
- Total acreage where worker scenarios exceeding RfD may occur
- Number of herbicide and NPE public scenarios exceeding RfD (other than drinking water contamination)
- Total acreage where these public exposure scenarios exceeding RfD may occur

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[8] The primary active ingredient in many of the non-ionic surfactants used by the Forest Service when applying herbicides is a component known as nonphenol polyethulate (NPE).
[9] A numerical estimate of a daily exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or minimum dose for producing effects.

- Number of herbicide and NPE public scenarios exceed RfD for drinking water contaminated by herbicide spray drift
- Total acreage where risk of public drinking water contaminated by herbicide spray drift exceeds RfD
- Number of herbicide and NPE public scenarios exceed RfD for drinking water contaminated by tanker spill into pond

Issue 5: Cost of Treatment and Effects on Land Uses.

The prevention and management of invasive plants can be costly and fiscal resources are always limited. Increased operating costs due to expanded invasive plant management may result in direct or indirect transfer of costs to users of National Forest lands. Also, invasive plant management may compete with other important land management needs, resulting in opportunity-cost tradeoffs.

Certain standards may have significant costs and potential to affect programs and users. Costs of conducting land management activities may be increased, potentially resulting in direct or indirect transfers to users of National Forest lands. Public access may be restricted from closing or decommissioning roads or off-road vehicle use areas.

Adjustments to range management such as grazing locations, intensity, timing, or outputs may occur. Recreation users may be required to supply weed free feed on some or all National Forest lands, which may increase the cost of using pack stock or restrict recreationists' ability to enter certain federal lands.

Factors for Comparison of Alternatives

- Annual acres of treatment for each alternative as an indicator of relative costs
- Estimated percentage increase in cost of heavy equipment work
- Tendency for standards to result in road closures and loss of off-highway vehicle access
- Tendency for standards to affect grazing locations, intensity, timing, or outputs
- Acres of National Forest where weed free feed would be required

Other Issues

Soil Contamination and Soil Productivity

Healthy soil microorganisms are fundamental to the ability of soil to provide water and nutrients to plants. All herbicides proposed under all alternatives affect soil microorganisms for a few days, as shown by growth inhibition or some other indirect measure. Picloram and sulfometuron methyl are particularly toxic to soil microorganisms and persistent in soil, and effects to soil microorganisms may persist beyond a few days. The analysis focuses on potential effects to soil microorganisms and productivity. This issue is adequately and equally addressed in all alternatives through Forest Service soil protection policies.

Aquatic Organisms

The application of herbicides in riparian areas has potential to contaminate water and cause mortality to fish and other aquatic species. One formulation of glyphosate, applied at the highest application rate, could result in mortality to fish. One threatened aquatic mollusk species in the region could be harmed by herbicide application. Herbicides that do not directly affect fish may affect their food chain through lethal effects to aquatic plants or algae. Sub-lethal effects, such as behavior changes, could result in increased vulnerability to predators. The public also expressed concern about estrogenic effects to fish. The analysis focuses on potential adverse effects to aquatic organisms. This issue is adequately and equally addressed in all alternatives through Forest Service water quality protection policies.

Threatened, Endangered and Sensitive Species

Forest Service policy related to the National Forest Management Act and Endangered Species Acts require disclosure of effects to threatened, endangered and sensitive species. Consultation has been initiated with appropriate regulatory agencies. The analysis focuses on the findings of “effect” for threatened and endangered species and “impact” for sensitive species. Potential effects to Management Indicator Species are also discussed. This issue is adequately and equally addressed in all alternatives through Forest Service special status species policies.

Tribal/Treaty Rights and Environmental Justice

Some Pacific Northwest Indian tribes have reservation lands held in trust status by the Secretary of the Interior. Protecting and maintaining traditional uses of plants, animals, fish, and water rights on these lands and the treaty rights of American Indian Tribes are important responsibilities of the Federal Government. Invasive plants have the potential to jeopardize the existence of key cultural plants. To that extent, invasive plants have the potential to impact the ability of tribal members to exercise their treaty rights.

Executive Order 12898 (1994) requires federal agencies to identify and address adverse effects to human health and the environment that may disproportionately impact minority and low-income people. The Order also directs agencies to consider patterns of subsistence hunting and fishing when an agency action may affect fish and wildlife. These issues are adequately and equally addressed in all alternatives through Forest Service policies related to tribes and treaty rights and environmental justice.

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CHAPTER 2 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 Introduction

Chapter 2 describes and compares the Proposed Action and three other alternatives (including No Action) for preventing and managing invasive plants in Region Six: Chapter 2.2 describes the alternatives considered; Chapter 2.3 discusses current management direction and the No Action alternative; Chapter 2.4 describes management direction common to the action alternatives; Chapter 2.5 displays management direction unique to each of the action alternatives; Chapter 2.6 compares the alternatives, including a summary (Table 2-6) of the environmental effects of implementing the alternatives; and Chapter 2.7 addresses several alternatives that were considered, but not developed for detailed study.

2.2 Alternatives Considered in Detail

Four alternatives are considered in detail: No Action (Alternative A), the Proposed Action (Alternative C), Alternative B and Alternative D, (hereafter referred to as the "alternatives"). All the alternatives follow the Integrated Pest Management (IPM) approach (Chapter 2.3). The three "action alternatives" (Proposed Action, B and D) were developed to meet the underlying need for action and address the issues identified in Chapter 1. The action alternatives would amend Forest Plans within the Region by approving four kinds of invasive plant management direction, including: Desired Future Condition statements (DFCs), Goals, Objectives, and Standards. In addition, an inventory and monitoring plan framework is also included in each of the action alternatives (Chapter 2.4).

The **No Action** alternative represents no change from the current direction.

The **Proposed Action** would amend all Forest Plans to provide new management direction specific to prevention and management of invasive plants, and replace current Forest Plan direction, associated with invasive plant management.

The Proposed Action emphasizes invasive plant prevention, early detection, early treatment, and restoration of affected habitat, monitoring, and long-term site management. A key feature of the Proposed Action is the requirement to develop long-term site goals for all invasive plant sites prior to treatment. Long-term site goals provide the mechanism to link treatment to prevention, revegetation/restoration and monitoring in an integrated and adaptive process for management of invasive plants.

Alternative B responds to issues and suggestions received during scoping, including those received from a coalition of citizen's groups interested in prevention and management of invasive plants on National Forest lands. The coalition developed an alternative for consideration in this EIS (the "Restore Native Ecosystems Alternative"). The Regional Forester considered this alternative in total and decided to dismiss it from detailed study (see discussion in Chapter 2.7 for rationale). However, many elements of the coalition's alternative are incorporated into the action alternatives, particularly Alternative B.

Alternative B builds on the Proposed Action by increasing the emphasis on preventing invasive plants by reducing conditions that contribute to their introduction, establishment and spread. Disturbance to intact ecosystems would be avoided where possible. Land uses that contribute to increased risk of spread of invasive plants would be modified or curtailed as needed. Under Alternative B, invasive plant treatment tools associated in the scientific literature with human and/or ecological harm would be avoided where possible and herbicides would be a "tool of last resort." Treatment projects would be prioritized to favor those projects with the highest likelihood of restoring native plant communities.

Alternative D is similar to the Proposed Action with greater emphasis on maintaining planning and operational flexibility at the Forest/Ranger District level. Greater flexibility is intended to reduce the treatment costs and impacts on land uses and user groups. The language of some standards has been adjusted to reduce restrictions and allow local land managers a larger degree of discretion in how and when invasive plant prevention practices are implemented.

Alternative D includes the use of two, less expensive and more risky herbicides (2,4-D and Dicamba). In addition, as Alternative D places greater emphasis on reducing treatment costs; the use of broadcast and aerial application of herbicides is expected to increase under Alternative D.

Table 2-1 displays key features of the alternatives.

Table-2-1 Key Features of the Alternatives

Key Feature	No Action	Proposed Action	Alternative B	Alternative D
Overall Approach	Adaptive management, focusing on prevention, early detection, early treatment of invasive plants.	Adaptive management, with increased emphasis on prevention, updated treatment tools, restoration and long-term site management goals.	Similar to the Proposed Action, increases the emphasis on reducing the conditions that contribute to invasive plants.	Similar to the Proposed Action, with a less "prescriptive" approach to prevention and more flexibility in the use of herbicides.
Inventory	Emphasizes early detection.	Emphasizes early detection and requires inventories be consistent with nationally accepted data structures.	Same as the Proposed Action.	Same as the Proposed Action.
Prevention	Direction for prevention is provided primarily by the 1988 EIS/ROD and the 1989 Mediated Agreement	Requires the use of a suite of invasive plant prevention standards.	Similar to the Proposed Action, with more required prevention standards.	Similar to the Proposed Action, with fewer and less prescriptive prevention standards.
Treatment	Treatment methods, including five herbicides. 2,4-D is a tool of "last resort".	Treatment methods include ten herbicides, but not 2,4-D.	Emphasis is on non-chemical methods. Includes four herbicides and they are considered tools of "last resort".	Treatment methods include twelve herbicides, including 2,4-D.
Restoration	Favors the use of native plants and allows the use of non-native plants in certain situations.	Favors the use of native plants for restoration, allows use of non-invasive non-native plants in certain situations.	Requires use of native species for restoration, except as an intermediate step toward native restoration.	Requires the use of plant species that do not invade or persist.

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2.3 Current Direction and the No Action Alternative

Current invasive plant policy supports an Integrated Pest Management (IPM) approach. IPM requires an ecologically based, interdisciplinary analysis for all aspects of managing unwanted organisms (pests). Table 2-2 identifies key components of IPM strategies.

Table-2-2 Key Components of IPM Strategies:	
•	Public and Forest Service employee awareness and education.
•	Prevention through land management and public-use activities.
•	Detection and inventory.
•	Ecological risk assessment to prioritize treatment areas.
•	Identification of treatment strategies.
•	Identification of treatment methods.
•	Identification of long-term site goals for invaded areas.
•	Project monitoring, with evaluation and adaptation of strategies and methods.

Current direction for the management of invasive plants on the National Forests has been established by the 1988 EIS and ROD for Managing Competing and Unwanted Vegetation and the 1989 Mediated Agreement, individual Forest Plans for the nineteen National Forests in Region 6, the Forest Service Manual, and letters of Regional policy.

The following summarizes features of the No Action Alternative. For a complete listing of the existing Forest Plan Standards, and mitigation measures associated with the No Action Alternative please refer to Appendix F. For further clarification, the 1988 ROD and 1989 Mediated Agreement are included in Appendix K.

2.3.1 Prevention

The No Action Alternative, in compliance with the 1989 Mediated Agreement, requires consideration of prevention. Prevention was defined as actions conducted "to detect and ameliorate the conditions that cause or favor the presence of competing or unwanted vegetation in the forests." Specific guidance on how to actually prevent invasive plant introduction, establishment, and spread has been provided to National Forests in the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E). This national guidance is optional for use on National Forests. Examples of prevention practices recommended in the National

Guide include cleaning off-highway vehicles, use of weed-free feed for horses and pack animals, use of weed-free straw, and closing sensitive habitat within National Forests to OHV use. The Mt. Baker-Snoqualmie National Forest is the only forest in Region Six that has amended its Forest Plan to require use of some of these prevention practices. Other forests, including the Colville, Okanogan/Wenatchee, and the Rogue River have developed their own guidelines for preventing and managing invasive plants, but they have not been incorporated in Forest Plan direction.

All the Forest Plans in the Region were written before the National Prevention Guide was published. Some Forest Plans did consider invasive species when the plans were developed and incorporated some prevention requirements. For example:

- Okanogan National Forest Plan prohibits use of unprocessed hay or feed in Wilderness Areas (USDA FS, 1989).
- Winema National Forest Plan encourages use of certified pelletized feed for pack animals used in Wilderness Areas (USDA FS, 1990).
- Mt. Baker-Snoqualmie National Forest Plan requires use of weed-free straw and mulch for revegetation actions (USDA FS, 1999).
- Several National Forest Plans restrict OHV use in undeveloped areas, or where forage and other resources may be threatened by permitted activities: Mt. Baker Snoqualmie, Ochoco, Rogue River, Siuslaw, Umatilla, and Umpqua National Forests.

The following sections provide a brief description of existing direction and current situation by land use activity.

Timber and Other Vegetation Management

Timber management contracts throughout Region Six currently include mandatory provisions that require off-road equipment be free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. Timber purchasers certify in writing that off-road equipment is free of invasive species prior to each start-up of operations and for subsequent moves of equipment within timber harvest areas.[10] Equipment operating in areas infested with invasive plants is required to be cleaned prior to being moved from the infested area, unless the equipment is moving to an infested area containing the same invasive species. In some cases, vehicles must be cleaned on National Forest to avoid spreading invasive plants. In addition, purchasers must promptly report all new infestations of invasive plants within a timber sale area. These requirements apply only to activities associated with timber sales and do not apply to use of ground-based heavy equipment for mechanical site preparation, pre-commercial thinning, or other vegetation management projects.

Road Management

Road management environmental analysis and planning processes which address impacts of invasive plants, including recommendations for prevention and treatment, are not mandatory Region-wide under current direction and only a few Forests have developed plans. Cleaning equipment to avoid transporting invasive plants to other areas, is generally not required on road maintenance equipment, and clear direction for such washing does not currently exist. While some road contracts have clauses in place that can be used to control timing of operations, little coordination to schedule activities to prevent the spread of invasive plants is taking place. Public works contracts currently have specifications that straw and mulch must be free from weeds, but no certification requirements are included in these specifications. Most straw and mulch used for forest projects generally does meet some level of weed free criteria. Most road related erosion control projects currently specify the use of seed mixes that include native type grasses. Consistent direction regarding invasive plant inspection of mineral resources used for road management projects does not exist. Inspection and subsequent treatment of mineral resources is done only intermittently throughout the Region.

The Mt. Baker-Snoqualmie National Forest already has a Forest Plan amendment that requires the use of invasive plant prevention practices related to road management. The other Forests are implementing invasive plant prevention and treatment/restoration practices related to roads management to varying degrees.

Livestock Grazing

Though not directly required, numerous annual operating instructions and grazing allotment management plans across the Region already include some components of invasive plant prevention measures and cooperative management goals. Direction requiring integration of invasive plant prevention measures and cooperative management goals into these documents has

[10] "Off-road equipment" includes all logging and construction machinery, except for log trucks, chip vans, service vehicles, water trucks, pickup trucks, cars, and similar vehicles.

not been addressed on a Region-wide scale. Currently, invasive plant prevention measures, such as those provided in the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E), are not being consistently applied in livestock grazing programs throughout the Region.

Fire and Fuels Management

Fire and fuels management is designed to meet the goals of the National Fire Plan, 10-Year Comprehensive Strategy, and Healthy Forests Initiative. Post-fire restoration and hazardous fuel treatment projects are currently required to consider invasive plants and develop mitigation measures and project design criteria to prevent establishment of invasive species where an identifiable risk exists, and to reduce the risk of further spread of any such species already present in the project area.

Currently, cleaning equipment to prevent the spread of invasive plants is not always required by National Forests for fire rehabilitation and restoration or fuels projects. Equipment cleaning on large fires where a Type 1 or 2 incident management team is in place is becoming standard practice, although cleaning usually occurs only during demobilization of equipment and not during mobilization and suppression operations. Equipment cleaning on smaller incidents is not a widespread practice. As better equipment is developed and invasive plant awareness increases, the use of equipment washing is expected to increase as a control measure during the suppression of large fires, and likely will become a standard operating procedure. No significant change in equipment washing practices on smaller, less complex fires, is expected under current direction and trends.

Post-fire rehabilitation projects generally use some form of weed-free straw and mulch and native seed. Such projects are not bound by any Region-wide specific criteria or certification standards of weed-free or local native seed specifications.

Recreation Management

Invasive plant prevention measures are generally not a priority issue in current recreation management. Consistent direction for inclusion of invasive plant prevention measures in recreation management and planning does not currently exist. Some forests in the Region have adopted recreation related components of the USDA Forest Service Guide to Noxious Weed Prevention Practices. The Mt. Baker/Snoqualmie National Forest requires that pack and saddle stock use pelletized or certified weed-free feed when in Wilderness Areas. Forest Service off-highway vehicle (OHV) policy and implementation strategies for OHV management are currently being developed; this issue is among the agencies top priorities.

Minerals and Mining

For all types of mineral activities, submissions of plans of operation typically trigger an Environmental Assessment or other NEPA analysis. Depending upon the site-specific proposal, site conditions and risk, the agency can attach reasonable terms and conditions, or mitigation measures, to the approval of plans of operation, including the need for a reclamation plan and reclamation bond.

2.3.2 Treatment and Restoration

The process for determining treatment priority under the No Action Alternative is established, in general terms, through the 1988 ROD and 1989 Mediated Agreement. Regional direction/guidance specific to prioritizing invasive plant treatment is lacking.

The 1989 Mediated Agreement addresses processes which National Forests should use for selecting treatment strategies: "In planning for, and before proceeding with site-specific projects to treat competing or unwanted vegetation, another requirement is to analyze the proposed strategy." The Mediated Agreement lists areas of consideration, including: understanding the elements basic to the analysis; the potential human health risks, potential environmental effects; knowledge of the physical and biological characteristics of the site; etc.

Table 2-3 lists methods to be used alone or in combination to treat invasive plants under the No Action Alternative. These treatment options apply to all the National Forests in the Region that have completed site-specific environmental analysis, except the Malheur National Forest, where only manual treatments are currently allowed as the result of a 2002 U.S. District Court decision[11].

These treatment options are available for consideration within all National forest lands, with the exception of Wilderness, which was not addressed in the 1988 EIS and ROD or the 1989 Mediated Agreement.

Under the No Action Alternative, the use of biological control would continue on National Forest lands in the Region with the exception of the Malheur National Forest. The 1988 EIS

[11] Blue Mountain Biodiversity Project v. U.S. Forest Service – CV 01-703-HA, 2002)

authorizes the use of biological control in cooperation with USDA Agricultural Research Service or individual state programs. Allowable biological control agents include all agents approved by USDA Animal and Plant Health Inspection Service (APHIS). Any agents approved by APHIS, but not yet introduced into a given state, would require state approval before National Forests can use them.

Table-2-3 Invasive Plant Treatment Methods Under No Action

METHOD (TOOL)	SCOPE
Manual	Hand pulling and use of hand tools.
Mechanical	Any mechanical tool that is known to be useful for treating invasive plants.
Biological	Agents used would be APHIS and state approved (no use on the Malheur NF).
Cultural	Grazing animals, addition of fertilizer/soil amendments, competitive planting, or any other cultural practice known to be useful for treating invasive plants.
Herbicides	Formulations containing only the following active ingredients are permitted (except on the Malheur NF): Glyphosate, Picloram, Triclopyr, Dicamba, and 2,4-D (a "tool of last resort"[12]). All application methods consistent with label requirements are permitted.
Fire	Broadcast and pile burning.

Region Six has a regional policy encouraging the use of native plants in revegetation. This policy was articulated in an April 1994 letter signed by Regional Forester, John E. Lowe:

> "Use local native plant species to meet management objectives. Follow appropriate seed and plant movement guidelines. Non-native plant species may be used when (1) needed to protect basic resources values (site productivity), (2) as an interim, non-persistent measure designed to aid in the re-establishment of native plants, or (3) local native plant species are not available."

Policies for each National Forest vary on the emphasis placed on restoration of native plant communities after an infestation of invasive plants has been treated. For example, the Columbia River Gorge National Scenic Area requires re-establishment of native grasses in degraded areas that have been invaded by non-native plants. The Siuslaw National Forest Plan discourages the

[12] A "tool of last resort" means that 2,4-D can only be used when other methods have proven ineffective.

use of non-native plants for revegetation and, if seeding is needed, will use native species most of the time (Segotta, 2003 personal communication).

The No Action Alternative includes a list of required mitigation measures to reduce, avoid, minimize, rectify, or compensate for impacts on the environment and human health, which might result from treatment activities developed in the 1988 EIS.

2.3.3 Inventory and Monitoring

The intent of the No Action Alternative is to detect and resolve vegetation management problems before they cause serious losses or require large treatment projects. The No Action Alternative calls for evaluating the need for action when problems are expected. This evaluation includes site-specific surveys and documented local experience.

All National Forests have done some level of inventory and mapping of invasive plant sites, and have entered this information into Geographic Information Systems (GIS) and databases. Most Forests are beginning to use the Natural Resource Information System's Terrestrial Module (NRIS /TERRA) data collection protocols for invasive plant inventory.

In monitoring Forest-wide vegetation management programs, Forests are currently required to address the following points:

- Describe the projected need for vegetative management by method, over the next three to five years.
- Describe how the projected need for treatment can be reduced, and identify the steps that can be taken to reduce reliance on herbicides and prescribed burning.
- Determine criteria that can be used to review progress on an annual basis toward reducing reliance on herbicides and prescribed burning.
- Evaluate program success in achieving resource management goals, such as controlling invasive plants.

In monitoring individual vegetation management projects, Forests must address the following considerations:

- Site-specific post-treatment information should be used to aid future project planning. The information to be evaluated includes treatment effectiveness and cost.

- Any impacts to human health from using herbicides and other methods of treatment.

A five-step process for project development was adopted in the 1988 EIS and ROD (Figure 2-1). It is an adaptive management approach that focuses attention on site-specific ecological features of the proposed treatment site and the Forest Plan goals for that site. It requires careful examination of what action is needed, prudent project design and implementation, and follow-up monitoring, learning and adjustment.

Figure 2-1 The Five Step Approach for Managing Competing and Unwanted Vegetation.

2.4 Management Direction Common to All Action Alternatives

Four kinds of new management direction would be added to Forest Plans in Region Six under the action alternatives: Desired Future Condition statements, goals and objectives, prevention and treatment/restoration standards, along with an inventory and monitoring plan framework.

Desired Future Condition (DFC) statements describe how National Forests should look and function in the future in relation to invasive plants, as opposed to dwelling on past problems. The description is optimistic, but attainable. The DFC represents a positive depiction of what would result from successful Forest Plan implementation. The DFC is common to all action alternatives.

Goals are broad, general terms describing how to achieve the DFC, with no specific time frames by which the goals are to be achieved. Goal statements form the basis from which objectives are developed. The goals are common to all action alternatives.

Objectives are specific statements of actions or results designed to help achieve goals. Objectives break down goals into components, and form the basis for project-level actions or proposals to help achieve Forest goals. The rate of achieving objectives is dependent on budgets and other variables. The time frame for achieving objectives is generally considered to be the planning period, or the next 10 to 15 years. The objectives are common to all action alternatives.

Standards are binding limitations placed on management actions, designed to contribute to the attainment of objectives. Standards must be within the authority and ability of the Forest Service to enforce. A project or action that varies from a relevant standard may not be authorized unless the Forest Plan is amended to modify, remove, or waive application of the standard. Each action alternative contains a unique suite of standards developed so that projects will contribute to meeting goals, objectives and desired conditions.

An ***Inventory and Monitoring Framework*** is included to ensure that Forest Plan standards are being followed, and to evaluate the effectiveness of standards in meeting goals and objectives. Inventory and monitoring is also intended to reveal adverse effects of land management and use activities. All of the action alternatives would add inventory and monitoring requirements to Forest Plans in Region Six, and provide a blueprint for future, more detailed monitoring plans.

2.4.1 Desired Future Conditions, Goals and Objectives

The following DFCs, goals and objectives would be added to the already existing sets of DFCs, goals and objectives in Forest Plans across the Region. Unless specifically noted, they apply to all the action alternatives:

Desired Future Condition - In National Forest lands across Region Six, healthy native plant communities remain diverse and resilient, providing high quality habitat for a full suite of native organisms. The need for invasive plant treatment is reduced due to the effectiveness and habitual nature of preventative actions, and the success of restoration efforts.

Goal 1 - Maintain weed-free native plant communities, and protect ecosystems from the impacts of invasive plants through an integrated approach that emphasizes prevention, early detection, and early treatment. All employees and users of the National Forest recognize that they play an important role in preventing and detecting invasive plants.

Objective 1.1 - Implement appropriate invasive plant prevention practices to help reduce the introduction, establishment and spread of invasive plants associated with management actions and land use activities.

Objective 1.2 - Educate the workforce and the public to help identify, report, and prevent invasive plants.

Objective 1.3 - Detect new infestations of invasive plants promptly by creating and maintaining complete, up-to-date inventories of infested areas, and proactively identifying and inspecting susceptible areas not infested with invasive plants.

Objective 1.4 - Use an integrated approach to treating areas infested with invasive plants. Utilize a combination of available tools including manual, cultural, mechanical, herbicides, biological control.

Objective 1.5 - Control new invasive plant infestations promptly, suppress or contain expansion of infestations where control is not practical, conduct follow up inspection of treated sites to prevent reestablishment.

Goal 2 - Minimize the creation of conditions that favor invasive plant introduction, establishment and spread during land management actions and land use activities. Continually review and adjust land management practices to help reduce the creation of conditions that favor invasive plant communities.

Objective 2.1 - Reduce soil disturbance while achieving project objectives through timber harvest, fuel treatments, and other activities that potentially produce large amounts of bare ground.

Objective 2.2 - When working in vegetation types with relatively closed canopies, retain shade to the extent possible to suppress invasive plants and prevent their establishment and growth.

Objective 2.3 - Reduce the introduction, establishment and spread of invasive plants during fire suppression and fire rehabilitation activities by minimizing the conditions that promote invasive plant germination and establishment.

Objective 2.4 - Incorporate invasive plant prevention as an important consideration in all recreational land use and access decisions. Use forest-level Access and Travel Management planning to manage both on-highway and off-highway travel and travel routes to reduce the introduction, establishment and spread of invasive plants.

Objective 2.5 - Place greater emphasis on managing previously "unmanaged recreation" (OHVs, dispersed recreation, etc.) to help reduce creation of soil conditions that favor invasive plants, and reduce transport of invasive plant seeds and propagules.

Goal 3 - Protect the health of people who work, visit, or live in or near National Forests, while effectively treating invasive plants. Identify, avoid, or mitigate potential human health effects from invasive plants and treatments.

Objective 3.1 - Avoid or minimize public exposure to herbicides, fertilizer, and smoke.

Objective 3.2 – Reduce reliance on herbicide use over time in the Region (Proposed Action and Alternative B only).

Goal 4 – Implement invasive plant treatment strategies that protect sensitive ecosystem components. Reduce loss or degradation of native habitat from invasive plants while minimizing adverse effects from treatment projects.

Objective 4.1 - Avoid chemical contamination of water from invasive plant treatments.

Objective 4.2 - Protect native plants and animals from negative effects of both invasive plants and applied herbicides. Where herbicide treatment of invasive plants is necessary within the riparian zone, select treatment methods and chemicals so that herbicide application is consistent with riparian management direction, contained in Pacfish, Infish, and the Aquatic Conservation Strategies of the Northwest Forest Plan.

Objective 4.3 - Protect threatened, endangered, and sensitive species habitat threatened by invasive plants. Design treatment projects to protect threatened, endangered, and sensitive species and maintain species viability.

Goal 5 – Expand collaborative efforts between the Forest Service, our partners, and the public to share learning experiences regarding the prevention and control of invasive plants, and the protection and restoration of native plant communities.

Objective 5.1 - Use an adaptive management approach to invasive plant management that emphasizes monitoring, learning, and adjusting management techniques. Evaluate treatment effectiveness and adjust future treatment actions based on the results of these evaluations.

Objective 5.2 - Collaborate with federal, state, local and private land managers to increase availability and use of appropriate native plants for all land ownerships.

Objective 5.3 - Work effectively with neighbors in all aspects of invasive plant management: share information and resources, support cooperative weed management, and work together to reduce the inappropriate use of invasive plants (landscaping, erosion control, etc.).

2.4.2 Inventory and Monitoring Plan Framework

In addition to the monitoring already required under various Forest Plans, an inventory and monitoring plan framework is part of all action alternatives. The framework would assist in developing a more detailed monitoring plan(s) at the sub-regional or site-specific project level. Measures included within the monitoring framework that will improve the Forest's ability to detect, respond rapidly to new infestations include: maintaining an invasive plant inventory consistent with nationally accepted (e.g., NRIS/TERRA) protocols; and periodically inspecting all Forest Service administrative sites, recreation facilities, roads and rights-of-way for presence of invasive plants. As a minimum, invasive plant inventories should be updated annually.

Three different types of Monitoring are included in the framework:

Implementation Monitoring - Adaptive management strategies require implementation monitoring to determine whether we did what we said we were going to do. This is a necessary step in order to determine whether actions are taking place as described in the environmental document. Monitoring needs to include the timing of actions and mitigation. If actions are not timely, they may not be effective. When mitigation measures are not implemented, effects may be different from what was predicted.

Treatment Effectiveness Monitoring –A long-term adaptive management approach is based on changing conditions. The invasive plant infestation conditions need to be monitored in order to know when it is appropriate for action to be taken, and whether that action is effective. If treatment were not effective, the decision maker would review the strategy outlined in the adaptive management decision to determine whether treatment actions need to be changed.

Environmental Effects Monitoring - Are the effects as predicted? The environmental effects of the actions being implemented need to be monitored to confirm the predicted effects are valid. This is critical for long-term programs such as invasive plant management because we will need to periodically address whether or not our decisions and the basis for those decisions are still valid as we continue to implement them year after year.

The complete Inventory and Monitoring Plan framework is included in Appendix M.

2.5 Management Direction Unique to Each Action Alternative

All the action alternatives follow IPM approaches described under No Action. The action alternatives represent different approaches to two of the key components of IPM: (1) prevention through land management and public-use activities, and (2) identification of treatment methods. The alternatives would provide different responses to the following key IPM questions:

- How extensive and restrictive should invasive plant prevention practices be that are applied to National Forest management activities and public uses?
- Under what circumstances and management restrictions should herbicides be used to treat invasive plant infestations?

In addition to the management direction (DFCs, Goals, Objectives), and the Inventory and Monitoring Framework common to all the action alternatives, the action alternatives contains a suite of new Forest Plan standards. These standards were designed in cooperation with Forest Service staff, to ensure that long-term multiple use goals and objectives would not be significantly altered through the alternatives developed (Forest Service Manual 1922.51/52). Table 2-4 displays and compares the Forest Plan standards associated with each of the action alternatives.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
Prevention Standards			
1.	Prevention of invasive plant introduction, establishment and spread will be addressed in watershed analysis; roads analysis; fire and fuels management plans, Burned Area Emergency Recovery Plans; emergency wildfire situation analysis; allotment management plans, and other land management assessments.	Same as Proposed Action, **plus:** These documents will address the conditions that spread invasive plants and emphasize maintaining/restoring healthy ecosystems as the first line of defense against their spread.	Same as Proposed Action.
2.	Actions conducted or authorized by the Forest Service that will operate outside the limits of the road surface (including public works and service contracts), require the cleaning of all heavy equipment (bulldozers, skidders, graders, backhoes, dump trucks, etc.) prior to entering National Forest System Lands. This standard does not apply to initial attack of wildfires, and other emergency situations.	Actions conducted or authorized by the Forest Service that will operate outside the limits of the road surface (including public works and service contracts), require the cleaning of **all vehicles** prior to entering National Forest system land. This standard does not apply to initial attack of wildfires, and other emergency situations. Actions conducted or authorized by the Forest Service (including public works and service contracts), clean **all vehicles** that have operated outside the limits of the road surface before leaving the project site, when operating in areas where invasive plants are present at a level where transport of invasive plant seed or vegetative propagules (root fragments) is likely and a concern.	Same as Proposed Action.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
3.	Use weed-free straw and mulch for all projects, conducted or authorized by the Forest Service, on National Forest System Lands. If State certified straw and mulch are not available, individual Forests should use materials that meet "weed-free" standards.	Same as Proposed Action.	Same as Proposed Action.
4.	Use weed-free feed in all Wilderness Areas and Wilderness Trailheads. If State certified hay is not available, individual Forests should require sources that meet "weed-free" standards or require weed-free pelletized feed.	Use weed-free feed on all National Forest System land. If State certified hay is not available, individual Forests should require sources that meet "weed-free" standards or require weed-free pelletized feed. Use weed-free project staging areas, livestock and packhorse corrals, and OHV staging areas. Inspect these areas annually to detect any establishment or spread of invasive plants.	No corollary standard. (Same as current direction)
5.	No corollary standard. (Addressed as Objective 2.2)	Maintain intact native vegetation communities in and around project areas as buffers to inhibit the establishment and spread of invasive plants (consistent with other project objectives). Maintain forest canopies adjacent to areas such as roads and clearcuts where invasive species are abundant.	No corollary standard. (Addressed as Objective 2.2)

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
6.	Through annual operating instructions, and the revision of grazing allotment management plans, incorporate invasive plant prevention measures that help reduce the spread of invasive plants. Plan and implement these measures in cooperation with the grazing permit holder.	Same as Proposed Action, **plus**: Prevention practices may include, but are not limited to: Managing livestock movement patterns to reduce ground disturbance and transport of invasive plant seeds from invaded areas to non-invaded areas; Altering season of use to improve native plant vigor and reduce conditions that favor invasive plants; Resting pastures to allow native plants to recover (passive restoration); Retiring the allotment (eliminate livestock grazing) in areas of high populations of invasive plants; Actively restoring native plant communities by revegetating degraded areas; Protecting areas of intact biological soil crusts by delaying reintroduction of livestock for at least three years following wildfires.	Same as Proposed Action.
7.	Inspect active gravel, fill, sand stockpiles, quarries, and borrow material for invasive plants before use and transport on National Forest System land. Treat or require treatment of infested sources for eradication, and strip and stockpile contaminated material before any use of pit material.	Inspect active gravel, fill, sand stockpiles, quarries, and borrow material **annually** for invasive plants. Treat or require treatment of infested sources for eradication, and strip and stockpile contaminated material before any use of pit material.	Inspect active gravel, fill, sand stockpiles, quarries, and borrow material for invasive plants before use and transport on National Forest System land. Treat or require treatment of infested sources before any use of pit material.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
8.	Conduct road blading, brushing and ditch cleaning in areas with high concentrations of invasive plants in consultation with District or Forest-level invasive plant specialists, incorporate invasive plant prevention measures as appropriate.	Same as Proposed Action, **plus:** Where possible, postpone this work until the invasive plants have been treated. In situations where road safety considerations dictate action, work from the edges of the infestation toward the center to avoid spreading invasive plants to relatively uninfested areas. Inspect and clean road graders, mowers, and other equipment as needed after operating in infested areas to remove plant seed and propagules.	Same as Proposed Action.
9.	No corollary standard. (Addressed as Objective 2.4)	Close or decommission non-essential roads where roads analysis indicates that a particular route may be a high-risk vector for spread of invasive plants.	No corollary standard. (Addressed as Objective 2.4)
10.	No corollary standard. (Addressed as Objective 2.5)	Prohibit cross country use of off-highway vehicles (OHVs) and only allow the use of OHVs on designated routes and in designated areas.	No corollary standard. (Addressed as Objective 2.5)
Treatment and Restoration Standards			
11.	Prioritize infestations of invasive plants for treatment at the landscape, watershed or larger multiple forest/multiple owner scale.	Same as Proposed Action.	No corollary standard. (Same as current direction)
12.	Develop a long-term site strategy for restoring/revegetating treated infestations of invasive plants.	Same as Proposed Action.	Same as Proposed Action.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
13.	Native plant materials are the first choice in revegetation for restoration and rehabilitation where timely natural regeneration of the native plant community is not likely to occur. Non-native, non-invasive plant species may be used when: 1) needed in emergency conditions to protect basic resource values (e.g., soil stability, water quality and to help prevent the establishment of invasive species), 2) as an interim, non-persistent measure designed to aid in the re-establishment of native plants, 3) native plant materials are not available, and 4) in permanently altered plant communities. Under no circumstances will non-native invasive plant species be used.	Use local native seed and seedlings in revegetation of invasive plant sites, fire lines and burned areas. If native seeds/plants are not available, revegetation projects will rarely be undertaken until native plant seed or plants become available, except as an intermediate step toward native restoration.	In re-vegetation efforts use plant species that will not invade or persist. More persistent non-natives, such as crested wheatgrass, clover and range alfalfa may be necessary on degraded sites, where less persistent species have been shown to be unsuccessful in competing with invasive plants.
14.	Use only APHIS and State-approved biological control agents. Agents demonstrated to have direct negative impacts on non-target organisms would not be released.	Same as Proposed Action.	Same as Proposed Action.
15.	Application of any herbicides to treat invasive plants will be performed or directly supervised by a State or Federally licensed applicator.	Same as Proposed Action.	Same as Proposed Action.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
16.	Select from herbicide formulations containing one or more of the following **10 active ingredients**: chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. All herbicide application methods are allowed including wicking, wiping, injection, spot, broadcast and aerial, as permitted by the product label. Chlorsulfuron, metsulfuron methyl, and sulfometuron methyl will not be applied aerially. The use of triclopyr is limited to selective application techniques only (e.g., spot spraying, wiping, basal bark, cut stump, injection). Additional herbicides may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.	Herbicide application methods allowed include wicking, wiping, injection, spot spray, broadcast, and aerial, as permitted by product label. Select from herbicide formulations containing one or more of the following **4 active ingredients**: clopyralid, glyphosate, sethoxydim, and triclopyr. The use of triclopyr will be limited to selective application techniques only (e.g. spot spraying, wiping, basal bark, cut stump, injection). Additional herbicides, with the exception of picloram, sulfonylurea herbicides and acetolactate synthase-inhibiting herbicides, may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.	Select from herbicide formulations containing one or more of the following **12 active ingredients**: 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. All herbicide application methods are allowed including wicking, wiping, injection, spot, broadcast and aerial, as permitted by the product label. Additional herbicides may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.
17.	No corollary standard. (Addressed as Objective 3.2	Reduce herbicide use over time at both the regional and local scale, proportionate to invasive plant population levels. Select non-chemical treatment methods over chemical methods, unless non-chemical methods are shown to be ineffective or infeasible. Use herbicides as a tool of last resort.	No corollary standard.
18.	Use only adjuvants (e.g. surfactants, dyes) and inert ingredients reviewed in Forest Service hazard and risk assessment documents such as SERA, Inc., 1997a, 1997b; Bakke, D. 2002.	Use only adjuvants and herbicide formulations for which all ingredients have been publicly identified.	Same as Proposed Action.

Table 2-4 Action Alternative Standards

Standard Number	Proposed Action	Alternative B	Alternative D
19.	To reduce or eliminate direct or indirect negative effects to water quality and aquatic biota from the application of herbicide, use site-specific soil characteristics, proximity to surface water and local water table depth to determine *herbicide formulation* (e.g. use of aquatic labeled products), size of buffers needed, if any, and application method and timing.	Same as Proposed Action, **plus**: Minimize application of herbicides and prohibit broadcast spraying in riparian reserves and in known aquatic and terrestrial amphibian habitat, including breeding, rearing, and overland dispersal areas. Avoid application of herbicides with adverse effects on aquatic species and amphibians.	Same as Proposed Action.
20.	Design invasive plant treatments to reduce or eliminate adverse effects to proposed and listed species, and their critical habitat. This may involve surveying for listed or proposed plants prior to implementing actions within unsurveyed habitat if the action has a reasonable potential to adversely affect the plant species. Use site-specific project design (e.g. application rate and method, timing, wind speed and direction, nozzle type and size, buffers, etc.) to mitigate the potential for adverse disturbance and/or contaminant exposure.	Same as Proposed Action.	Same as Proposed Action.
21.	Provide a minimum buffer of 300 feet for aerial application of herbicides near developed campgrounds, recreation residences and private land.	Same as Proposed Action, **plus**: Provide buffers to adequately protect culturally significant plant and wildlife resources during broadcast application of herbicides.	Same as Proposed Action.
22.	Prohibit aerial application of herbicides within legally designated municipal watersheds.	Same as Proposed Action.	Same as Proposed Action.

2.6 Comparison of Alternatives

This section provides a comparison of the treatment methods/tools available under each alternative (Table 2-5), and a summary/comparison of the effects of implementing each alternative found in Chapter 4 (Table 2-6). Information in Table 2-6 is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

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Table 2-5 Treatment Methods Under the Alternatives

No Action (Current Direction)	Proposed Action	Alternative B	Alternative D
Manual			
Hand pulling and use of hand tools.	All manual techniques known to be useful for treating invasive plants.	Same as Proposed Action.	Same as Proposed Action.
Mechanical			
Any mechanical tool that is known to be useful for treating invasive plants.	Same as Current Direction.	Same as Current Direction.	Same as Current Direction.
Biological			
Agents used would be APHIS and state approved (no use on the Malheur NF).	Agents used would be APHIS and State-approved. Agents demonstrated to negatively impact non-target organisms would not be used.	Same as Proposed Action	Same as Proposed Action
Cultural			
Grazing animals, addition of fertilizer/soil amendments, competitive planting, or any other cultural practice known to be useful for treating invasive plants.	Same as Current Direction, plus mulching with a variety of materials and other local remedies (e.g., spraying vinegar, spraying water/salt/sugar mixtures).	Same as Proposed Action.	Same as Proposed Action.

Table 2-5 Treatment Methods Under the Alternatives

No Action (Current Direction)	Proposed Action	Alternative B	Alternative D
Herbicides			
Formulations containing only the following active ingredients are permitted (except on the Malheur NF): Glyphosate, Picloram, Triclopyr, Dicamba, and 2,4-D (a "tool of last resort"[13]). All application methods consistent with label requirements are permitted.	Herbicide formulations containing only the following active ingredients: chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. All types of herbicide application methods are allowed including wicking, wiping, injection, spot, ground level broadcast and aerial, as permitted by product label. Chlorsulfuron, metsulfuron methyl, and sulfometuron methyl will not be applied aerially. The use of triclopyr is limited to selective application techniques only (spot spraying, wiping, basal injections, etc.). Additional herbicides may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.	Herbicide formulations containing only the following 4 active ingredients: clopyralid, glyphosate, sethoxydim, and triclopyr. The types of herbicide application methods allowed include wicking, wiping, injection, spot spray, and ground-level and aerial broadcast, as permitted by product label. The use of triclopyr will be limited to selective application techniques only (spot spraying, wiping, basal bark, cut stump, injection, etc.). Prohibits use of picloram, sulfonylurea herbicides and acetolactate synthase-inhibiting herbicides. Additional herbicides may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.	Formulations containing only the following active ingredients: 2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. All types of herbicide application methods are allowed including wicking, wiping, injection, spot, ground level broadcast and aerial, as permitted by product label. Additional herbicides may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.
Prescribed Fire			
Broadcast and pile burning.	Broadcast and pile burning, flaming and foaming.	Same as Proposed Action.	Same as Proposed Action.

[13] A "tool of last resort" means that 2,4-D can only be used when other methods have proven ineffective.

Table 2-6 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Issue 1: *Strategies to prevent and control invasive plants can vary in effectiveness*				
Estimated annual rate of invasive plant spread	8-12%	4-6%	3-4%	6-9%
Estimated acreage of invasive plants treated annually	25,000 Acres	30,000 Acres	20,000 Acres	40,000 Acres
Number of years until invasive plants may be controlled	Never	21-32 Years	34-47 Years	18-34 Years
Issue 2: *Invasive plant treatments may harm non-target plants and native plant communities.*				
Number of herbicides included in each alternative that have a relatively higher potential to harm non-target plants	4 – picloram, glyphosate, triclopyr, dicamba	3 – glyphosate, imazapyr, picloram	1 – glyphosate	5 –chlorsulfuron, metsulfuron methyl, sulfometuron methyl, picloram, glyphosate, triclopyr, dicamba
Number of herbicides included in each alternative that have known potential to cause toxic effects to honey bees	3 – 2,4-D, glyphosate and triclopy	2 – glyphosate and triclopyr	1 –glyphosate	3 – 2,4-D, glyphosate and triclopyr

Table 2-6 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Acres of annual herbicide treatment with these herbicides that have a relatively higher potential to harm non-target plants	12,956	8,369	2,031	15,428
Issue 3: *Application of certain herbicides may harm some vegetation-eating or insect-eating birds and mammals and/or amphibians*				
The number of plausible exposure scenarios in each alternative that could result in harmful doses to birds and mammals.	29	22	13	50
Acres of annual herbicide treatment for each alternative where a plausible scenario could occur	13,646	8,989	2,539	27,299
Number of herbicides approved that may harm amphibians	3	1	1	3
Issue 4: *Invasive plant treatments may result in risks to human health, including contamination of drinking water*				

Table 2-6 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Number of worker days of exposure to manual treatment hazards	36,593	30,711	8,602	44,948
Number of herbicide and NPE worker scenarios exceeding reference dose (RfD)	Typical 0 Worst-Case 12	0 11	0 6	1 19
Total acreage where worker scenarios exceeding RfD may occur	Typical 0 Worst-Case 12,281	0 4,960	0 508	13,765 24,317
Number of herbicide and NPE public scenarios exceeding RfD (other than drinking water contamination)	Typical 0 Worst-Case 5	0 5	0 5	3 18
Total acreage where these public exposure scenarios exceeding RfD may occur	Typical 0 Worst-Case 591	0 930	0 508	13,765 15,141
Number of herbicide and NPE public scenarios exceed RfD for drinking water contaminated by herbicide spray drift	Typical 0 Worst-Case 0	0 0	0 0	0 1

Table 2-6 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Total acreage where risk of public drinking water contaminated by herbicide spray drift exceeds RfD	Typical 0 Worst-Case 0	0 0	0 0	0 13,765
Number of herbicide and NPE public scenarios exceed RfD for drinking water contaminated by tanker spill into pond	Typical 1 Worst-Case 5	1 7	1 4	1 10
Issue 5: *Cost of Treatments and Effects on Land Uses*				
Annual acres of treatment for each alternative as an indicator of relative costs	24,606	29,058	20,310	40,482
Estimated percentage increase in cost of heavy equipment work	0%	2%	11%	2%
Tendency for standards to result in road closures and loss of off-highway vehicle access	No Direct Effect. New restrictions on OHV use may occur from new national policy.	Same as No Action	Tendency for more roads to be closed or decommissioned and OHV use areas to be restricted. New restrictions on OHV use may occur from new national policy.	Same as No Action

Table 2-6 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Tendency for standards to affect grazing locations, timing , intensity and outputs	No Direct Effect.	No Direct Effect.	Adjustments to range allotments and ultimate AUM reduction likely	No Direct Effect.
Acres of National Forest where weed free feed would be required	1.0 million	4.6 million	24.9 million	1.0 million

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2.7 Alternatives Considered but Eliminated From Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of this EIS, not met the Purpose and Need for Action, not reasonably feasible or not viable, duplicative of the alternatives considered in detail, or were determined to cause unnecessary environmental harm.

Prohibiting OHVs, Grazing, Logging, and other Land Management Activities

A number of comments received during the scoping process suggested that the Forest Service consider prohibiting major land-use activities on National Forests in the Region, such as OHV use, logging, livestock grazing, and access for all motorized traffic. The Proposed Action and the other Alternatives (especially Alternative B) do include standards that place restrictions on some or all of these activities. The alternative of eliminating or prohibiting these activities was considered, but eliminated from further study. Eliminating these multiple-use activities is outside the scope of this Proposed Action and inconsistent with current laws governing the management of National Forest System lands.

No Treatment of Invasive Plants

Some public comments suggested that the Forest Service not take action to treat invasive plants, but rely only on prevention and passive restoration. An alternative of this nature was discussed by the team, but eliminated from detailed analysis.

The purpose and need of this EIS includes making new practices, technologies, and chemical formulations of herbicides available for use on National Forests lands in Region Six. There is an abundance of scientific literature that supports the timely and appropriate treatment of invasive plants, and the active restoration of native plant communities as important tools for effective integrated management (See Chapters 3 and 4). Eliminating the consideration of these elements of IPM would not address the purpose and need for this action, and would likely cause unnecessary environmental harm.

No use of Herbicides

Additional public comments suggested that the Forest Service consider an exclusively non-herbicide alternative. An alternative of this nature was discussed by the team, and associated resource specialists, but eliminated from detailed analysis because:

1. A non-herbicide alternative does not meet the underlying need for action. Some invasive plants that infest or can be expected to infest National Forests in Region Six, can only be effectively controlled with herbicides.

2. A non-herbicide alternative would not be a reasonable alternative for a region-wide document that must provide a variety of state-of-the-art tools for effectively managing extensive populations of invasive plant species while protecting native plant communities and environmental quality.

The issue of scale needs to be considered when planning treatments of invasive species. (Randall, 2003 personal communication). Large populations of certain invasive species can only be effectively controlled with herbicides. At present, the only method to control large stands of Japanese knotweed is with repeated application of herbicides (Sieger, 1991). The potential for large-scale restoration of wildlands infested with quackgrass is probably low to moderately low, unless the infested area is tilled, treated with herbicide, and reseeded, or unless large-scale, resource-intensive prescribed burn programs, coupled with herbicide and other restoration programs are implemented (Batcher, 2002). The best control of perennial pepperweed seems to be from the use of herbicides (Morisawa, 1999). Renz (2000) states that many control methods are ineffective against perennial pepperweed or can only be used in specific areas. The only non-chemical control method effective against large populations is long-term flooding, but it is not known if plants will reestablish if the flooding regime is removed from these areas. Lyons (1998) states that the most successful control efforts for whitetop combine several management practices such as herbicide application and physical removal by hoeing or tilling followed by competitive species plantings.

The purpose and need of this EIS includes making new practices, technologies, and chemical formulations of herbicides available for use on National Forests lands in Region Six. As explained in Chapter 1.2, the tools currently available to manage invasive plant infestations in the Region, are proving to be inadequate in the face of the complexity of the ecological problem that invasive plants incur on native ecosystems. Making additional herbicides available for use by National Forests will increase available options for controlling invasive species while protecting native plant communities and environmental quality. National Forests will still be required to do site-specific environmental analysis before using herbicides. By making additional herbicides available, it does not mean that Forests will be choosing to use herbicides over other types of control methods. Through this EIS, the Forests will be able to consider different herbicides with distinct properties that better address the balance of effective control and protecting the environment.

Additional Herbicides

Some public comments request that the Forest Service consider the use of other herbicides, in addition to the herbicides being analyzed in the EIS. The Forest Service EIS team did not consider additional herbicides for the following reasons:

Any herbicide considered for vegetation treatment of National Forest lands within the jurisdiction of the U.S. District Court of Oregon must comply with the requirements of the Court's judgment in *Northwest Coalition for Alternatives to Pesticides v. Block*, Civil No. 83-6272-E-BU (D. Ore., 1984). The judgment requires that the Forest Service must make its own evaluation of herbicides used in its programs, rather than depending solely on EPA evaluation and registration for these herbicides.

The Forest Service has evaluated the twelve herbicides considered in the action alternatives, using its program of national peer-reviewed risk assessments. These twelve herbicides were selected for evaluation based on their applicability to Forest Service programs and their relatively benign environmental effects, compared to other EPA-registered herbicides.

The twelve herbicides considered in this EIS will fully meet the purpose and need identified for the EIS. Among the twelve herbicides at least one, and generally two or more herbicides would effectively meet control objectives for all currently known invasive plants. Some EIS alternatives also allow National Forests to consider additional herbicides on a case-by-case basis, if needed to meet site-specific control objectives, providing the candidate herbicide is evaluated as required by NEPA and the District Court of Oregon judgment.

No use of Biocontrol Agents

Some public comments request that the Forest Service prohibit the use of biocontrol agents. An alternative of this nature was discussed by the team, and associated resource specialists, but eliminated from detailed analysis.

Biological management of invasive plants is the deliberate use of natural enemies (parasites, predators, or pathogens) to reduce invasive plant populations. Natural enemies help prevent invasive plants from dominating native habitats. Biological management is self-perpetuating, selective, energy self-sufficient, economical, and well suited to integration in an overall invasive plant management program (Wilson and McCaffrey, 1999). Biological control is based on the idea that one of the reasons introduced plants become invasive is their natural enemies were left behind (Rees et al., 1996). Many of the non-native plants that become invasive in this country are not invasive in their native lands and are only minor components of their native plant communities (Rees et al., 1996). Introducing predators, parasites, or pathogens from a plants country of origin does not eradicate, but controls any given invasive plant. Biological control is used when eradication is no longer deemed possible. The use of biological control agents is an attempt to make an invasive plant a minor component of its newly adopted community.

All agents considered for use in the United States undergo rigorous host-specificity testing, designed to ensure that introduced biological control agents are limited in host range and do not threaten native, nursery, or crop plants (see Chapter 3.3.2). This testing also helps to limit the introduction of organisms that will not survive or will not affect the target invasive plant, identifies non-target plants likely to become impacted, and examines the host-specificity of organisms closely related to the proposed agent. Testing also ensures that climatic and biotic constraints on the agent are considered.

The use of bio-controls is an important tool in a complete program of IPM. Eliminating the consideration of bio-controls would not address the purpose and need for this action, and would likely cause unnecessary environmental harm.

Prohibit Aerial Application Of Herbicides

Some public comments suggested that the Forest Service prohibit the aerial application of herbicides (spray application from planes, helicopter). An alternative of this nature was discussed by the team, and associated resource specialists, but eliminated from detailed analysis.

The purpose and need of this EIS includes making new practices, technologies, and chemical formulations of herbicides available for use on National Forests lands in Region Six. A "no aerial application alternative" does not meet this underlying need for action. There are locations (Hell's Canyon being the best example), where because of scale, topography and/or access, prohibiting the use of aerial application of herbicides to treat invasive plants would essentially mean no effective invasive plant control would occur. In these rare cases, aerial application of herbicides is the only effective control method.

Restore Native Ecosystems Alternative (RNEA)

The Restore Native Ecosystems Alternative (RNEA) was prepared by a coalition of citizens and citizen groups who are interested in prevention and control of invasive plants on National Forest, and other federally managed lands in the Region. The focus of RNEA is to enhance the ecological integrity of National Forests and grasslands by restoring natural processes, native species, ecosystem function, and resilience of plant and animal communities.

Under RNEA, invasive plant treatment and restoration actions must utilize a precautionary approach (i.e., proceed experimentally and cautiously) using the best available science, incorporating information gained from local experts where applicable.

RNEA would require an adaptive process that incorporates information learned from monitoring and evaluation. The public would be directly involved in the process.

Under RNEA, those land management activities associated in the scientific literature with increases of invasive species (e.g., livestock grazing, logging, road maintenance and construction, and off-road vehicle travel), are avoided in favor of National Forest activities that are compatible with native vegetation and ecological integrity.

RNEA requires use of the least intrusive techniques available to restore ecological integrity.

Treatments methods associated in the scientific literature with human and/or ecological harm are avoided, wherever possible, in favor of treatments that are effective without causing collateral damage.

Under RNEA the use of herbicides for treatment of invasive plants is a tool of "last resort" and the use of herbicides is mandated to decline within the Region over time.

The Regional Forester considered this alternative in total, and decided to dismiss it from detailed study because certain components of RNEA were outside the scope of this EIS, not reasonably feasible or not viable, or duplicative of the alternatives considered in detail. However, many of the main concepts from RNEA, (e.g., proceeding experimentally and cautiously, favoring nonchemical over chemical treatments, reducing the amount of herbicide use over time, and reducing conditions that favor invasive plants) have been incorporated into the action alternatives, particularly Alternative B.

Table 2-7 reviews the components of RNEA that were dismissed from detailed consideration. The items in parenthesis (e.g., ORV 1, MONITOR 1, etc.) refer to action items in RNEA. A full copy of RNEA is included in Appendix L.

Table 2-7 Components of the RNEA Dismissed From Detailed Consideration

Component	Reasons for Dismissal
Include realistic and dedicated funding for monitoring and appropriate responses to monitoring (ORV 1). If baseline and post-treatment evaluation monies are not available, then the project shall not be approved (MONITOR 1). Eliminate funding based on acres of vegetation directly treated the previous year without: documented alternation of the conditions that favored the presence of invasive plants, and/or restoration programs to restore the site to native vegetation (CEPA 5).	The scope of program funding is too large for Forest Plan management direction and is outside the decision space of this EIS. Congress is responsible for funding the Forest Service, thus the Regional Forester cannot base project approval on future funding.
Develop a long-term (e.g., 100-year) plan for preventing and minimizing invasive plans and restoring ecosystem integrity (PRIORITIES 9).	National Forest Plans typically describe long-term (e.g. 50 years) desired conditions but include shorter-term (10 year) action plans. A 100 year plan is beyond the scope of management direction included in Forest Plans.
Include new requirements for Fire Management Plans (PRIORITIES 12 thru 17).	Standard 2 requires consideration of invasive plant management in plans such as fire management plans. Additional requirements for Fire Management Plans are outside the scope of this action.
Cease new road construction and most road reconstruction in riparian areas (PREVENTION 10).	This EIS discusses management direction related specifically to invasive plant management on National Forest lands. Prohibiting road construction within riparian areas is outside the scope of this action.
Implement home-site fuels treatments and restoration projects within the wildland-urban interface (PREVENTION 13, 15-17).	This EIS discusses management direction related specifically to invasive plant management on National Forest lands. Implementation of vegetation treatments on private lands is outside the scope of this action.

Table 2-7 Components of the RNEA Dismissed From Detailed Consideration	
Component	**Reasons for Dismissal**
Herbicide treatments shall be used only in conjunction with eliminating or reducing the conditions that have favored the presence of invasive plants (PRIORITIES 4).	Alternative B includes the following standard: "Use herbicides as a last resort, as part of a treatment regime that eliminates or reduces conditions that favor invasive plants and encourages conditions that resist invasive plants." This standard reflects the concept behind PRIORITIES 4, without making it a hard and fast rule. There may be situations where no reasonable options exist to reduce or eliminate the condition that favors the presence of invasive plants (i.e. open road systems) where such a standard would be commensurate with a No Herbicide alternative. This component would not meet the purpose and need for action, which includes making new practices, technologies, and chemical formulations of herbicides available for use on National Forests in Region Six.
Limit timber sale hauling to dry (where pathogens like Port-Orford-Cedar root disease and laminated root rot can be spread) or frozen conditions.	Root diseases and root disease mitigation are outside the scope of this action.
Prohibit surface disturbance associated with oil and gas exploration, development, and production (PREVENTION 25, 27 thru 30, 31, 35).	This EIS discusses management direction related specifically to invasive plant management on National Forest lands. Regulations regarding surface disturbance related to oil and gas exploration, development and production is outside the scope of this action. All action alternatives require consideration of invasive plans during planning of projects approved by the Forest Service.
Use existing data, map and describe the presence and integrity of biological crust at the ecoregion and watershed levels (PREVENTION 36).	This approach may be appropriate for site-specific projects, but not relevant or realistic at the Regional or Forest-wide scale.
Prepare and implement a general plan for damaged biological crusts (PREVENTION 38).	This approach may be appropriate for site-specific projects, but not relevant or realistic at the Regional or Forest-wide scale.
Adopt a Carhart Model for completing minimum requirement analyses and minimum-impact tool analysis for Wilderness.	This EIS discusses management direction related specifically to invasive plant management on National Forest lands. Designating decision making models for Wilderness management is outside the scope of this action.
Use prescribed fire only in concert with a restoration assessment with clear objectives for native plant composition (PREVENTION 17).	This EIS discusses management direction related specifically to invasive plant management on National Forest lands. Requiring use of prescribed fire solely as a restoration tool is beyond the scope of this EIS.
Assure availability of native seed and plants (REVEGETION 4).	The Regional Forester cannot ensure commercial availability of native seeds and plants. Alternatives PA and B emphasize use of native plants as available.

Table 2-7 Components of the RNEA Dismissed From Detailed Consideration	
Component	**Reasons for Dismissal**
Following fire or other disturbances, do not propose reseeding unless it can be shown that natural regeneration is unlikely (MONITOR 1).	This EIS discusses management direction related specifically to invasive plant management on National Forest lands; general direction related to responses to disturbance is outside the scope. All alternatives do require consideration of invasive plants in burned area emergency recovery plans.
Offer simple invasive plant exotic species reporting forms to visitors (CEPA 1).	This type of public involvement can be implemented thru routine program mechanisms that do not require a NEPA analysis or decision.

CHAPTER 3 AFFECTED ENVIRONMENT

Due to the complexity of information in this EIS, the affected environment and the environmental consequences have been split into two chapters (Chapters 3 and 4, respectively). The effects invasive plants are having on physical, biological and social resources in Region Six are part of the current condition or baseline by which to base analyses. They differ from the effects of the alternatives on the various physical, biological and social resources, which will be covered in Chapter 4 Environmental Consequences.

Chapter 3 is organized into three parts. Chapter 3.1 discusses the current extent of invasive plants, the mechanisms by which these plants are spreading, and the invasive plant species found in Region Six. Chapter 3.2 discusses the influence of invasive plants on ecosystem components in Region Six. Chapter 3.3 describes all the invasive plant management techniques included in this EIS; it describes how the various methods of prevention, treatment and restoration work to deter invasive plant introduction, establishment, and spread.

3.1 Invasive Plants and Mechanisms of Invasion

Terminology

The many terms used to describe and discuss invasive plants may be confusing. Frequently used terms include: weed, exotic, alien, invasive, non-native, and noxious weed. While often used interchangeably, there are important distinctions between these terms.

Weed is a human oriented term generally applied to any plant that is growing where someone doesn't want it. Which plants are wanted and unwanted depends on the setting or on individual prejudices and taste (Randall 1997). Not all weeds are non-native. The word weed is occasionally used in this document.

Exotic and **alien** are often used interchangeably to describe an unwanted plant (weed) that has been introduced to an ecosystem, or is **non-native**.

Invasive plants are distinguished from other weeds by their ability to spread (invade) into native ecosystems. Invasive plants are defined here as "a non-native plant whose introduction does or is likely to cause economic or environmental harm or harm to human health" (Executive Order 13122).

Noxious weed is a legal designation that can be assigned at both the State and/or Federal level. Noxious weed lists vary by State and often focus on species that have a negative impact on commercial agriculture or rangelands.

States have developed laws that require the control or elimination of noxious weeds by landowners. Not all invasive plants are designated as a State or Federal noxious weed.

Gross Infested Area- This area is defined by drawing a line around the outer perimeter of an infestation. The area within the line can have significant parcels of land that are not occupied by an invasive plant and can include more than one species.

Infested Area- This is the contiguous area of land within a gross infested area that is occupied by a single invasive plant species (i.e. the infested area excludes the portion of the gross area that is not occupied by an invasive plant). The infested area is estimated through visual inspection of the gross area.

3.1.1 Current Extent of Invasion

National Forests in Region Six total nearly 25 million acres. Many more millions of acres of federal, state, Tribal, and private lands are found interspersed with these lands. Invasive plant management involves a complex set of interactions between land uses that occur within and around National Forests.

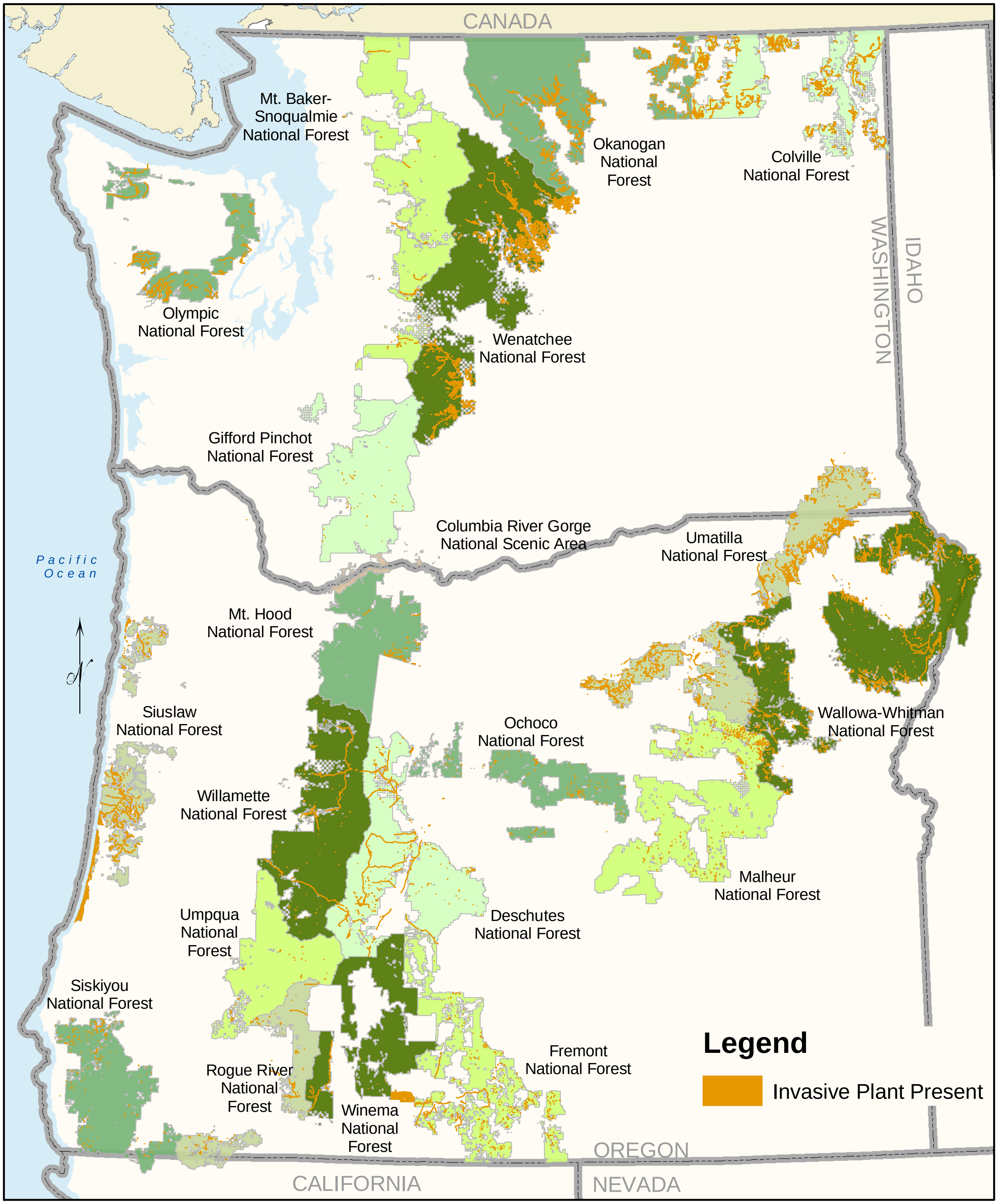
An estimated 420,000 acres[14] of National Forests and Grasslands in Region Six are infested with an estimated total of 107 species of invasive plants (See Figure 3-1). Appendix B provides summary information for all 107 invasive species that are reported to occur on National Forest in Oregon and Washington. It is highly likely additional species are present on the National Forests in this Region, but have yet to be discovered. New invasive plants arrive at an estimated rate of nine new species per state per year (Old, 1992).

Invasive plant populations increase in acreage at an estimated rate of 8-12 percent per year on Forest Service lands (USDA Forest Service, 1999). Using this range, if one estimates spread at 10 percent per year, about 4, 200 acres of National Forest will be infested annually in Region Six. This rate of invasion will likely increase exponentially during the next decade (Mack et al., 2000).

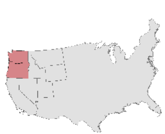
From 1985 to 1996, invasive plants quadrupled to 17 million acres on western federal lands (Asher, 1997; Westbrooks, 1998). Distributions of invasive plants within the Region are increasing most rapidly in National Forests east of the Cascade crest (USDA, 2000).

[14] Invasive plant surveys on National Forests in Region Six are not yet complete, and existing inventories vary from one National Forest to another. The estimate of 420,000 acres of invasive plants are based on the best information available from the 19 National Forests in the Region Six.

Figure 3-1 Invasive Plants Inventory, April 2003



Invasive Plants EIS Project
USDA Forest Service
PO Box 3623
Portland, OR 97208



0 20 40 80 120 Miles

0 30 60 120 180 Kilometers

Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

No warranty is made by the US Forest Service as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

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3.1.2 Mechanisms of Invasion

The presence of invasive plants is not a new phenomenon. But the geographic scope, frequency, and the number of species involved have grown enormously as a direct consequence of expanding transport and commerce in the past 500 years, and especially in the past 200 years. Invasion occurs when non-native species are transported to new, often distant places where they proliferate, spread, and persist. For example, some invasive plants have been accidentally introduced to this country as contaminants among crop seed, ballast in cargo ships, or on other vessels (Mack et al., 2000). The rapid rate of human expansion accounts for a majority of the long-distance dispersal of newly invading species (Grime, 2001).

Purposeful and accidental introductions have occurred for centuries, but major introductions have occurred most rapidly over the past century. Introductions of invasive plants for forage (i.e. contaminated livestock feed), ornamental landscaping, road and dune stabilization, and erosion control have occurred throughout National Forest and adjacent lands in the Pacific Northwest. Most invasive plants have been introduced for horticultural use by nurseries, botanical gardens, and individuals (Reichard and White, 2001). Commercial landscape nurseries in Oregon and Washington sell, or once sold, exotic species for domestic landscaping that later were found to be invasive (e.g. butterfly bush, pampas grass, purple loosestrife, English ivy). These have been shown to spread to federal lands (Whitson, 2001). Pacific Ocean dune ecosystems were "stabilized" using beach grass; which has affected the distribution and demographics of many species inhabiting the dune habitat. Non-native species have been used in seed mixes on National Forests for erosion control, bank stabilization, and burned area rehabilitation. In many cases, these non-native species are not invasive. Timothy and Kentucky bluegrass, for example, are clear exceptions.

The plant invasion process occurs in three phases: introduction, establishment, and spread. Once an introduction occurs, a delay or lag phase often occurs while the invasive plant becomes established (Figure 3-2). The length of this initial phase varies, but can last for up to 100 years (Hobbs and Humphries, 1995). This phase is followed by a period of rapid growth that continues until the invasive plant reaches the bounds of its new range (Mack et al., 2000).

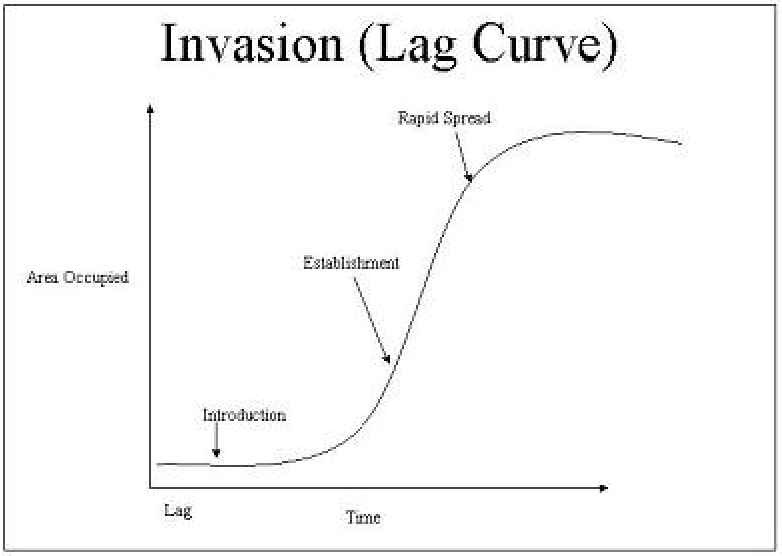


Figure 3-2 Three Phases of Invasion

This model provides direction for making management decisions. For species in the lag phase, preventing continued spread using early detection and eradication is central to success and should be a priority for managers. Controlling infestations during periods when the invasive plants are establishing when enough residual desired species remain in the understory is also a crucial time. Once the rapid expansion has ceased and the majority of the area is dominated by invasive plants, control can be difficult and extensive restoration/rehabilitation is necessary.

The study of biological invasion began in earnest with Charles Elton's work, as described in the 1958 version of *The Ecology of Invasions by Animals and Plants* (Elton, 2000). Decades later, Grime (1974) proposed that a plant responds to stress, competition, and disturbance in its environment, and these factors drive the survival and invasion strategies a species might employ. Since then, other researchers have attempted to characterize the traits that make invasive species so successful (Hobbs, 1991; Perrins et al., 1992; Williamson and Fitter 1996; Reichard and Hamilton, 1997).

Although biological traits of individual invasive plant species vary, most possess one or more of the following characteristics (Baker, 1974; Rejmanek and Richardson 1996; Rejmanek, 2000). These traits (Table 3-1) enable invasive plants to rapidly colonize new areas and displace native vegetation. Plants that possess a combination of these traits are able to succeed in a wide variety of habitats.

Table 3-1 Biological Traits That Enable Invasive Plants to Colonize New Areas
• Early maturation, i.e., invasive plants grow and reproduce earlier in the year than do many native plants.
• Long-lived seeds that can survive harsh conditions, and often have more than one inherent dormancy pattern.
• Adaptations for spreading both long and short distance (e.g., hooks, bladders, and wings).
• Seeds are easily dispersed by human activity and natural vectors.
• Capacity to produce many seeds, especially in favorable environmental circumstances.
• Long-lived, often perennial (e.g., persisting for several years).
• Tolerate a wide range of physical conditions.
• Rapid growth, often with high photosynthetic rates providing a competitive advantage.
• Self-pollinating (i.e., able to produce seed without being cross-pollinated by another plant).
• Compete intensely for nutrients.
• Produce allelopathic (toxic) compounds that negatively affects neighbors.
• Able to reproduce vegetatively (i.e., without having to produce seed).

Natural Vectors

Once introduced, natural vectors such as birds, insects, wildlife, wind, and water also assist in the distribution of invasive species. Wind and water in particular, are major natural dispersal agents. For example, wind blown seed of rush skeleton weed can be dispersed up to twenty miles. Water is a primary aid in the dispersal of many species, including Japanese knotweed. In many situations, even upland invasive plants are disseminated along river corridors and then move upland (LeCain, 2000). Rivers and waterways may be one of the biggest spread mechanisms for invasive plants (Sheley et al., 1995).

Various wildlife species can contribute to the spread of invasive plant species by dispersing seeds in their dung, on their coats or feathers, or between their hooves. For example, birds feeding on the berries of English Ivy are the primary vectors for this invasive plant (Alien plants working group, 2004a). Scotch broom seeds are dispersed not only through birds, but also ants (Parker et al., 1998). Research has been conducted on seed dispersal by birds, rabbits (Malo et al., 2000), and ungulates (Bodmer, 1991; Gill and Beardall, 2001; Howe and Smallwood, 1982; Janzen, 1984; Malo and Suarez, 1995; Vickery, Phillips, and Wonsanage, 1986). Viable seeds and subsequent plant germination have been documented from the dung of cattle, sheep, horses, deer, and pheasants (Gardner, McIvor, and Jansen, 1993; Malo, Jimenez, and Suarez, 2000; Thill, Zamora and Kambitsch, 1986; Welch, 1985). In the British Isles, over 60 plant species have been shown to germinate from deer fecal pellets (Gill and Beardall, 2001, citing Malo and Suarez, 1995; and Welch, 1985).

Seed characteristics are important in determining the ability of viable seeds to be transported by or pass through digestive systems of wildlife or livestock (Gill and Beardall, 2001). Small hard seeds are more likely to survive mastication and digestive acids, enzymes, and bacteria (Gardner, McIvor; and Jansen, 1993). Seeds with hooks, spurs, or awns can attach to fur or wool and be transported farther than seeds without obvious means of attachment (Graae, 2000).

The Role of Disturbance in Invasion

Invasion and dominance by invasive plants are highly correlated with soil disturbance, but are not limited to disturbed areas (Cox, 1999). Invasive plants readily invade, occupy and dominate conifer plantations, road prisms, trails and trailheads, mined sites, gravel pits, river corridors, wildlife wallows and bedding areas, and rangelands. Many invasive species can also establish in naturally occurring disturbances or small openings. For example, once highly competitive vegetative growth begins, the condition of rangeland, even if excellent, will probably do little to slow expansion of the infestation (Sheley and Petroff, 1999). Natural and human induced small-scale and large-scale disturbances create “safe sites” for seedling establishment, and in areas where desirable species are not available to occupy these sites, invasive weeds dominate (Lukan, 1990).

While characteristics that lead to invasiveness continue to be debated, many agree that understanding the biological traits of an invasive plant and the environmental (physical) factors that make a habitat susceptible is critical to understanding the process of invasion (Kimberling et al., 2003). Understanding this interaction will be critical for not only managing current infestations, but also in predicting the location of the next invasion. Important environmental requirements for successful establishment of many invasive plants include increased light, bare ground, available water, and nutrients.

All ecosystems are subject to natural and human caused disturbances (Lukan, 1990). Some type of disturbance usually precedes the establishment of most species, including invasive plants in native forest communities. The greater the extent and intensity of ground disturbance, the more likely an invasive plant will be successful in a native plant community (Crawley, 1987; Evans and Young, 1972; Hobbs, 1989). Disturbance creates patches of open ground and increases the availability of one or more limiting resources. Disturbances can create conditions favorable for desired species, depending upon its size, severity, frequency, and timing (Sheley et al., 1996). Disturbance may be an essential precursor to invasion (Fox and Fox, 1986; Hobbs, 1989; Hobbs and Huenneke, 1992). Even when invasions proceed without continuing disturbance, there is often an initial disturbance event that initiates the invasion (Hobbs, 1989).

The requirement of ground disturbance while typical is not always the case. Such 'super invaders' as false brome can invade low elevation closed canopy coniferous forests in the Willamette Valley and Cascade foothills and can become dominant in the understory, out-competing native vegetation including rare species and can even out-compete tree seedlings (Kaye, 2001).

Many forests experience multiple natural and human imposed disturbances, which have synergistic effects in altering native plant communities and increasing probabilities of plant invasions. Fires have been implicated as a major natural disturbance, creating conditions favorable to invasive species. For example, Jacobs and Sheley (2003) found that Dalmatian toadflax seeds increased 10-fold after a fire. In addition, tansy ragwort dramatically increased after wildfire (Trainor, 2003). Major efforts have been necessary to manage invasive plants after wildfires (Goodwin and Sheley, 2001).

Hiking and wildlife trails, as well as roads and roadsides can pass through burned areas, increasing the susceptibility to plant invasions (Greenberg et al., 1997; Hobbs, 1991; Harrod, 2001). Invasive roadside plants have become established in newly burned areas that were previously intact native communities (Milberg and Lamont, 1995).

Despite the linkages between disturbance and invasive plants, much remains to be learned about invasion success. Some disturbance types can be managed to favor desired plant communities (grazing regimes, timber harvest, prescribed fire, road construction, etc.). For example, disturbance may be necessary for the restoration/rehabilitation of weed infested rangeland. Other disturbance types, though, cannot be managed (floods, drought, storms, most wildland fire, etc.). The intensity and size of the activity can influence plant community composition, trajectories, and susceptibility to invasion. This susceptibility is also dependant on site conditions, invasive plant seed proximity, and a number of other variables. Not all disturbance levels lead to plant invasions, especially if the disturbances that result from the activity are small and minimize soil disturbance/displacement or seeds of invasive species are not available for colonization (Sheley et al., 1996).

The following section summarizes land management and land use activities linked with ground disturbance and subsequent invasion in Region Six. For a thorough discussion, see the PNW Research Station Causal White Paper, “Forest Service Land Management Actions as Contributors to Non-Native Plant Invasions in Pacific Northwest Forests and Rangelands: A Review” (Kimberling et al., 2003) and “Ungulates as Contributors to Non-native Plant Invasions in Western Landscapes: A Review” (Parks et al., 2003) in Appendix D.

Timber and Other Vegetation Management Activities

Timber harvest and other vegetation management activities (thinning, mechanical site preparation, hand scalping for conifer release, and pruning) can alter forest ecosystems. As habitats are altered, new generalist species or edge-adapted species, including invasive plants can be favored. The gaps in forest canopy created by these activities can increase the amount of light reaching the forest floor increasing the temperature, thus improving invasive seed germination and favoring early seral and invasive plants with rapid growth rates. Soil disturbances associated with vegetation management can create hospitable environments for establishment of invasive plants.

The intensity and size of a vegetation management project can influence susceptibility to invasion. Reader and Bricker (1994) examined the effects that plot size (amount of tree removal), increased light, and exposed mineral soil had on the establishment of non-forest species in a deciduous forest in southern Ontario, Canada. Non-forest plant species (native and exotic were not distinguished) were able to establish when 8 percent irradiance occurred at floor level. More non-forest species established in plots with higher percentages of exposed mineral soil, but there was no single minimum area required for establishment. They concluded that smaller disturbances are less susceptible to invasion, and that some disturbances do not lead to invasion. Deciduous forests may respond in different ways to disturbance (e.g., logging) than coniferous forests, but the relationship between disturbance and plant invasions is consistent with other studies (Fox and Fox, 1986; Hobbs, 1991; Hobbs and Huenneke, 1992; Hodkinson and Thompson, 1997; Mack et al., 2000; Pickett and White, 1985.)

Ground-based heavy equipment used in vegetation management operations, operating in areas infested with invasive plants, can spread seeds contained in dust, mud, and slash on the equipment to new previously uninfested areas. Logs skidded through existing infested sites can catch seeds in the bark and in the accompanying slash. Skidding logs disturbs and displaces soil components exposing mineral soil. Logging landings can be a collection center for logs and slash, where material embedded with invasive plant seeds gets sorted for delivery. Debris from trucks, slash, bark pieces, and mud can spread seeds along roads establishing new populations of invasive plant sites.

In the past, logging and clearcutting usually followed road building in forests. Clearcutting fragments forests, decreasing core areas, and increasing edge density (Tinker et al., 1998). The gaps in forest canopy created by roads and clearcuts increase the amount of light reaching the forest floor, which can increase seed germination and seedling establishment of exotic non-forest plants.

As a result of changes and court interpretation in environmental laws, a shift to ecosystem management on public lands, and changing public attitudes, the nature of timber harvest on National Forests in Region Six has changed dramatically over the last 35 years. Consequently, clearcut acres on National Forests in Region Six have dropped from approximately 64,600 acres in 1967 to 718 acres in 2001 (USDA Forest Service, 2003), while the amount of acres thinned and treated with selection harvest have both increased. Overall, the amount of logging occurring on the National Forest has dropped significantly from 354,400 acres in 1967 to 44,698 acres in 2001 (USDA Forest Service, 2003).

Current vegetation management on National Forests in the Region is primarily thinning of densely canopied young forests, fuels reduction of over-stocked stands resulting from years of vigorous fire suppression, and/or uneven-aged stand management (selection and improvement cuts). Trees harvested in current timber sales are relatively small in diameter, as compared to the size of trees removed during the clearcutting years of 1960 thru 1990. The removal of these smaller diameter trees creates smaller gaps in the forest canopy, and creates less ground disturbance. The increased use of helicopter yarding and new log forwarding technology to transport logs also decreases the amount of ground disturbance created.

Road building for timber sales, which can spread seeds and create environments susceptible to invasive plants, has been reduced. Fewer new roads are being built; the roads that are built are typically low standard temporary roads, for one time use and are re-vegetated at the end of operations.

Roads Management

Region Six manages approximately 93,000 miles of roads, or about one-quarter of all roads in the National Forest system. These roads primarily provide access to National Forest system lands, but may also be used by private landholders to access their lands under various forms of cooperative agreements or easements. Most of the traffic on the road system is generated by recreation use, but commercial activities and local communities also use these roads. Forest Plans provide forest-level direction and guidelines for development, operation, and management of the transportation system. Data on the regional road network was compiled as of October 6, 2003, and is presented in Table 3-2 and Table 3-3.

Table 3-2 Regional Road Mileage by Maintenance Level and Surface Type.

	Surface Type					
Operational Mtce Level	**Unkown**	**Paved**	**Aggregate**	**Pit Run**	**Native**	**Total**
Unknown			11		1	12
1	5	18	3,321	894	19,737	23,974
2	7	483	19,897	4,770	29,094	54,251
3	2	909	9,213	809	530	11,462
4		1,677	557	5	1	2,241
5	0	958				958
Total:	13	4,044	33,000	6,478	49,363	92,898

Table 3-3 Regional Road Mileage Summary			
Road Type	**Miles**	**Percentage of System**	**Percentage of Group**
Closed Surfaced	4,232	4.6	18
Closed Unsurfaced	19,742	21.3	82
	23,974		
High Clearance Surfaced	25,160	27.1	46
High Clearance Unsurfaced	29,103	31.0	54
	54,263		
Highway Safety Act Surfaced	14,128	15.2	96
Highway Safety Act Unsurfaced	532	0.6	4
	14,660		

Approximately 15,000 miles (16 percent) of roads within the region are designed and operated to allow travel by standard passenger cars (Maintenance level 3, 4, and 5). Most of these roads (96 percent) have hard pavements (normally asphalts) or aggregate surfacing. Traffic volumes range from less than 50 to several thousand vehicles per day on roads leading to major recreation attractors such at Mt. St. Helens. Several sections of the Highway Safety Act apply to these roads and the Forest Service spends most of its limited maintenance budget on this system. Some portion of this system may also have seasonal closures for wildlife or other reasons. However, there is no consistent data available at the regional scale on the extent of these seasonal closures.

Approximately 54,000 miles (58 percent) of roads within the region are designed and operated to allow travel by high clearance highway vehicles. Approximately 46 percent of these roads have some type of surfacing (usually aggregate or pit run). These roads are maintained infrequently and have low daily traffic volumes, usually less than 30 vehicles per day. Some portions of these roads have seasonal closures for wildlife or other reasons. However, there is no consistent data available at the regional scale on the extent of these seasonal closures.

About 24,000 miles (26 percent) of roads within the region are closed to highway vehicles for periods that exceed one year in length. The roads are closed by some form of physical barrier (earth berm, gate, concrete barrier, etc). These closed roads may be used as trails, and may be open to motorized trail vehicles, horses, and hikers. Only 18 percent of these roads have some type of surfacing. These roads may be re-opened for their primary use some time in the future, and should be considered held in storage.

There are an estimated 483 aggregate stockpiles in Region Six. Approximately 20 percent are used annually for road maintenance. There are an estimated 6300 rock pits and quarries in Region Six, which are also used for road maintenance. Approximately 300 are actively in use. Because of the disturbed nature of these sites, invasive plants could easily invade or be brought in by equipment. Established populations would then become a seed source for more equipment to pick up and move to new locations.

The region does not have the funding to maintain the road system to standard. The region spends approximately $10 million/year on road maintenance (based on FY 02 budget level). Condition surveys conducted on the road system from 1999 – 2003 indicate that the region should be spending approximately $120 million/year to maintain the system to standard (Maintenance Needs Summary, 2002). It's estimated that there is a $950 million backlog of deferred maintenance and at current funding levels the situation will steadily grow worse.

Roads and roadside habitats are particularly susceptible to plant invasions for a number of reasons. Roads eliminate some of the physical and environmental barriers that prevent plant invasions by increasing light availability and opportunities for dispersal. Micro-environmental changes along roads can provide opportunities for invasion because many invasive plants are favored by open, disturbed habitats. Disturbance closely associated with roads and the establishment and spread of invasive plants are vehicular traffic and maintenance activities, road grading, roadside mowing, and keeping roads free of fallen or overhanging vegetation. These activities can increase invasive plant introductions because vehicles can carry and distribute seeds and propagating plant parts. Because roads create new open spaces with higher light availability, invasive plants can follow roads by natural dispersal mechanisms or be transported along them by animals or humans. For this reason roads are primary vectors for the spread of invasive species.

There are several other pathways for introduction of invasive plants that are indirectly related to roads. Recreational use includes a number of activities that can negatively affect the integrity of native plant communities. OHV recreation can create soil disturbance and can be an effective means of invasive plant distribution. Use of road systems by horseback riders, pack animal users, hikers, and backpackers can also aid in creating soil disturbances and spreading invasive plants.

Studies have shown that motor vehicles can pick up and move invasive species seeds and that these seeds will germinate. Schmidt (1989) systematically sampled a car driving over 15,000 kilometers during the growing season. He found 124 species of which he grew a total of 3,926 seedlings. The majority of these were small seeds that tended to persist (remain viable). Though most were associated with roadside disturbed communities, a good portion also came from open grasslands, forest edges and woodlands, meaning that the motor vehicle was the main vector for their movement.

Hodkinson and Thompson (1997) postulated that the maximum distance dispersed by cars is likely to be several orders of magnitude greater than by 'conventional' dispersal methods. They sampled mud from the undercarriages of cars of 201 cars split between the summer and fall seasons. They germinated seeds of 37 species from these deposits and found that the majority of seeds were small and persistent. They noted that a great majority of invasive species did not possess obvious dispersal adaptations for wind, animals or water and that motor vehicles may be used as plausible dispersal mechanisms.

Livestock Grazing

Domestic and wild grazing animals can both contribute to plant invasion through: (1) selective eating of native plants which means unpreferred invasive species would be left, thus favoring an increase in invasive plants; (2) ingesting invasive plant seeds in one area and spreading them to other areas through scat, digestive products, skin, fur and hooves, and (3) disturbing the soil and creating conditions favorable to invasive plants.

Several intentional and unintentional introductions of invasive plants into native plant communities have been associated with livestock management, and some introductions have resulted in widespread invasions (Baker, 1974; Sheley and Petroff, 1999). Landscape spread of invasive plants can occur when seeds are moved along transportation corridors from infested sites or infested ungulate forage, attached to or held within animals, or attached to vehicles used to transport them. Both domestic and wild ungulates spread seeds by these means (Janzen, 1984).

Direct effects of grazing can include plant trampling, disturbance of soil crusts and creation of bare soil, and high input rate of nitrogen to the soil by deposition of dung and urine; all of which play a role in limiting the abundance of palatable species (Augustine and McNaughton, 1998), and thereby increasing the "invasibility" of a plant community (Lonsdale, 1999). While management activities such as timber harvest provide episodic ground disturbance (i.e. change in forest structure and composition dramatically at a given point in time), ungulate grazing and browsing can function as a chronic disturbance, exerting continuous influence over long periods (Parks et al., 2003).

Prescribed grazing, when properly designed and implemented, can also be used as a tool to maintain healthy and vigorous vegetation that is capable of resisting invasion. Healthy plant communities provide resistance to invasion (Sheley et al., 1996; Pokorny et al., 2004.) The influence of grazing on plant invasion is complex, but the frequency, intensity, and season of grazing determine whether this disturbance assists in achieving a desired future condition or invites invasion (Heitschmidt and Stuth, 1991). For example, in eastern Washington, the establishment of diffuse knapweed was enhanced only when defoliation of native bluebunch wheatgrass exceeded 60%; in many undefoliated plots, knapweed density was higher than where moderately grazed. Periodic grazing appeared to favor stronger plants, so long as they were able to fully recover before the next defoliation (Sheley et al., 1997).

Proper grazing can be successfully used to control some invasive plants once they are established (Bowes and Thomas 1978; Olson and Wallander, 2001; Olson, et al., 1997). For instance, sheep and goats prefer broadleaved weeds over many native species, especially grasses (Olson, 1999). Grazing is considered a treatment under the various alternatives in this EIS and is described in greater detail in Chapter 4.1.

Table 3-4 displays the number and type of grazing permits and authorized use levels in Region Six. HM stands for "head months" and AUM stand for "animal unit months," both measures of animal use. An AUM is the amount of forage needed by an "animal unit" (AU) grazing for one month. The animal unit in turn is defined as one mature 1,000 pound cow and her suckling calf. It is assumed that such a cow nursing her calf will consume 26 pounds of dry matter per day as forage.

Table 3-4 Annual Grazing Statistical Detail (Grazing Season 2002)

Region 6

Authorized to Graze

			Cattle		Horses		Sheep & Goats		Total	
Forest	Allot-ments	Permit-tees	HM	AUMs	HM	AUMs	HM	AUMs	HM	AUMs
Deschutes	26	6	7,205	8,271					7,205	8,271
Fremont	70	50	46,345	60,238					46,345	60,238
Gifford Pinchot	3	4	1,231	1,625					1,231	1,625
Malheur	79	83	71,574	93,938	22	26	4,504	1,351	76,100	95,315
Mt. Hood	6	8	3,924	5,180					3,924	5,180
Ochoco	83	44	30,122	39,761			17,918	5,375	48,010	45,136
Crooked River National Grass Land	1	1	16,732	21,509	198	238			16,930	21,747
Okanogan	69	53	33,022	42,148					33,022	42,148
Olympic	1	1	0	0					0	0
Rogue	21	16	7,235	9,507	37	44			7,272	9,551
Siskiyou	11	7	465	594					465	594
Siuslaw	2	1	11	15					11	15
Umatilla	45	44	29,214	38,562			13,991	4,197	43,205	42,759
Umpqua	7	4	604	797					604	797
Wallowa-Whitman	142	106	92,792	122,242	647	777	17,070	5,121	110,509	128,140
Wenatchee	39	11	1,992	2,631	10	12	20,623	6,187	22,625	8,830
Willamette	1	0							0	0
Winema	13	10	15,279	20,168			10,830	2,447	26,109	22,615
Colville	59	42	21,660	28,591					21,660	28,591
Columbia River Gorge	2	2	453	598					453	598
Total	680	493	379,860	496,375	914	1097	84936	24678	465,680	522,150

Fire and Fuels Management

The number and intensity of wildland fires in the United States is increasing. The relationship between fire and exotic plant invasions is well known and continues to be explored (D'Antonio and Vitousek, 1992). After a fire, a site is often more susceptible to exotic plant invasions (Milberg and Lamont, 1995). The most important environmental requirements for successful establishment of many invasive plants are increased light, open ground, available water, and nutrients. Fire provides these conditions, thus providing an ideal place for invasive plants to establish in natural areas (Goodwin and Sheley, 2001; McDaniel et al., 2000; Morghan et al., 1999; Ojima et al. 1990; Trabaud, 1990).

Fire initiates secondary succession in a plant community. Invasive plants are often the pioneer species in this process (Koniak, 1985). There are three general types of species found after fire occurrences: (1) annuals or biennials that invade the area immediately after the fire and disappear with fire exclusion, (2) truly invasive species that persist once established, and (3) species that increase with fire (Trabaud, 1991). Pioneer species that inhabit a site for only a short period of time after fire are not as much of a concern as some other more persistent species, such as cheat grass (*Bromus tectorum*) (Keeley and Keeley, 1984). Plant community succession can be impacted by the colonization of invasive plants that follow a fire (Sheley et al., 1996).

Native plants are often at a disadvantage after an uncharacteristically severe fire. As fire severity increases, native survivorship declines, and invasion potential increases (Goodwin et al., 2002). Fires that are more severe reduce litter more completely, increase nutrient availability and turnover, and alter soil surface characteristics. Native species that are adapted to cooler fires cannot survive (Brooks, 2002). When invasive annual grasses reduce the fire return interval, woody plants, and many perennial grasses are unable to reestablish.

Fuels management such as thinning, slashbusting/chipping, pile burning, and broadcast burning, while vital to reducing the intensity and threat of wildfire around communities will also provide new avenues of invasive plant introduction and spread. Ground disturbance from heavy equipment related to thinning and brush cutting, as well as the creation of openings where the microsite has been changed from moister to drier conditions, will promote invasion. Movement of equipment, crews, and vehicles from infested to un-infested areas will contribute as well. Hand pile burning could create soils open to pioneer species, including invasive plants. Broadcast burning could in some cases reduce some species of invasive plants, but in other species could increase growth and competitive advantage. (Galley and Wilson, 2001).

The Healthy Forests Restoration Act of 2003 will result in significant increases in fuel reduction projects, greatly increasing the potential for introduction, establishment and spread of invasive plants within the Region. Fuel reduction projects will also likely result in a cumulative increase in weed treatments associated with follow-up activities such as fuelbreak maintenance. Long term positive effects of these wildfire prevention projects would include enhancement of native habitat and improvement of ecological processes.

Fire can also be a tool in invasive plant management. It is frequently used in combination with other methods, serving to reduce plant vigor. Its effectiveness is usually limited to the above ground portions of plants. It is considered as a treatment under the various alternatives in the EIS and its effectiveness and effects on resources are described in more detail in Chapters 4.1 and 4.2.

Recreation and Recreation Management

The Forest Service is the largest provider of outdoor recreation opportunities in the country and in the Pacific Northwest. Recreational activities are influenced by, and have influence on, the rate and degree of invasive plant spread. Region Six National Forestlands in Region Six provide outdoor recreational opportunities of local, regional, national, and international importance. People can enjoy highly valued settings while participating in a variety of active or passive recreational activities such as hiking, camping, picnicking, climbing, boating, horse riding and packing, skiing, bicycling, OHV riding, hunting, fishing, wildlife viewing, ecotourism, and automobile touring. These and other recreational pursuits can promote the spread of invasive plant seeds and propagating plant parts. Recreational activities also have the potential to create ground disturbances that favor invasive plants.

A recent study by the Oregon Parks and Recreation Department (2003) found that between 1987 and 2002 the greatest percent increase in outdoor recreation in Oregon was in “nature study activities such as nature/wildlife observation” (+170 percent). Other activities with noteworthy growth include non-motorized boating (137.9 percent), snowmobiling (97.2 percent), hunting (birds and small game, 30.1 percent; big game rifle, 69.5 percent; big game bow, 124 percent), RV/trailer camping (95.5 percent), fishing from a boat (44.3 percent), and ATV (3 and 4 wheeler) riding (38.4 percent). Activities (of relevance to national forest lands) with declining participation include horseback camping (-38.5 percent), dune buggy driving (-32.7 percent), and horseback riding (-31.5 percent).

The Region is home to 13 percent (24.8 million acres) of the nation's National Forests (Burchfield et al., date unknown). Nineteen percent (4.6 million acres in 59 separate Wilderness areas) of the Region's National Forest land is designated Wilderness, comprising 13 percent of the nations total Wilderness acreage (See Figure 3-1). The Region's 1,179 miles of Wild and Scenic Rivers comprise 27 percent of the nation's total. There are 3.5 million acres of inventoried roadless areas in the Region (areas outside of designated wilderness that do not contain roads), encompassing 14 percent of the Region's National Forest land. About 13 percent (17,149 miles) of all National Forest recreation trails are located in the Region, with 6,510 miles of trail within designated Wilderness. There are 538 National Forest campgrounds in the Region, comprising 12 percent of the nation's total.

Invasive plants can detract from the desirability of using recreation sites and participating in certain recreational activities. For example, stiff plant stalks, thorns, sharp bristles, and allergies created by invasive plants can prevent humans from walking, sitting, setting up camp, and finding a place to fish or tie up a raft.

Many invasive plants most successfully propagate in recently disturbed areas, and recreational activities can, to varying degrees, create such disturbances. Heavy use areas such as trailheads, parking lots and riparian zones are easily denuded of their native vegetation, creating prime environment for invasive plants. Recreation users can also unknowingly spread invasive plant seeds and propagating parts across and between landscapes. With the most likely vectors of spread being roads, trails and riparian corridors.

The scoping process revealed two recreational issues of particular concern; OHV use and requirements of weed-free feed for livestock. Dispersed recreation and visual quality have also been identified as issues of high priority.

In this document, OHV refers to vehicles used for off-highway pursuits and may include 3 and 4 wheelers, motorcycles, dune buggies, 4 x 4 vehicles, and others. OHV users (like other recreation users) are diverse in their activities, desired settings and trail types, and motivations for participation. OHV use remains a legitimate use of national forest lands, and the provision of high-quality motorized opportunities and balanced environmental impacts are among the agencies current goals (USDA Forest Service, 2000). However, OHV use, compatibility, and management on National Forest lands is an issue requiring urgent attention for numerous reasons. OHV ownership and use is gaining in popularity. It was reported at the 2003 National OHV Managers Meeting that between 1997 and 2002 OHV sales increased in the western United

States by 171 percent (Oregon Off Highway Vehicle Association, 2004). More OHV permits (9,178) were sold in Oregon in May 2003 than any other month ever (Oregon Parks and Recreation Department data, 2003). Oregon sold a total of 58,040 OHV permits in 2002, and Washington data shows that about 61,000 OHVs are currently owned in that state (Herbert Research Inc., 2003). About 72 percent of OHV recreationists ride on publicly owned lands (Oregon Off Highway Vehicle Association, 2004).

The potential for OHVs to spread invasive plants has been tracked by studies in Montana, West Virginia, and Wisconsin; in each case, OHVs where shown to be effective vectors of invasive plant transport and dispersal (Lacey et al 1997; Stout, 1992; Rooney (pending publication)). OHVs allow recreationists to travel across many more miles in a given time than with non-motorized modes of transportation, greatly expanding the activities ability to spread invasive plants from one location to another. Also, OHV use, especially "cross-country" (away from roads or designated trails) use, can create new soil and seedbed disturbances that can negatively affect the integrity of native plant communities and can favor establishment of invasive plants (Kimberling et al., 2003).

Many people value National Forests as places where they can camp and travel using horses, mules, llamas, and other pack animals. Unfortunately, invasive plants can find their way onto National Forest lands in weed infested feed brought along for pack animals. These seeds are often deposited near disturbed areas such as trailheads, trails, watering holes, roads, horse camps, and other disturbed areas where invasive plants are best suited to grow. Invasive plant seeds can also be spread in the manure of pack animals.

While OHVs and pack animal feed are clear modes of invasive ground disturbance and/or invasive plant seed transport, other vectors also exist; including humans participating in a range of dispersed and concentrated recreational activities. People (and their pets) participating in recreational pursuits can unknowingly spread invasive plant seeds or propagating plant parts. Seeds stick to gear, clothing, hair, and other objects and are then easily transported and deposited.

Scenery is among the most important amenity values provided by the Forests in Region Six (Quigley and Arbelbide, 1997). Humans are very sight oriented beings and visual quality is an important component of the recreation experience. Visual impacts of invasive plant populations are experienced primarily at the immediate foreground and middle ground rather than at the background level or at a "horizon" scale. Many recreational activities bring people into close physical contact with their immediate surroundings, where such amplified foreground and middle ground visual impacts are likely to be experienced. Since many recreational activities involve movement across landscapes, recreation participants are likely to experience increased exposure to invasive plant populations as they travel across the recreational landscape. Invasive plants can reduce the diversity of the types, forms, and colors of plants in an area, and also the experiences that those plants provide. The historic range of variability in landscape flora is also of value to many people. People who are unaware they are looking at invasive plants (unaware of their negative relationship to the ecosystem and potential economic effects) may find them to be attractive components of the landscape. They may even unintentionally spread seeds by gathering and transporting invasive plants to be visually enjoyed or studied elsewhere. Invasive plants also degrade the recreation experience by reducing and competing with the variety and amount of native flora available for observation or study.

Minerals and Mining

Minerals prospecting and exploration, and mining operations may be lead to conditions favorable to invasive plants. Typical surface disturbing activities include access road construction or reconstruction, excavating, clearing of vegetation and soil to facilitate mining operations, and to create drill pads, and reclamation of disturbed areas. Such surface disturbance and reclamation activities often create environments in which invasive plant species out-compete and overrun native plant communities.

3.1.3 Invasive Plant Species in Region Six

Of the 107 species reported in Region Six forests, about twenty species cover the majority of inventoried acres. Keeping in mind that the completion level of forest inventories vary, these species are (in order of most acres to least): diffuse knapweed, meadow hawkweed, small bugloss, spiny plumeless thistle, spotted knapweed, scotch broom, European beachgrass, musk thistle, Dalmation toadflax, Canada thistle, yellow starthistle, St. Johnswort, Himalayan blackberry, bull thistle, tansy ragwork, Scotch thistle, houndstongue, whitetop and medusahead. This list reflects the species of most concern on Forests in Region Six, not necessarily the species of most concern throughout the region under different ownership. This list does not include such riparian species as Japanese and giant knotweed or purple loosestrife, which are usually underestimated due to the linear nature of their populations. These species are considered as very serious threats in both the Pacific Northwest in general and on Forest Service lands.

Other species that are starting to spread on Region Six lands and considered by local authorities as important species to control before their acreage grows are: rush skeletonweed, perennial pepperweed, leafy spurge, orange hawkweed, common toadflax, slender false brome, meadow knapweed and numerous other invasive knapweed species. These species have invaded lower elevation lands under Bureau of Land Management, state and private ownership, but may still be controlled on Forest lands in Region Six.

Below, five species were selected to represent and portray the variety of plant types, growth and reproductive strategies, and control challenges faced by National Forests in Oregon and Washington. These widespread species are of particular concern either because of the large number of acres they have invaded, their potential for further spread, and/or the difficulty associated with their control

Dalmatian toadflax (Linaria dalmatica)

Dalmation toadflax occurs on all but five National Forests in the Region and has been expanding rapidly in drier, eastside forests.

Dalmatian toadflax is native to the Mediterranean region and is named for its occurrence along the (Dalmatian) coast of Croatia (Alex, 1962). Also known as broad-leaved toadflax, this species has been under cultivation in Europe for centuries and was introduced into North America as an ornamental.

Dalmatian toadflax prefers sandy or gravelly soil, and tolerates low temperatures. It is most commonly found along roadsides, and in rangelands, dry forests, and pastures, but adapts to a wide range of habitats. It tolerates low temperatures. The species invades disturbed or cultivated ground, but can also invade relatively undisturbed plant communities. Dalmatian toadflax reproduces by both seed and extensive horizontal roots. This species is an aggressive invader, capable of forming colonies through adventitious buds from creeping root systems (Carpenter and Murry, 1998). These colonies can push out native grasses and other perennials, thereby altering the species composition of natural communities.

The deep, extensive root systems of this perennial species make it difficult to control. The taproot may penetrate 1 meter into the soil and lateral roots may be several meters long (Carpenter and Murry, 1998). Vegetative reproduction can even occur from small root fragments (as short as 1 cm in length) left in the ground (Carpenter and Murry, 1998).

Japanese knotweed (Polygonum cuspidatum)

Though Japanese knotweed is currently reported on only five National Forests, the difficulty with control and the high potential for spread is of concern.

Japanese knotweed is native to eastern Asia and was introduced from Japan as an ornamental garden plant in the late 1800's. It is now widely distributed in much of the eastern U.S., and occurs in coastal areas of Oregon and Washington. Japanese knotweed is a riparian species that spreads quickly to form dense tall thickets that shade out other species and prevent regeneration of native plants. It reduces species diversity and damages wildlife habitat (Sieger, 1991). Japanese knotweed poses a significant threat to riparian areas where it can survive severe floods and is able to rapidly colonize scoured shores and islands (Alien Plant Working Group, 2004b). Once established, populations are extremely persistent.

Rhizomes can regenerate from small fragments (Sieger, 1991). Dispersal can occur naturally when rhizome fragments are washed downstream and deposited on banks, or more commonly, when humans transport soil as fill dirt (Sieger, 1991). Monitoring for the introduction of Japanese knotweed and manually removing the entire plant can prevent establishment. Repeated cutting may control small stands, but the only known method to control large stands is with repeated application of herbicides (Sieger, 1991). Innovative herbicide applications such as stem injection are being used with success and can mitigate effects to non-target species (Soll, 2004).

Medusahead (Taeniatherum caput-medusae)

A winter annual native to the Mediterranean region of Eurasia, medusahead was introduced into the United States in the late 1880s and spread rapidly in the 1930s (Maurer et al., 1988). Since then it has become predominant on millions of acres of semi-arid rangeland in the Pacific Northwest (Whitson et al., 2001).

This species is so competitive that it can replace other invasive species such as cheat grass (*Bromus tectorum*) on certain soils. It threatens native grasses in sparse rangelands, as well as in more complex communities degraded by disturbances, such as overgrazing, fire, or cultivation (Maurer et al., 1988). Established populations form stem mats 5-12.5 cm thick which decompose slowly, due in part to the high amount of silica in the foliage. This dense litter cover enhances medusahead germination, ties up soil nutrients, and contributes to fire danger in the summer (Maurer et al., 1988).

Spotted knapweed (Centaurea biebersteinii)

This species is reported to occur on every National Forest in Region Six. This native of Europe (named for the dark fringe on the flower head) is one of eight invasive Centaurea species reported to occur in the Region. Spotted knapweed infests a variety of habitats including roadsides, fields, forests, prairies, meadows, pastures, and rangelands. Its rapid establishment and spread are typically linked to some form of disturbance (Alien Plant Working Group, 2004c).

Spotted knapweed out-competes native plant species, reduces native plant and animal biodiversity, and decreases forage production for livestock and wildlife (Alien Plant Working Group, 2004c). Sites infested with spotted knapweed have been shown to have higher than normal water runoff and stream sediment loads (Lacey et al., 1989). This species is an aggressive competitor and produces an allelopathic compound (*cnicin*).

Spotted knapweed is a perennial that lives up to 9 years and is capable of producing seed each year (Sheley and Petroff, 1999). Literature suggests that seeds are viable in the soil for at least 8 years; therefore, treatments aimed at preventing seed production, such as manual treatments, must be a long-term.

Yellow starthistle (Centaurea solstitialis)

Occurrence of yellow starthistle is reported on eight forests in the region, and is rapidly expanding in eastern Oregon. Yellow starthistle is a winter annual that can form dense impenetrable stands that displace desirable vegetation in natural areas, rangelands, and other places (DiTomaso, 2001). This species was introduced into North America as a seed contaminant in Chilean-grown alfalfa seed sometime after 1849 (DiTomaso, 2001). In the past 40 years it has spread exponentially throughout the west.

Yellow starthistle is best adapted to open grasslands with deep well-drained soils and annual precipitation between 10 and 60 inches, but competes successfully in a wide range of habitats (DiTomaso, 2001). It favors sites originally dominated by perennial grasses, primarily bluebunch wheatgrass (*Psuedoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), and Sandberg bluegrass (*Poa secunda*) (Sheley and Petroff, 1999).

Yellow starthistle displaces native plant communities and reduces plant diversity (Sheley and Petroff, 1999). It forms solid stands that dramatically reduce forage production for livestock and wildlife (Sheley and Petroff, 1999). This species causes a fatal neurological disorder when ingested by horses called "chewing disease."

3.2 Influence of Invasive Plants on Ecosystem Components

This section addresses the influence of invasive plants on specific components of the ecosystem. Each resource is discussed separately after the following introductory paragraphs beginning with the physical environment. Discussions include not only an affected environment description, but also information on how invasive plants affect each resource.

Invasive plants can compromise healthy, native ecosystems if they persist and/or increase in abundance over time. Once established, they can be self-perpetuating, and can spread from site to site, often without human assistance (Randall, 1996). The impact of invasion can be permanent when economic and environmental factors limit the ability of a managing agency to restore the ecosystem to a healthy state (NAS, 2002). Invasive plants have already caused permanent damage to public lands across the western United States (Asher et al., 1998).

Until fairly recently, natural processes alone influenced the distribution of the world's flora. Human activities during the last 100 years have circumvented natural processes so that non-native species are invading continents at an increasing rate (Leibhold et al., 1995). These human-induced biological invasions are occurring on a global scale, and are beginning to blur the regional distinctiveness of the Earth's biota (Westbrooks, 1998). Escalating human population growth and improved transcontinental transport are the primary factors behind this increasing rate and scale of movement (Ewel et al., 1999).

Invasive plants have cascading effects on ecosystems, and affect significant chemical, physical and biological components and processes (e.g. nutrient cycling, erosion, species competition). Currently, the following effects (Table 3-5) of invasive plants on native plant and animal species are known; these effects may act cumulatively and/or synergistically to disrupt extant ecological relationships.

Table 3-5 Known Effects of Invasive Plants on Ecosystems
Habitat change resulting from invasive plants
• Alter forage quality
• Decrease favored or nutritionally preferred food
• Lack of use of favored forage may affect plants previously evolutionarily favored, and affect mutualistic relationship
• Disrupt herbivore/plant ecological relationships
• Disrupt insect composition and plant relationships (e.g. butterfly/bee/pollinator/plant relationships, with cascading effects to other pollinator/plants.)
• Disrupt mychorrhizal fungi through plant changes; in turn, this may affect long-term habitat components pertaining to structure and function of vegetation
• Alter fire behavior; which can affect fire intensity, duration, and frequency
• Alter soil stability through loss of plant cover, debris, and detritus
• Change in local ecology of keystone plant species that has cascading effects on plant and wildlife composition and habitat use (e.g. beach grass, Japanese knotweed)
• Change in soil ph and chemistry
• Change in soil biota
• Habitat fragmentation and increased edge effect
Other effects of invasive plants
• Impact to ecosystems already undergoing climatic change
• Direct and indirect changes in water availability and moisture regimes
• Loss of biological diversity, ecological integrity, and ecosystem structure/function
• Reduced population of native species with local extinctions and extirpations

3.2.1 Soils

Productive soil is fundamental to healthy, functional ecosystems and is dependent on a thriving subsurface ecosystem adapted to geology, hydrology, climate, and surface ecology. Region Six includes a wide variety of soils, from shallow or deep; very young or ancient and well-developed; based on sedimentary, igneous, or metamorphic geology; and contain virtually no organic matter or covered with thick organic layers. Topography and climate within the Region is similarly diverse, ranging from steep to gently rolling; from sea level to over 10,000 feet in elevation; and annual precipitation from less than 20 inches per year to more than 100 inches per year.

Land management activities such as road construction and maintenance, grazing, logging, burning (either prescribed or wildfire) and trail construction, can affect soil productivity by compaction or displacement of soil. Management impacts to soil productivity in the Region vary considerably, based on the intensity and sensitivity of the activities conducted. FSM 2550 and FSH 2509.18, along with individual forest plans and region-wide forest plan amendments (e.g. the Northwest Forest Plan, Pacfish and Infish) provide varying degrees of guidance on protecting soil productivity in the Region. FSH 2509.18 (Chapter 2.2.1) recommends 15 percent reduction of soil productive capacity (soil productivity) as a guideline for determining when change becomes detrimental or significant. Individual forest plans may determine detrimental or significant change in soil productivity at a lower proportion.

Invasive plants can have dramatic and irreversible effects on soil productivity due to changes in soil characteristics such as nutrient and water availability, organic matter in the soil, diversity and abundance of soil biota, and soil water holding capacity. Invasive plants can also increase the soil surface exposed to wind or water erosion, change fire frequency and frequency, and produce toxic chemicals that affect soil organisms. Some of these changes may be difficult to reverse and can result in difficulty in reestablishing native vegetation. In a few instances, invasive plants can positively affect soil through enrichment of certain nutrients and erosion control. Some examples of invasive plant effects on soil productivity follow.

Lacey et al.(1989) found that rangelands infested with spotted knapweed had more bare ground than natural bunchgrass/forb grasslands. In a simulated rainfall test, they found that soil erosion more than doubled in knapweed-dominated areas compared to uninfested areas. Even modest losses of the soil surface can have large impacts on soil productivity, since most of the biologically active organic matter is concentrated in the top 1 to 4 inches of soil. Soil erosion also has negative impacts on water quality in associated aquatic systems. Lacey et al.(1989) additionally found significantly lower infiltration rates in the knapweed sites. Reduction of infiltration decreases groundwater recharge.

Tyser (1992) also observed low canopy cover of native forbs and low biological soil crust cover in stands invaded by spotted knapweed. He also found lower grass cover in stands invaded by common timothy. Low canopy cover can decrease soil moisture content, since more rain runs off as surface flow, and soil is directly exposed to solar radiation and dries rapidly. A dry soil surface hinders seedling establishment and will negatively impact plants with surface root systems, such as many native grasses. Exposure of the soil surface causes soil temperatures to be more extreme, due to solar heating during the day and greater irradiative cooling at night. These extreme temperatures make seedling establishment more difficult and may affect soil organisms (Sheley and Petroff, 1999).

One function of soil is cycling nutrients from dead organic matter into forms that are available to plants. Nutrient cycling is essential for the health and productivity of the ecosystem, and is a complex process that depends on a multi-level food web that is specific to the site. Biota involved in nutrient cycling includes bacteria, actinomycetes, fungi (pathogenic, saprobic, and mycorrhizal), amoebas, and a wide range of invertebrates. Since this entire system is powered by root exudates and decomposing vegetation from the plant community, changes in plant communities caused by non-native invasion can have large effects on the soil food web (Hobbie, 1992; Van der Putten, 1997).

A study that compared soil organisms in native grasslands in a natural state and after invasion by cheatgrass (*Bromus tectorum*), found that the cheatgrass caused changes in most levels of the soil food web (Belnap and Phillips, 2001). Although it is difficult to predict the specific effects of these changes, it is important to recognize that any change in the soil food web has the potential to interfere with critical nutrient cycling processes, and to threaten the long-term integrity of the ecosystem. For example, some reforestation failures in the Siskiyou Mountains have been attributed to a shift from soil biota high in fungal biomass, to a biota dominated by bacteria and actinomycetes due to management activities (Friedman, et al., 1989). Reforestation of these clear cuts has failed after 4 or 5 attempts over 30 years (Perry, 1994).

A study found pronounced differences in soil properties when soil under non-native understory plants was compared to soil under native shrubs (Ehrenfeld, et al., 2001). Soil pH was significantly higher under the non-native plants, as was extractable nitrate. Net nitrogen mineralization was also higher under the non-native plants, indicating changes in the composition or activity of soil microbes caused by non-native plants. Over time, these changes may have effects on the ecosystem as a whole. Many invasive plants establish more readily on sites with high nutrient availability. Invasive plants that increase the availability of nitrate in the soil may be promoting conditions that favor their own expansion at the expense of native plants that tolerate low nutrient levels. Increases in soil nutrient levels have been shown to favor the invasion and success of non-native species in a serpentine soil ecosystem where resources were limited (Huenneke, et al., 1990).

On the other hand, many invasive species deplete soil nutrients. Spotted knapweed has been implicated in reducing available potassium and nitrogen (Harvey and Nowierski, 1989). A reduction in soil nutrient levels makes it difficult for native plants to compete with the invasive plants, and probably affects the soil biotic community. The long-term effects of these changes are not known.

Some invasive plants produce secondary compounds that affect other plants (allelopathy) or soil organisms (Sheley and Petroff, 1999). If an invasive plant produces a secondary compound, the population of soil microbes that can metabolize this compound will increase, while the populations of other microbes will decrease (Sheley and Petroff, 1999). Again, these changes will affect the soil food web and nutrient cycling, impacting native plant communities.

One group of soil organisms that is of particular concern is mycorrhizal fungi. These fungi form a mutualistic relationship with plants in nearly all ecosystems and are critical in supplying water and nutrients to plants, as well as protection from root pathogens. Mycorrhizal fungi also play an important role in creating soil structure, particularly in young or poorly developed soils. Mycorrhizal fungi can produce up to 200 meters of hyphae per gram of forest soil. This mass of hyphae binds soil particles together, stabilizing the soil system. Mycorrhizal fungi also produce polysaccharides that bind soil particles into aggregates. These aggregates increase the water holding capacity of the soil, improve oxygen penetration into the soil, and provide small sites for the normal development of communities of bacteria, actinomycetes, and amoebas. Mycorrhizal fungi appear to mediate the transfer of sugars and nutrients from one plant to another. This function may be important in maintaining diversity in the plant community, and in the recovery of the plant community after disturbance. The fruiting bodies produced by some mycorrhizal fungi are an important food source for a variety of animals, from invertebrates to large mammals. More than 70 percent of the diet of some small mammals, including the northern flying squirrel, consists of fruiting bodies of mycorrhizal fungi.

Research on the impact of invasive plants on mycorrhizal fungi is lacking, but since plants and mycorrhizal fungi are strongly dependent on each other, it seems likely that drastic changes in the plant community caused by the invasion of non-natives will be accompanied by changes in the mycorrhizal fungus community. Sylvia and Jarstfer (1997) compared the mycorrhizal status of young slash pines (*Pinus elliottii var. elliottii*) in plots with weeds and plots that were kept weed free with herbicide treatment. After 3 years, the number of pine root tips colonized by mycorrhizal fungi was 75 percent lower in the weedy plots than the weed free plots. In addition, the species distribution of the mycorrhizal fungi associated with the trees had changed.

In the Sylvia and Jarstfer study, the invasive plants were associated with different fungi than the trees. It is likely that competition from these introduced fungi, caused the decrease in the fungi associated with the trees. If mycorrhizal fungi associated with invasive plants successfully compete with native fungi, a redistribution of soil resources in favor of the invasive plant will occur. In addition, species of mycorrhizal fungi associated with native plants may be lost from the area of infestation. It may then be difficult to reestablish native vegetation on the site after the invasive plants are removed.

Researchers have found that specific "helper" bacteria in the soil promote the establishment of mycorrhizae, and mycelial growth of mycorrhizal fungi (Garbaye and Bowen, 1989). Although little is known about the ecological requirements of these organisms, it is possible invasive plants do not support helper bacteria employed by native plants and fungi.

Without treatment, invasive plants are likely to cause significant changes to the physical, chemical, and biological properties of soils. In some cases it may be difficult to reverse these changes and restore soil productivity. This legacy of disrupted soil function may increase the effort required to restore native vegetation long after invasive plants are removed.

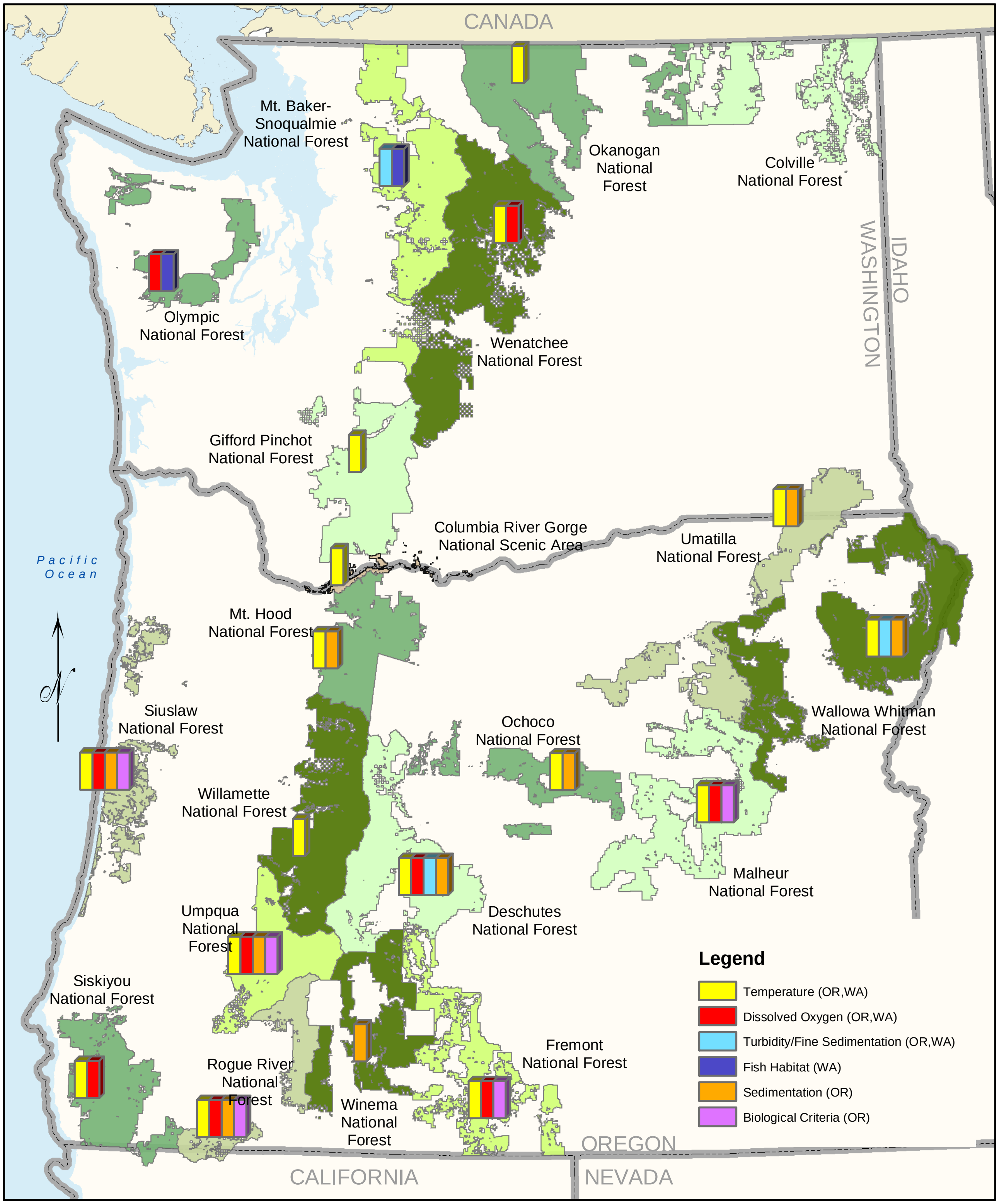
3.2.2 Water Quality

National Forest watersheds provide drinking water to nearly 300 public water supply systems serving up to 2.9 million people in Oregon and Washington. Many others use smaller systems tapping water produced from National Forest lands for domestic use or irrigation. Rivers, streams and lakes within or downstream of the planning area are used for swimming, fishing, boating, and water sports. Additionally, National Forest streams provide habitat and clean water for fish and other aquatic biota, each with specific water quality requirements. The Clean Water Act protects water quality for all of these uses.

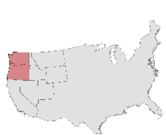
The Clean Water Act requires States to set water quality standards to support water use within and downstream of planning areas. The Act requires States to identify the status of all waters and prioritize water bodies whose water quality is limited or impaired. The EPA approves both water quality standards and lists of water quality limited waters. Oregon Department of Environmental Quality, Washington Department of Ecology, Idaho Department of Environmental Quality, and California State Water Resources Control Board web-sites list water quality limited waters and water quality standards.

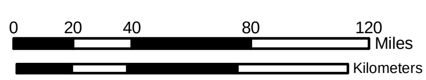
By direction of the Clean Water Act, where water quality is limited, States develop plans to improve water quality to meet State water quality standards, and support beneficial uses of water. For water quality limited streams on national forest lands, the Forest Service provides information, analysis, and site-specific planning efforts to support state processes to protect and restore water quality. For streams on National Forest lands that meet or exceed water quality standards, anti-degradation rules in each State are supported by implementation of best management practices and management measures. The Northwest Forest Plan, Pacfish and Infish, all include management measures and best management practices designed to protect and improve water quality. In the past ten years, passive and active restoration of riparian processes and water quality has been conducted under these plans with subsequent water quality improvement.

Figure 3-3 Occurrence of Listed Water Quality Limited Water Bodies



Invasive Plants EIS Project
USDA Forest Service
PO Box 3623
Portland, OR 97208





Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

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Invasive plants can create or exacerbate conditions that reduce water quality. Directly or indirectly, invasive plants can affect stream bank stability, sediment, turbidity, shade and stream temperature, dissolved oxygen, and pH. Once water quality is degraded, invasive plants can complicate or prevent water quality restoration. Invasive plants can also reduce water quantity. For instance, tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*) can alter stream form and use more water than native streamside plants, which can reduce, or even eliminate, the availability of surface water.

Every National Forest within the Region has water bodies that are water quality limited, though not all limiting parameters are related to invasive plants. On NFS lands in Oregon and Washington, the most common water quality limiting parameter is elevated summer stream temperatures. In Washington State, invasive plants affect fish habitat, fine sediment, and dissolved oxygen water quality parameters; while in Oregon, sedimentation, turbidity, dissolved oxygen, and biological criteria (quantities and diversity of aquatic invertebrate species) are affected by invasive plants. Sediment is the most common water quality limiting parameter in California and Idaho. See Figure 3-3.

Roots of riparian vegetation help prevent erosion, provide slope and stream bank stability, and reduce suspended sediment (FEMAT, 1993). Lacey et al. (1989) reported runoff and sediment yield were higher on sites dominated by spotted knapweed than on sites dominated by native bunchgrasses in a Montana study. Suspended sediment complicates treatment of water for human use and consumption, and can render water unsuitable for recreational activities.

Invasive plants that form a monoculture in riparian areas can deposit large amounts of organic matter into streams over a short time. In contrast, diverse riparian communities deposit varying quantities and kinds of organic matter over a longer time period. Sudden introduction of large amounts of organic matter can influence pH by increasing the concentration of organic acids; increase biological oxygen demand, reducing the available oxygen for stream biota; and increase dissolved carbon dioxide due to respiration (Peters et al., 1976).

3.2.3 Riparian

Riparian vegetation plays a key role in forming aquatic habitat for fish and other aquatic species. Roots help hold stream banks, preventing accelerated bank erosion and providing for the formation of undercut banks, important cover for juvenile and adult fish. Riparian areas supply downed trees (large wood) to streams. In turn, downed trees in streams influence channel morphology characteristics such as longitudinal profile; pool size, depth, and frequency; channel pattern; and channel geometry. Turbulence created by large wood increases dissolved oxygen in the water for use by fish, invertebrates and other biota. Large wood in streams creates complex aquatic habitat, provides cover from predators, acts as a substrate for biological activity, while it stores sediment and organic matter, slowing their movement in streams and providing substrate for fish and invertebrates (FEMAT, 1993). The extent of the hyporheic zone adjacent to and under the stream surface is increased by large wood in streams. Hyporheic zone influence on temperature, nutrients, and productivity is a topic of emerging understanding (Wordzell, personal communication, 2003; Fausch et al., 2002). Additionally, riparian vegetation is an important energy source for aquatic ecosystems, providing leaf and other particulate organic matter to the food-web (FEMAT, 1993). Invasive plants can prevent the establishment of native trees, decreasing or delaying the future supply of large wood in channels.

Riparian forest canopy protects streams from solar radiation in summer, and can moderate minimum winter nighttime temperature, preventing the incidence of anchor ice or freeze-up in streams (Beschta, et al., 1987). Changes in water temperature regime can affect the survival and vigor of fish, and affect interspecies interactions (FEMAT, 1993).

In Region Six inventoried gross weed-infested acres range from 0 percent to 47.5 percent within any single subbasin (Subbasin Report of Inventoried Invasive Plants Near Water Compared to Uplands, 2003). Estimating invasive plant infestation in riparian areas, 36,000 inventoried acres of invasive plants are within 300 feet of water, representing 12 percent of land in the Region within 300 feet of water. However, inventories are incomplete in many subbasins and area within 300 feet of water may not include many small streams, so these numbers are approximate.

Riparian areas are dynamic. Disturbances characteristic of uplands such as fire and windthrow, as well as disturbances associated with streams, such as channel migration, floods, sediment deposition by floods and debris flows, shape riparian areas (FEMAT, 1993). Frequently disturbed ground in riparian areas makes them especially vulnerable to plant invasion. The dynamic nature of riparian communities has produced unique adaptations in some riparian species. For example, many riparian hardwood species either require, or at least regenerate better on, disturbed or open ground (Winward, 2000). Seedlings of these species are often poor competitors in dense vegetation. This adaptation limits the ability of these species to compete with riparian invaders such as reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*). These invasive plants are uniquely adapted to riparian habitat and once established can quickly dominate the landscape. Invasive plants such as purple loosestrife can replace or suppress native vegetation in wetlands (Mullin et al. 2000, Duncan, 1997). Purple loosestrife crowds out native plants such as cattails and bulrush, provides neither food nor shelter for most wetland wildlife, occludes channels, increasing sediment deposition and decreasing channel capacity (Donaldson, 1997).

The rapid growth of many invasive plants allows them to out-compete native vegetation. This competitive advantage results in the loss of functional riparian communities, loss of rooting strength and protection against erosion, decreasing slope stability and increasing sediment introduction to streams, and impacts on water quality (Donaldson, 1997). Invasive plants are especially difficult to control in riparian areas since weeds thrive in the moist environment and treatment measures are limited.

Japanese knotweed is an example of an invasive plant with wide-ranging effects to riparian areas. Japanese knotweed leaves fall off in a short period in the fall, leaving soil beneath knotweed relatively unprotected from rain, leading to increased erosion and sediment delivery to streams. Leaves decomposing in streams could locally increase the biological oxygen demand and deplete dissolved oxygen for other organisms in the stream. Chemical characteristics such as pH can be affected by large, sudden inputs of organic material (MacDonald, et al., 1991). While these effects may be local or mitigated by dilution or turbulence, the potential for negative effects to aquatic ecosystems is plausible.

3.2.4 Aquatics

Fish are an important cultural, economic and recreational resource on the National Forests in Region 6. Declining populations of fish have been a management concern. The Northwest Forest Plan, Pacfish and Infish forest plan amendments responded to concern for the continued existence of a number of species. A number of species have special management status as endangered, threatened, or proposed under the ESA, or sensitive species identified by the Regional Forester.

The Magnuson-Stevens Fishery Conservation Act requires the identification of habitat "essential" to conserve and enhance federal fishery resources that are commercially fished. Essential Fish Habitat (EFH) is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR 600.10). EFH is located on portions of fifteen National Forests and one Scenic Area. EFH for Chinook, Coho and Puget Sound pink salmon includes all streams, lakes, ponds, wetlands tributaries and other water bodies currently viable and most of the habitat historically accessible to these fish (Pacific Fishery Management Council, 2004).

Due to the topographical, geological, vegetative, and climatic variation across the project area, considerable variation in aquatic systems also exists. Four general settings for aquatic systems are present on National Forest lands within the project area: those occurring in the coast range mountains, Cascade mountains, eastside range lands, and east side mountains. See Figure 3-3.

Coast range river systems are relatively short systems, with a high drainage density, and flow directly into the Pacific Ocean. Annual precipitation levels are high, with frequent high water events occurring throughout fall, winter, and spring seasons. Summer flows are provided by subsurface storage and thunderstorm events. Native fish species typically present include sculpin (*cottidae sp.*), coastal cutthroat trout (*Oncorhynchus clarki clarki*), coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), rainbow trout and steelhead (*Oncorhynchus mykiss*), lamprey (*Lampetra* species), and a few minnow (*Cyprinidae*) and sucker (*Catostomidae*) species. As in all stream systems throughout the region, complex life history assemblages are often present for salmonid and lamprey species, including resident, fluvial, and anadromous life history strategies. Juvenile anadromous salmonids rear in fresh water for a few months to more than two years, depending on species and adult migration timing. Non-native species sometimes present include striped bass (*Morone saxalis*), smallmouth bass (*Micropterus dolomieui*), and American shad (*Alosa sapidissima*). Coastal aquatic food chains are generally more detritus based than inland systems.

Cascade range river systems are generally longer than coast range systems, with a moderate to high drainage density, and may drain directly into the Pacific Ocean, or to the Willamette or Columbia Rivers. Annual precipitation levels are moderately high, but vary considerably, depending on elevation. Summer flows are provided by snowmelt, subsurface storage, and thunderstorm events. At higher elevations, above migration barriers, native fish species typically present include coastal cutthroat trout, rainbow trout, and dace. Bull trout (*Salvelinus confluentus*) are also present in some locations. Below migration barriers, coho salmon, Chinook salmon, and steelhead are generally present, and some minnow and sucker species occasionally present. Other less common native fish species are also present. Non-native fish species often include brook trout (*Salvelinus fontinalis*), and occasionally brown trout (*Salmo trutta*). Food chains are detritus based at higher elevations, with significant contributions from primary production within the stream occurring at lower elevations.

Stream systems occurring on rangelands east of the Cascades are longer river systems, have a low drainage density, with the vast majority draining into the Columbia River and a few draining into the Klamath River. The climate is generally arid, and annual runoff patterns tend to be dominated by annual spring snowmelt. Many headwater channels are located in isolated mountain ranges. Summer flows are provided by snowmelt, subsurface storage, and thunderstorm events. Native fish species are generally rainbow trout, steelhead, Chinook salmon, bull trout, and several minnow and sucker species. Other less common native fish species are also present. Non-native fish species often include smallmouth bass and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Primary production is important to the food chain in this stream system, with a significant detritus based component.

Eastside mountain streams occur in mountain ranges east of the Cascade Mountains. They are generally either the headwaters of eastside rangeland stream systems, or flow directly into the Columbia River system. Most precipitation occurs during the winter months as snow, and annual runoff generally follows a classic snowmelt pattern. Native fish species are generally rainbow trout and steelhead, but Chinook salmon, bull trout, and a few minnow and sucker species may also be present. Food chains are similar to those found in the Cascades, but with a higher primary productivity component.

Invasive plant effects to aquatic ecosystems are indirect and are not fully appreciated. For instance, invasive plants that exclude trees decrease shade, increase bank erosion, and reduce large woody debris sources. Summer stream temperatures can be increased due to input of solar radiation due to lack of tree shade. Fine sediment deposition in spawning gravels can reduce survival of fish eggs and juveniles, reduce primary production and benthic invertebrate abundance, thereby reducing food availability. Severe accelerated sediment delivery can also alter habitat by filling pools. Suspended sediment increases turbidity, which can disrupt fish feeding and social behavior (FEMAT, 1993). Large wood in streams is important to fish, as discussed earlier. Invasive plants can complicate and delay restoration of stream characteristics that support native fish, decreasing the possibility that degraded ecosystems and reduced fish populations can successfully recover from disturbance due to management or natural events. One example may help to illuminate this concern.

Headwater streams rely heavily on leaves falling into streams for energy and organic matter. Leaves are food for stream detritivores, which consequently provide food for other stream organisms. In riparian areas infested by Japanese knotweed, exchanging organic matter input from a variety of sources to Japanese knotweed leaves may be problematic for detritivores.

Stream detritivores may be able to use the knotweed leaves, but it is also possible that they are toxic or inedible, though the relationship is unknown. In diverse ecosystems, emergence of leaves, flowering, seed set, and shedding of leaves occurs at various times for different species. Timing and nutrient values of a single species is not likely to provide food for all native detritivores in and near streams, which in turn can affect other organisms in the food chain. If Japanese knotweed excludes trees, important riparian functions are affected locally and effects may persist for decades, until trees and other native vegetation can be reestablished.

3.2.5 Native Plants and Plant Communities

Plant communities can be classified by a variety of factors such as vegetation structure, site moisture, overstory and understory. Specific vegetation classification approaches were taken for this EIS. The potential vegetation modeling process developed by Forest Service Ecologist Jan Henderson was used for Oregon and Washington west of the Cascade crest. East of the Cascade Crest, potential vegetation groups developed for the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 2000) were used (Hann et al., 1997).

Terminology

The term potential vegetation type (PVT) is used to represent the combination of species that could occupy the site in the absence of disturbance. Potential vegetation differs from existing vegetation in that it represents the vegetation that could occupy a site versus the vegetation that actually occupies the site. These vegetation types can be further aggregated into potential vegetation groups (PVGs) based on similar moisture or temperature environments. In this document we use PVGs to discuss vegetation at the broad scale and examine current trends.

High = high susceptibility to invasion. Invasive plant species invades the cover type successfully and becomes dominant or co-dominant even in the absence of intense or frequent disturbance.

Moderate = moderate susceptibility to invasion. Invasive plant species is a “colonizer’ that invades the cover type successfully following high intensity or frequent disturbance that impacts the soil surface or removes the normal canopy.

Low = low susceptibility to invasion. Invasive weed species does not establish because the cover type does not provide suitable habitat.

A major conclusion of the ICBEMP analysis was that, in general, grasslands, riparian areas, and relatively dry, open forests are more susceptible to invasion than are dense moist forests, high montane areas, and serpentine areas. The former have frequent gaps in the plant cover, which favor invasive plant establishment, whereas the latter have relatively closed plant cover or have extreme climate or soils, which are tolerated by fewer invasive plant species. The full results of this analysis are available in *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins, Volume II* (Quigley and Arbelbide, 1997). Across Region Six these conclusions may vary. For example, some serpentine areas in the Region are experiencing invasion at a greater pace than other serpentine areas.

Table 3-6 and Figure 3-4 provide a summary of potential vegetation groups (PVG) found in Region Six, and their susceptibility to damage from invasive plants. The susceptibility of plant communities to invasion can be influenced by many factors, including disturbance levels, community structure (Orians, 1986), resource availability (Burke and Grime, 1996; Elton, 2000; Stohlgren et al., 1999), and the biological traits of the invader (Davis and Thompson, 2000). Approximately 51 percent of the Region contains potential vegetation groups that are highly susceptible to damage from invasive plants.

Table 3-6 Potential Vegetation Groups			
Potential Vegetation Group (PVG)	**Description**	**Percentage of PVG on National Forests**	**Susceptibility to Invasion Rating**
Agricultural	Cropland/hay/pasture	less than 1	High
Alpine	Alpine shrub-herbaceous	2.3	Low
Cold Forest	Mountain hemlock, Pacific silver fir, Shasta red fir, Subalpine fir, Lodgepole pine (in SW Oregon), Western white pine	26	Low
Cool Shrub	Characterized by mountain big sagebrush and shrubs, grasses, forbs, and sedges. Appears east of the Cascade crest. It is limited by moisture availability due to low rainfall and/or shallow soils.	1.8	High
Dry Grass	Includes native grasslands, seeded grasslands, and cropland hay pasture. Characterized by bunchgrasses. Restricted to east of the Cascade crest, and most prevalent in the Blue Mountains.	2.3	High
Dry Shrub	Dominated by sagebrush but bunchgrass/forbs present. East of the Cascade crest at lower elevations than the Cool Shrub PVG.	less than 1	High
Eastside Dry Forest	Douglas-fir, Ponderosa pine, Lodgepole pine	29	Moderate to High
Eastside Moist Forest	Vegetation includes transitional areas between drier, lower elevation forest, woodland types, and higher elevation forest types in cold forests. The dominant overstory species found in this group include grand fir, Douglas-fir, cedar and hemlock.	18	Moderate to High
Riparian Shrub	Mountain riparian low shrub, saltbrush riparian, willow, alder, sedge. The linear nature of the riparian corridor makes this PVG highly susceptible to invasion.	less than 1	High
Riparian Woodland	Cottonwood with willow, ponderosa pine, Douglas fir, aspen. On many sites, the non-native species have become well established, commonly replacing native species or exerting large influences on the functional dynamics of existing habitats.	less than 1	High
Serpentine Forest	Jeffrey pine, Western white pine, Port Orford Cedar	less than 1	Low

Table 3-6 Potential Vegetation Groups

Potential Vegetation Group (PVG)	Description	Percentage of PVG on National Forests	Susceptibility to Invasion Rating
Serpentine Non-Forest	Serpentine barrens and fens	less than 1	Low
Westside Dry Forest	Although not described in ICEBMP, this group correlates with the Eastside Dry Forest PVG. The Douglas-fir and ponderosa pine series are included in this group. Douglas-fir, Ponderosa pine, Oregon white oak	2	High
Westside Moist Forest	White/Grand fir, Tanoak (in SW Oregon)	5.4	Low
Wet Forest	Western hemlock, Sitka spruce	12	Low
Woodland	This group is represented only east of the Cascade crest, occurs mostly on forests in the Blue Mountains, and is dominated by juniper. These sites generally have low water availability due to shallow soils	less than 1	Moderate to High
Total		**100% or 24,836,875 acres**	

**Potential vegetation groups in the ICBEMP dataset were mapped at a 1 km resolution grid. Potential vegetation zones for the west of the Cascade crest were aggregated to be consistent with ICBEMP data and re-sampled to 1 km. Therefore, areas covering less than 1 km, such as small wetlands would not be included in the above acreage.*

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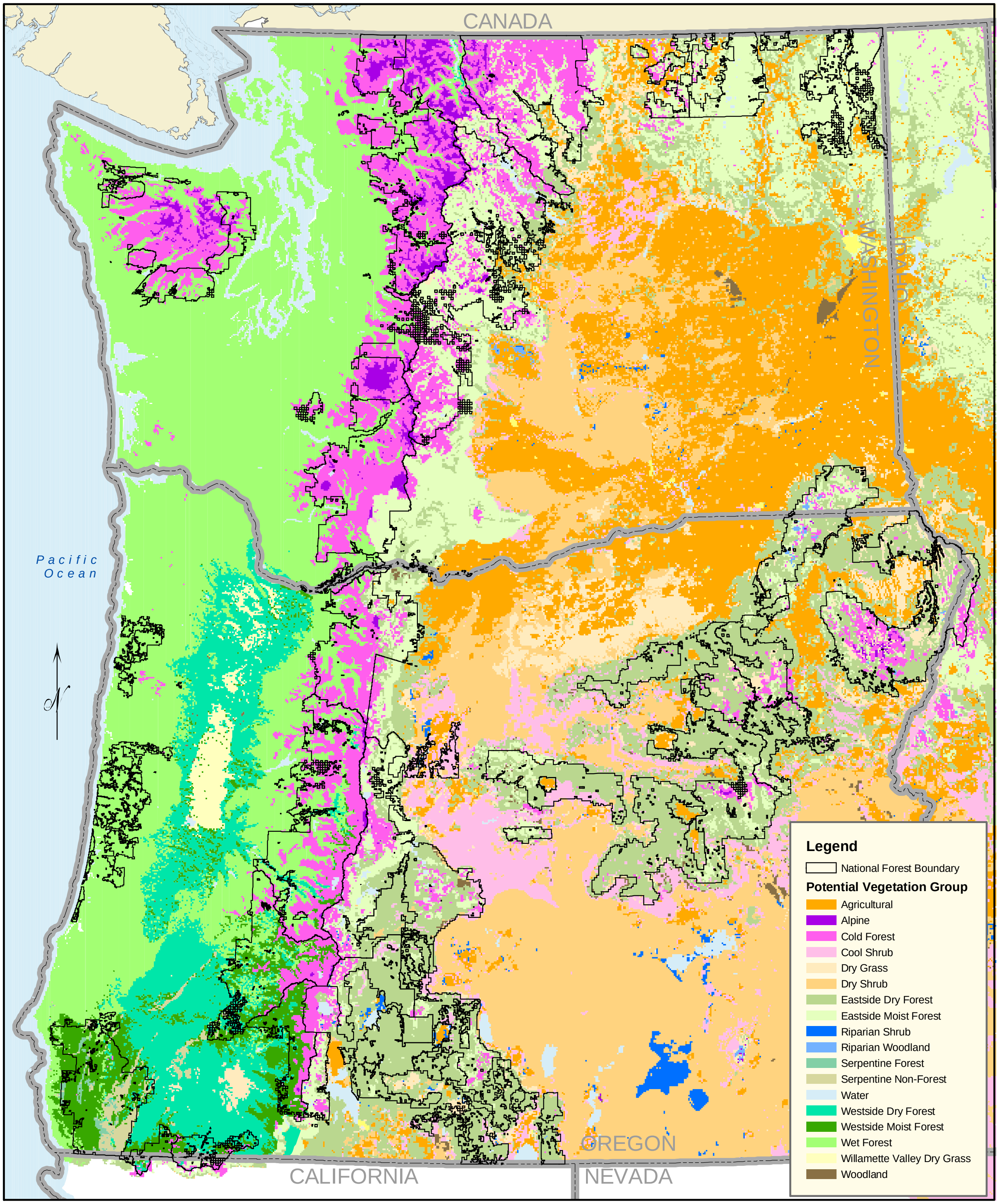
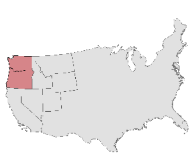
Figure 3-4 Potential Vegetation Groups



Invasive Plants EIS Project
USDA Forest Service
PO Box 3623
Portland, OR 97208



Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

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The impacts of invasive plants on native plants occur at multiple levels, including effects on individuals, genetics, populations, communities and ecosystem processes (Parker et al., 1999). Combinations of impacts at these various levels can result in rapid evolutionary changes in the native species (Sakai et al., 2001; Mooney and Cleland, 2001).

Invasive plants can often impede the germination, growth, and development of native plants. They can reduce the vigor of, or eliminate, individual native plants through competition. Invasive plants often use more than their share of nutrients, thereby limiting opportunities for natives to establish and thrive (Olson, 1999). For some invasive plants, early maturation allows them to deplete soil moisture and nutrients before the native plants have the opportunity to take full advantage of soil moisture and nutrients (Bonnivier, 1999). Invasive plants dominate, in part, by suppressing recruitment of native plant species. This is especially true for slow growers and ones with small seeds, which accounts for most of the native flora in some areas (Panetta and Hopkins, 1991; Blossey, 1999). Suppression can be accomplished in a number of ways. For example, many invasive plants are allelopathic and produce chemicals that inhibit the growth of competing vegetation (Stevens, 1986).

Invasives plants can eliminate native species through hybridization. For example, the North American codgrass, *Spartina alterniflora,* has hybridized with the European *S. maritima* to produce a new polyploid species (*S. anglica*) that is more invasive in Great Britain than the original form (Mack et al., 2000; Randall, 1996; Parker et al., 1999).

All these factors lead to alterations in plant community composition (Mack et al., 2000, Randall 1996; Belcher and Wilson, 1989; Rice et al., 1994; Callihan et al., 1994; Tyser and Key, 1988). Changes in species composition can lead to such impacts as declines in the availability of native plant resources, such as special forest products or species collected by American Indian tribes (ICBEMP, 2000). Many tribes in the Pacific Northwest gather and harvest plants (Prouty, 1994). Ethnographers have catalogued hundreds of plant species used as food, medicine, or for other purposes by native people (Corliss and Keith, no date). Examples of native plants that are harvested for food include biscuitroots (*Lomatium sp.*), camas (*Camassia quamash*), bitterroot (*Lewisia rediviva*), Indian potato (*Claytonia lanceolata*), and huckleberries (*Vaccinium sp.*). Other species such as beargrass (*Xerophyllum tenax*) are gathered for ceremony or basketry.

Invasive species invasions can alter ecosystem processes, slow or alter succession, and deflect or halt the normal dynamics of the community (Hobbs and Mooney, 1993; D'Antonio and Vitousek 1992; Tyser and Key, 1988). Some researchers have suggested that alteration of disturbance regime may be the most profound effect that a species can have on an ecosystem (Mack and D'Antonio, 1998; Bright, 1996). The best regional example of this may be the changes to fire frequency and intensity that result from the invasion of cheatgrass (*Bromus tectorum*). This species has been shown to alter historic fire intensity and to create “flash” fuels that otherwise would not have contributed to large-scale conflagrations.

Biological diversity is an indicator of healthy ecosystems, but not an indicator of resistance to invasive plants. High species diversity does not necessarily ensure less probability of invasion. In fact, diversity hotspots such as the tropics tend to have a higher percentage of exotics. Riparian areas which tend to have higher species diversity than uplands are also more susceptible (Planty-Tabacchi et al., 1996, DeFerrari and Naiman, 1994).

Invasive plants threaten ecological diversity at varying scales by potentially changing the structure and function of native plant communities. Monocultures are being created where a heterogeneous landscape once naturally existed. Ecosystem transformation has been so complete due to invaders that the landscape itself is profoundly altered. For example, wholesale transformation of the landscape in the Florida Everglades has occurred where seasonally flooded marsh has been converted to a fire-prone forest of invasive trees. Transformation of Amazon forests through burning and planting of African grasses has meant the conversion of diverse communities into a more fire-prone system, where these invasive grasses can continue to spread. The reduction in neotropical forests in general means a reduction in plant biomass and a build up of carbon dioxide in the atmosphere (Mack et al, 2000).

The impacts of invasion should not be misinterpreted to mean that protection of native plant communities from non-natives is hopeless. Daehler (2003) reviewed 79 independent native-invasive plant comparisons (i.e. studies that compared the performance of natives versus non-natives under varying environmental conditions). Findings showed invaders were not statistically more likely to have higher growth rates, competitive ability or fecundity. Rather, the relative performance of invaders and co-occurring natives often depended on growing conditions. Such variables as resource availability and altered disturbance regimes associated with human activities often differentially increased the performance of invaders over natives. Such a conclusion affirms the need to reduce practices that are conducive to spread of invasive plants.

3.2.6 Wildlife

Region Six provides diverse habitats, ranging from temperate rain forest to Great Basin desert, for a diverse array of wildlife species, including amphibians and reptiles.[15] The Region is located within the Pacific Flyway, which is a major migratory route for thousands of migratory birds. Many species that do not reside in Oregon and Washington may be found here during migration. Oregon and Washington include Bird Conservation Regions Five (Northern Pacific Forest), Nine (Great Basin), and Ten (Northern Rockies) (U.S. Fish and Wildlife Service, 2002). Within these regions, National Forests may provide significant habitat for 20 or more species listed by the U.S. Fish and Wildlife Service (FWS) as "birds of conservation concern" (U.S. Fish and Wildlife Service, 2002).

Hunting of game species is a popular activity in the Region and the National Forests provide a substantial amount of public land available for this activity. Game species in Region Six include elk (*Cervus elaphus*), black-tailed deer (*Odocoileus hemionus columbianus*), mule deer (*O. hemionus*), and white-tailed deer (*O. virginianus*), bighorn sheep (*Ovis canadensis*), mountain goat (*Oreamnos americanus*), moose (*Alces alces*), black bear (*Ursus americanus*), cougar (*Felis concolor*), waterfowl (including coots and many species of ducks, geese, and swans), wild turkey (*Meleagris gallopavo*), common snipe (*Gallinago gallinago*), and upland game birds (grouse, quail, ring-necked pheasant, chukar, partridge, dove, pigeon). Wild turkey, chukar, pheasant, and gray partridge are not native to the Region.

Some wildlife species utilize invasive plants for food or cover. For example, American goldfinch (*Carduelis tristis*), and red-winged blackbird (*Agelaius phoeniceus*) utilize purple loosestrife (Kiviat, 1996; Thompson, Stuckey, and Thompson, 1987), and non-native chukar (*Alectoris chukar*) and native bighorn sheep will utilize cheatgrass (Csuti et al., 1997). It has been reported that elk, deer and rodents eat rosettes and seed heads of spotted knapweed. Doves, hummingbirds, honeybees, and the endangered southwestern willow flycatcher (*Empidonax trailii extimus*) are known to use saltcedar (Barrows, 1996). However, the few uses that an invasive plant may provide do not outweigh the adverse impacts to an entire ecosystem (Zavaleta, 2000).

Invasive plants have adversely impacted habitat for native wildlife (Washington Dept. of Fish and Wildlife, 2003). Any species of wildlife that depends upon native understory vegetation for

[15] Refer to Marcot et al. (1998), ICBEMP, 2000, and NWFP, 1994 for thorough discussions of the wildlife resources on Forest Service administered lands in the Pacific Northwest.

food, shelter, or breeding, is or can be adversely affected by invasive plants. Species restricted to very specific habitats, for example pond-dwelling amphibians, are more susceptible to adverse effects of invasive plants.

Displacement of native plant communities by non-native plants results in alterations to the structure and function of ecosystems (MacDonald et al., in press), and constitutes a principle mechanism for loss of biodiversity at regional and global scales (Lacey and Olsen, 1991; Risser, 1988 as cited in Johnson et al., 1994). Mills (1989) and Germaine et al. (1998) found that native bird species diversity and density, were positively correlated with the volume of native vegetation, but were negatively correlated or uncorrelated with the volume of exotic vegetation. Invasive plants can adversely affect wildlife species by eliminating required habitat components, including surface water (Brotherson and Field, 1987; Dudley, 2000; Horton, 1977), reducing available forage quantity or quality (Bedunah and Carpenter, 1989; Rice et al., 1997; Trammell and Butler, 1996); reducing preferred cover (Rawinski and Malecki, 1984; Thompson et al., 1987); drastically altering habitat composition due to altered fire cycles (D'Antonio and Vitousek, 1992; Mack, 1981; Randall, 1996; Whisenant, 1990); and physical injury, such as that caused by long spines or "foxtails" (Archer, 2001). In the case of common burdock (*Arctium minus*), the prickly burs can trap bats and hummingbirds and cause direct mortality to individuals (Raloff, 1988; and documented in photos by Clay Grove, USFS, and Rosa Wilson, NPS). Invasive plants that grow large and densely can act as physical barriers to water sources and essential habitat (Bautista, S., *personal observation*).

Invasive plants can act as a population sink by attracting a species and then exposing them to increased mortality or failed reproduction (Chew, 1981). For example, Schmidt and Whelan (1999) reported that native birds increased their use of exotic *Lonicera* and *Rhamnus* shrubs over native trees, even though nests built in the exotic shrubs experienced significantly higher mortality rates.

Some invasive plants (such as knapweed) contain chemical compounds that make the plant unpalatable to grazing animals. Chemical compounds in invasive plants disrupt microbial activity in the rumen, or cause discomfort after being ingested, resulting in a reduced or avoided consumption of the invasive plant (Olson, 1999).

Habitats that become dominated by invasive plants are often not used, or used much less, by native and rare wildlife species. Washington Department of Fish and Wildlife (2003) identified noxious weeds, such as yellow starthistle and knapweed, as threats to upland game bird habitat.

Some hunters and wildlife managers are concerned that invasive plants are degrading the quality of remaining habitat for deer and elk and are adversely affecting the animal's distribution and hunting opportunities. Trammell and Butler (1995) found that deer, elk, and bison avoided sites infested with leafy spurge (*Euphorbia esula*). Tamarisk stands have fewer and less diverse populations of mammals, reptiles, and amphibians (Jakle and Gatz, 1985; Olsen, 1999). Invasion by purple loosestrife makes habitat unsuitable for numerous birds, reptiles and mammals (Kiviat, 1996; Lor, 1999; Rawinski, 1982; Thompson, Stuckey, and Thompson, 1987; Weihe and Neely, 1997; Weiher et al., 1996).

In summary, invasive plants are known or suspected of causing the following effects to wildlife (Table 3-7):

Table 3-7 Known Effects of Invasive Plants to Wildlife
• Embedded seeds in animal body parts (e.g. foxtails), or entrapment (e.g. common burdock) leading to injury or death.
• Scratches leading to infection.
• Alteration of habitat structure leading to premature predation (which alters population demography, and social breeding system).
• Change to effective population through nutritional deficiencies or direct physical mortality.
• Ingestion of plants or plant parts leading to poisoning.
• Altered food web, perhaps due to altered nutrient cycling.
• Source-sink population demography, with more demographic sinks than sources.
• Lack of proper forage quantity or nutritional value at critical life periods.
• Cascading effect of direct or indirect mortality on other species.

3.2.7 Threatened, Endangered and Sensitive Species

The Endangered Species Act of 1973, as amended (ESA), requires federal agencies to insure that their actions do not jeopardize the continued existence of endangered or threatened species, or result in destruction of critical habitat. Region Six provides habitat for many species that are listed as threatened or endangered (hereafter referred to as "listed") by the ESA. Currently, on National Forests with the Region, 23 fish, 9 terrestrial wildlife species, 1 insect, 1 mollusk, and 14 plants are listed (Appendix C).

The Region also maintains a list of sensitive species that are experiencing, or have experienced, significant declines in population[16]. On March 22, 2004, the Under Secretary, Natural Resources and Environment, USDA and the Assistant Secretary, Land and Mineral Management, USDI signed a Record of Decision eliminating the Survey and Manage Species program as a separate management procedure and indicating that plant, animal, and fungi species included in the Survey and Manage program would be evaluated for inclusion on the Regional Forester's Sensitive Species Lists. As a result of the evaluation, 102 former Survey and Manage plant and animal species are now included on the Regional Forester's Sensitive Plant and Animal List, effective July, 2004, which includes 39 fungi, 31 lichens, 10 bryophytes, 21 mollusks, and 1 mammal.

The current Regional Forester's lists of sensitive species are found in Appendix C. Species identified by the FWS as "candidates" for listing under the ESA, and meeting Forest Service criteria for protection, are included on the Regional Forester's Sensitive Species Lists.

[16] Refer also to Marcot et al. (1997), ICBEMP 2000, and NWFP 1994 for discussions of sensitive species on Forest Service administered lands in the Pacific Northwest

Terminology

Threatened Species = species likely to become endangered within the foreseeable future throughout all or a significant portion of its range (16 U.S.C. 1531 et seq.).

Endangered Species = species in danger of extinction throughout all or a significant portion of its range (16 U.S.C. 1531 et seq.).

Sensitive Species = species identified by the Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density; or significant current or predicted downward trends in habitat capability that would reduce a species existing distribution (FSM 2670).

Survey and Manage = mitigation measure adopted as a set of standards and guidelines within the Northwest Forest Plan Record of Decision intended to mitigate impacts of land management efforts on those species closely associated with late- successional or old growth forests whose long-term persistence is a concern.

Federally Listed and Sensitive Plant Species

Throughout the region, there are Threatened, Endangered, and Sensitive (TES) plant species being impacted by invasive plants. Most, but not all of the listed plants, are found in the dry grass or eastside dry forest vegetation group. Both of these vegetation groups are highly susceptible to weed invasions.

Seven federally listed plants have been documented and seven are suspected on the National Forests in Region Six. They are described in Table 3-8. Included in the table are the global/state rarity rankings. These rankings are part of an international system for ranking rare, threatened endangered species throughout the world. The system was developed by the Nature Conservancy and is now maintained by the Association for Biodiversity Information in cooperation with Heritage programs in all 50 states, in 4 Canadian provinces and in 13 Latin American countries (Oregon Natural Heritage Program, 2001). The ranking is a 1-5 scale, primarily based on the number of known occurrences, but also including threats, sensitivity, area occupied, and other biological factors. The ranking definitions are provided at the end of the table.

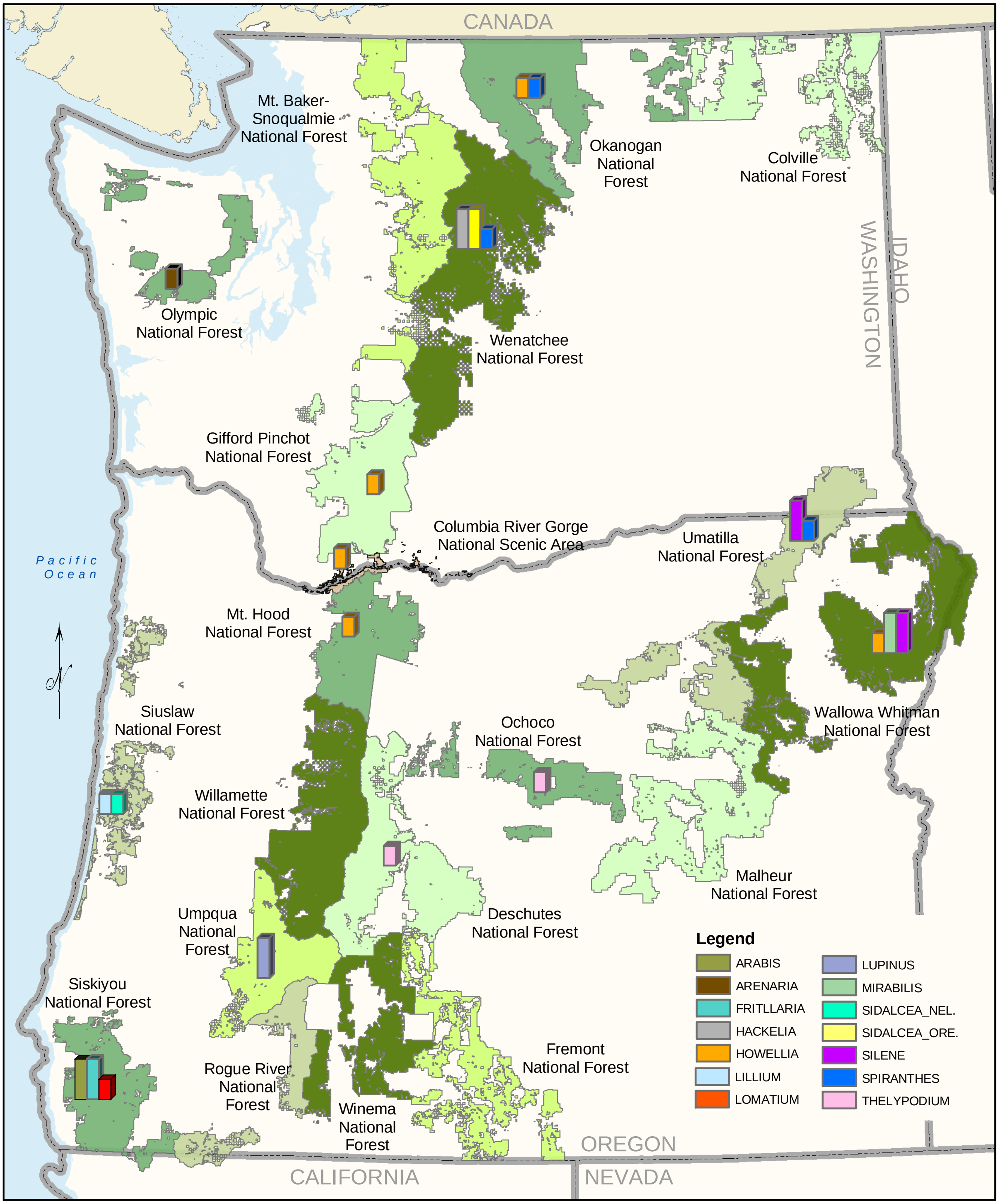
Table 3-8 Federally Listed Plant Species Documented or Suspected in Region Six		
Species Global/State Ranking	**Federal Protection Status**	**Habitat**
Hackelia venusta G1/S1 Washington	Endangered	Dry, loose granitic sand and crevices
Sidalcea oregana var. calva G1/S1 Washington	Endangered - Critical habitat designated	Moist meadows in eastside moist or dry forest
Arabis macdonaldiana G1/S1 Oregon	Endangered	Rocky, serpentine soils, open woods/slopes
Fritillaria gentneri G1/S1 Oregon	Endangered	Edges – oak woodlands or mixed hardwood/conifer
Lupinus sulphureus ssp. kincaidii G2/S1-Washington, S2-Oregon	Threatened	Remnant grasslands, upland prairie, some serpentine, roadsides
Mirabilis macfarlanei G2/S1 Oregon, S2 Idaho	Threatened - Pesticide use limits (EPA)	Low- to mid-elevation canyon grasslands
Silene spauldingii G2/S1-Oregon, S2 -Washington	Threatened	Mesic grass communities, palouse prairie region
Arenaria paludicola G1/SX	Endangered	Freshwater marsh
Howellia aquatilis G2/SH-Washington, SX-Oregon	Threatened	Vernal wetlands
Lilium occidentale G1/S1 Oregon	Endangered	Coastal wetlands
Lomatium cookii G1/S1 Oregon	Endangered	Moist, alluvial floodplains, grasslands
Sidalcea nelsoniana G2/S1 Washington),S2 Oregon	Threatened	Remnant native grasslands
Spiranthes diluvalis G2/S1 Washington	Threatened	Wet meadows
Thelypodium howellii ssp spectabilis G2/S1 Oregon	Threatened	Moist, alkaline meadows

G= Global ranking, S=State ranking, X=presumed extirpated or extinct, H=historical occurrence. Five levels of ranking: (1) Critically imperiled because of extreme rarity or because it is particularly vulnerable to extinction or extirpation; typically 5 or fewer occurrences, (2) Imperiled because of rarity or because it is vulnerable to extinction or extirpation; typically 6 to 20 occurrences, (3) Either very rare and local throughout its range or found locally (even abundantly) in a restricted range; typically 21 to 100 occurrences, (4) Apparently secure; typically 21 to 100 occurrences, (5) Demonstrably widespread, abundant and secure.

Figure 3-5 shows the location of the above listed plant species by forest and by the whether species have been documented or suspected to occur.

Figure 3-5 Federally Listed Plant Species Occurrence

Full bars represent documented occurrence.
Half bars represent suspected occurrence.



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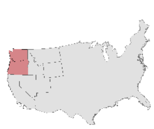

Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

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Over 400 sensitive species (including vascular, non-vascular plant and fungi species) are known in Region Six (Appendix C). The Regional Forester list is developed from a common set of criteria and species occurrence is listed as either documented or suspected for each Forest.

Plants are considered sensitive for numerous reasons. Resource requirements, size of range, habitat availability, and number and location of populations in relation to activities that could damage them are all important factors in determining the sensitivity of a species. Some sensitive plant populations could be stable due to the land allocation they are located in or the lack of ground disturbing activities in their habitats. For instance, serpentine endemics, which have an extremely narrow range, could be considered stable on the Siskiyou National Forest as long as mining activity remains low. Threats could increase to these species if activity increases or other ground disturbing activities occur. Those sensitive species found at high elevations in wilderness areas could be more stable than those found in multiple use lands. Likewise, some species may not be considered stable because of reasons such as reproductive limitations or lack of natural disturbance regimes such as frequent, low intensity fire to maintain their productivity.

Invasive plants have been documented as threats in the final rulings of some of the federally listed plants in this Region. Listed species documented or suspected on Forest Service land (Table 3-8) have varying degrees of susceptibility to infestations. Species associated with wetlands could be threatened by species such as Canada thistle, canary reedgrass or purple loosestrife. Species associated with native prairie or oak woodlands could be threatened by yellow starthistle, knapweeds or non-native grasses. Species associated with eastside dry grass and shrub communities could be threatened by cheatgrass, medusahead rye, rush skeletonweed or perennial pepperweed

Specific examples of documented threats to federally listed species from invasive plants include:

Showy Stickseed (Hackalia venusta) - This endangered species is threatened by spotted and diffuse knapweeds, dalmation toadflax, and kochia. Dalmation toadflax may be the primary problem because it has the ability to expand into relatively undisturbed areas.

Wenatchee Mountains checker-mallow (S*idalcea oregano var.calva*) - The invasive species, sulfur cinquefoil, threatens the endangered Wenatchee Mountains checker-mallow. Sulfur cinquefoil is a long-lived perennial that has become one of the most serious invaders of the Northern Rockies (Sheley and Petroff, 1999). The introduced sulfur cinquefoil is sometimes confused with native northwest cinquefoil (*Potentilla gracilis*) that grows at the same low and mid-elevations. The misidentification of sulfur cinquefoil as a native variety has contributed to the unchecked expansion of this introduced species (Sheley and Petroff, 1999). Within the Wenatchee Mountains checker-mallow populations, sulfur cinquefoil does occur interspersed with other native *Potentilla* species, making it more difficult to control.

MacFarlane's four-o'clock (*Mirabilis macfarlanei*) - Two of the most serious exotic species invading the habitat of this threatened plant are cheatgrass (*Bromus tectorum*) and yellow star thistle (*Centaurea solstitialis*) (USDI FWS, 2000). Continued invasion by weedy alien species has been an ongoing problem for MacFarlane's four-o'clock; as a result, the inhibition of its growth and development has been noted (Baker, 1983 cited in USDI FWS, 1996-Macfarlane's).

Spalding's Catchfly (S*ilene spauldingii*) - Invasion by non-native plants threaten virtually all of the remaining populations of this threatened species. Species that threaten it include yellow starthistle, leafy spurge, Canada thistle, sulfur cinquefoil, Russian knapweed and cheatgrass. Besides competition for water, nutrients and light, competition for pollinators from invasive plants has been documented for this species (Federal Register, 2001). Also noted in the Federal Register was that herbicide applications and/or grazing, both potential invasive plant treatment methods, threaten this species.

In Region Six, any sensitive species found in potential vegetation groups considered highly susceptible to invasion and/or where a high amount of ground disturbing activity takes place would be the most threatened by invasive plants.

An example of documented threats to a sensitive species from invasive plants follows:

Pale Blue Eyed Grass (*Sisyrinchium sarmentosum)* – Pale blue eyed grass is a narrow endemic member of the Iris family. There are very few populations occurring only in Oregon and Washington, and most are too small in numbers to be considered self-sustaining (Raven, 2003). It is documented on the Gifford Pinchot and Mt. Hood National Forests. These forests harbor 15 of the known 19 occurrences for this species. Noxious weeds have been documented as a threat to populations located in the Cave Creek grazing allotment. Canada thistle, tansy ragwort and houndstongue compete for resources both in and outside of grazing exclosures. Preliminary baseline data collected on the frequency of Canada thistle and tansy ragwort showed that 40 percent of quadrats contained Canada thistle and 20 percent contained tansy ragwort. The main impact of these species is competition for space and resources to the detriment of pale blue eyed grass. This is compounded by the fact that cattle will avoid these invasive plants, therefore increasing their establishment and spread.

More information can be found on sensitive species as well as federally listed species in specialist reports in the analysis file.

Federally Listed and Sensitive Wildlife Species

Table 3-9 and Figure 3-6 contain federally listed mammals, birds, and terrestrial invertebrates, their scientific name, and status, included in this document. Per Forest Service regulations, requests for lists of endangered, threatened, and proposed species within the Region were made, and lists were received from the FWS on August 16, 2002 and May 5, 2003. A request for updates to the list was sent to FWS on May 24, 2004; a reply is pending. Some species on the 2003 list received from the FWS do not occur on National Forests in the Region and will not be discussed further. Those species include all marine species, the short-tailed albatross (*Phoebastria albatrus*), Fender's blue butterfly (*Icaricia icarioides fenderi*), and Columbian white-tailed deer (*Odocoileus virginianus leucurus*). The host plant for the Fender's blue butterfly, Kincaid's lupine (which is listed as threatened), does exist on the Umpqua NF. Effects to the habitat for Fender's blue butterfly are discussed in the sections on listed plants.

Table 3-9 Federally Listed Mammals, Birds, and Invertebrates in Region Six

Common Name	Scientific Name	Status
Mammals		
Grizzly bear	*Ursus arctos horribilis*	Threatened
Gray wolf	*Canis lupus*	Endangered
Canada lynx	*Lynx Canadensis*	Threatened
Woodland caribou	*Rangifer tarandus caribou*	Endangered
Birds		
American brown pelican	*Pelecanus occidentalis*	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened
Marbled murrelet	*Brachyramphus marmoratus*	Threatened
Western snowy plover (coastal)	*Charadrius alexandrinus nivosus*	Threatened
Invertebrates		
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	Threatened

Critical habitat is designated for the northern spotted owl, marbled murrelet, western snowy plover, and Oregon silverspot butterfly. Candidates currently included on the Sensitive Animal List are yellow-billed cuckoo, Oregon spotted frog, Pacific fisher, Columbia spotted frog (Great Basin Distinct Population Segment (DPS)), western (Mazama) pocket gopher, and western sage grouse (Columbia Basin DPS). The Mardon skipper butterfly was recently designated as candidates for federal listing, but is currently not on the sensitive animal list. Life history descriptions for federally listed and sensitive animals are found in the project file.

Introduced species have adversely affected more than 50 percent of the species included on the Federal List of Threatened and Endangered Species (Flather et al., 1994), and are recognized as the second biggest threat to listed species worldwide (Wilcove et al., 1998).

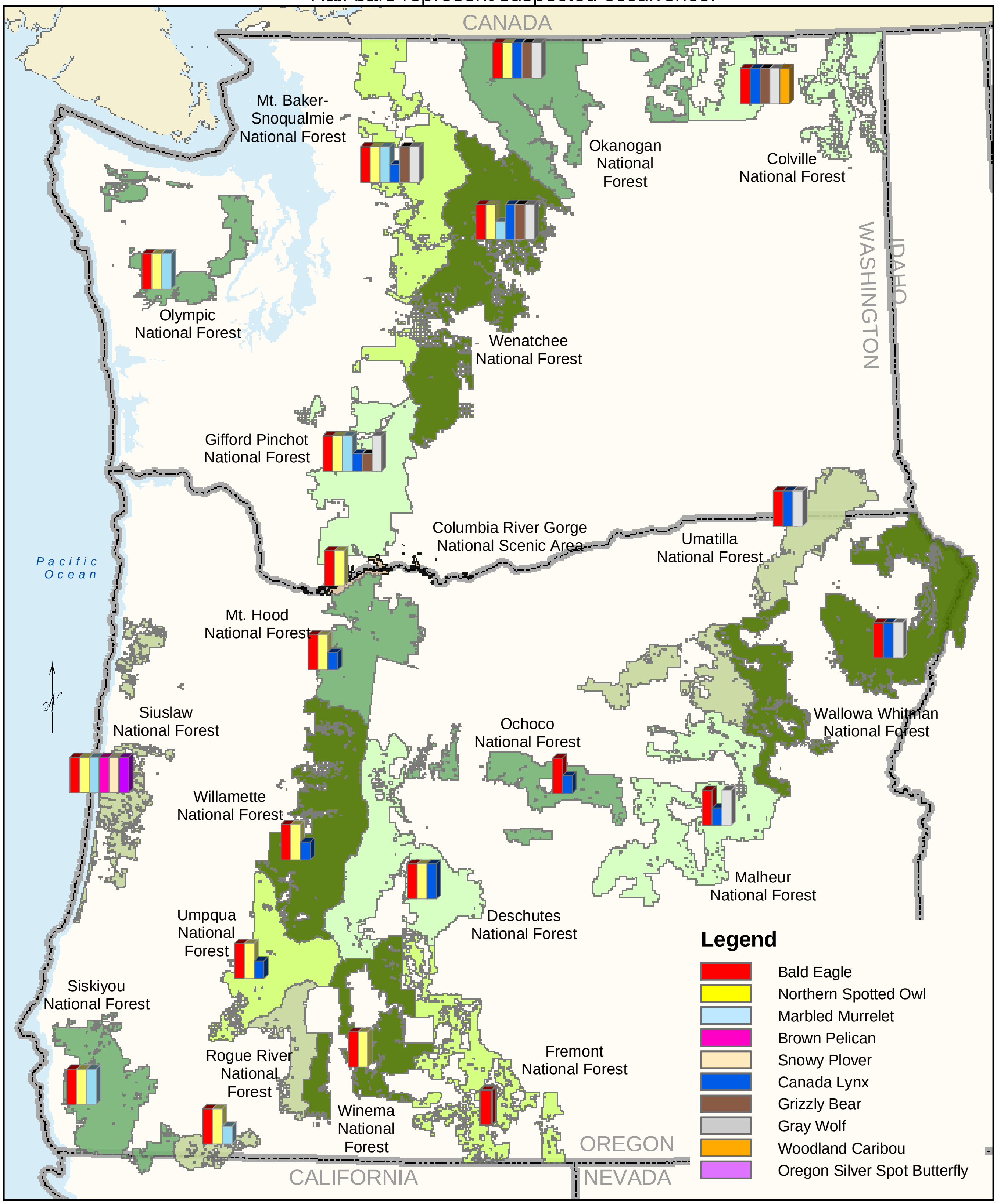
Specific information on the effects of invasive plants to a specific listed species is often unavailable. Research has been limited by the relative scarcity of endangered and threatened wildlife, and the attention to more immediate demographic threats. Some studies have documented effects or potential effects to listed species or their habitat. Endangered, threatened, and rare birds completely avoided invasive *Phragmites* while utilizing neighboring short grass wetlands (Benoit, 1997).

Within Region Six, invasive plants are adversely affecting several animals that are federally listed, candidates for listing, or Forest Service sensitive. Invasive reed canarygrass has been implicated in local extirpations of Oregon spotted frog, a candidate for federal listing (Hayes, 1996). Invasive cheatgrass adversely affects habitat for western sage grouse and sharp-tailed grouse.

Orange and meadow hawkweeds have displaced the grass and bulbs used by grizzly bears in the spring, and the invasive plants are approaching a significant impact to grizzly bear habitat in some areas (Layser, personal communication).

Figure 3-6 Federally Listed Terrestrial WildlifeSpecies Occurrence

Full bars represent documented occurrence.
Half bars represent suspected occurrence.



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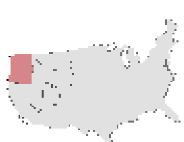

Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

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On the Colville National Forest, hawkweeds and knapweeds are infesting and expanding in some forest openings that provide summer forage for snowshoe hare, a primary prey for Canada lynx (Borgsewicz, personal communication.). The quantity and quality of elk forage has been reduced by many species of invasive plants, which may affect future use by gray wolves. Hawkweeds and knapweeds are also invading spring and summer foraging habitat for woodland caribou (Borgsewicz, personal communication). Elk are a primary prey for gray wolves, and invasive plants have contributed to changes in elk distribution and densities (Bedunah and Carpenter, 1989; Rice et al., 1997; Trammell and Butler, 1995).

The FWS identified encroachment of European beachgrass (*Ammophila arenaria*) on sand dunes used by western snowy plover for nesting as an important threat to this species (U.S. Fish and Wildlife Service, 2001). This beachgrass prevents regeneration of open expanses of sand, decreases the width of the beach, increases beach slope, and provides habitat for predators of snowy plovers, reducing nesting habitat and increasing mortality (USDI FWS, 2001).

The larval food plant for the Oregon silver spot butterfly is threatened by competition from invasive and native plants on the Siuslaw National Forest (Frounfelker, personal communication; USDI FWS, 2001).

Invasive plants are not affecting the following listed species or their habitat: brown pelican, bald eagle, northern spotted owl, and marbled murrelet.

Invasive plants are adversely affecting, or have the potential to adversely affect, most species on the Regional Forester's Sensitive Animal List. In particular, pygmy rabbit, greater sage grouse, sharp-tailed grouse, Columbian sharp-tailed grouse, most passerine type birds, frogs, turtles, and some salamanders are vulnerable to habitat changes created by invasive plants. Invasive plants have also adversely modified habitat for, and threaten the larval and adult food plants of, the Mardon skipper.

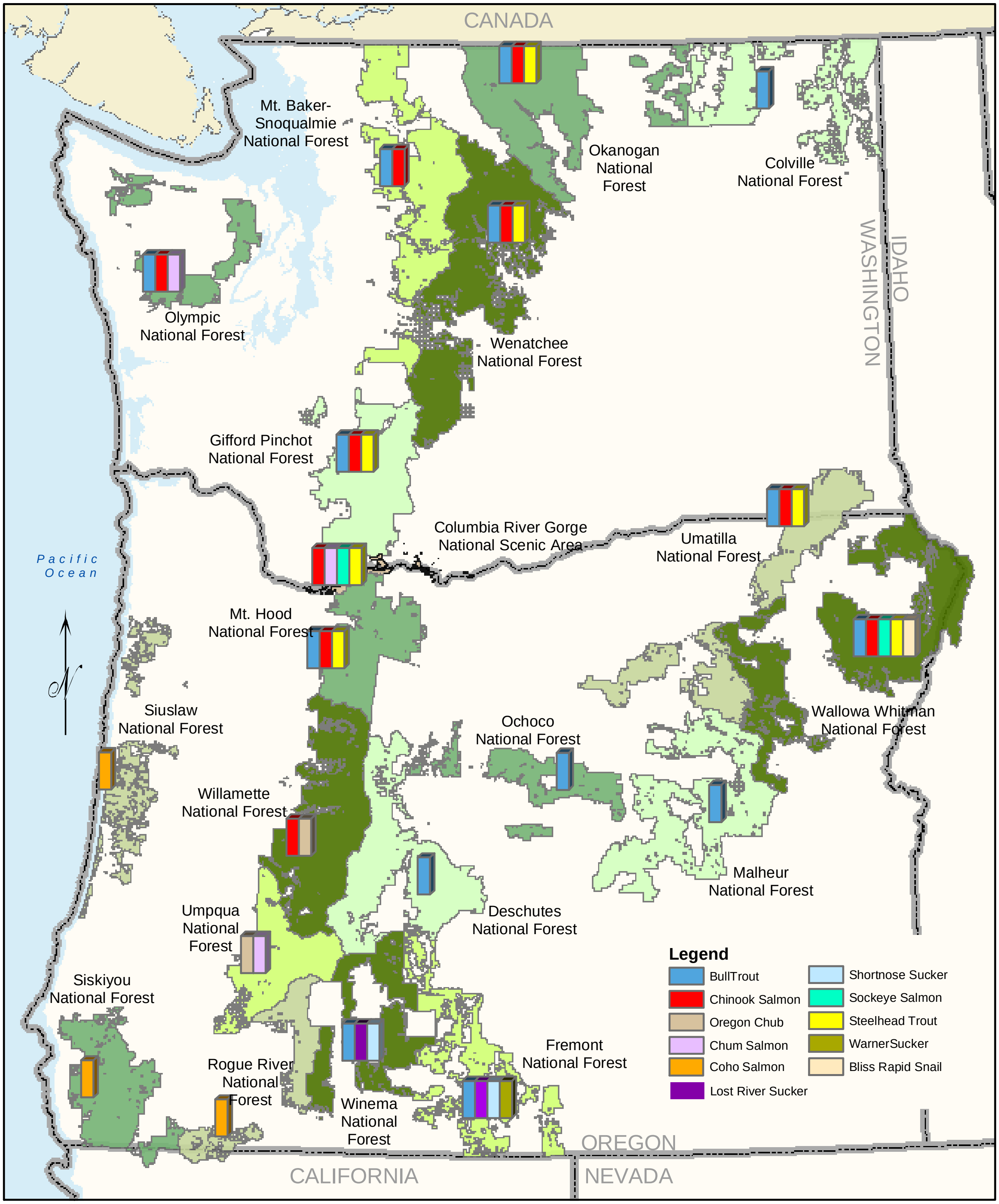
Federally Listed and Sensitive Aquatic Species

Fish species with complex life histories (such as Pacific salmonids) are often listed under the ESA by Evolutionarily Significant Unit (ESU). Evolutionarily Significant Units are reproductively isolated populations of the same species of fish (NOAA, 2000). There are six endangered fish ESUs in Region Six. Sixteen fish ESUs and one mollusk species are threatened within the Region. See Table 3-10 and Figure 3-7. Twenty-seven fish species are listed on the Regional Forester's sensitive species list. The habitat and life history requirements for all of the species in Table 3-10 are located in the project file. No endangered, threatened, or sensitive aquatic plant species are found in Region Six. Amphibian species are discussed in the wildlife section.

Table 3-10 Endangered and Threatened Fish and Mollusks

Common Name	Scientific Name (Genus and species)	Status
Snake River Sockeye Salmon - Migratory Habitat Only	Oncorhynchus nerka	Endangered
Upper Columbia River Spring Chinook	Oncorhynchus tshawytscha	Endangered
Upper Columbia River Steelhead	Oncorhynchus mykiss	Endangered
Lost River Sucker	Deltistes luxatus	Endangered
Shortnose Sucker	Chastistes brevirostris	Endangered
Oregon Chub	Oregonichythys crameri	Endangered
Southern Oregon/Northern California Coast Coho Salmon	Oncorhynchus kisutch	Threatened
Oregon Coast Coho	Oncorhynchus kisutch	Threatened
Snake River Spring/Summer Chinook	Oncorhynchus tshawytscha	Threatened
Snake River Fall Chinook	Oncorhynchus tshawytscha	Threatened
Puget Sound Chinook Salmon	Oncorhynchus tshawytscha	Threatened
Upper Willamette River Chinook	Oncorhynchus tshawytscha	Threatened
Lower Columbia River Chinook	Oncorhynchus tshawytscha	Threatened
Snake River Steelhead	Oncorhynchus mykiss	Threatened
Lower Columbia River Steelhead	Oncorhynchus mykiss	Threatened
Mid Columbia River Steelhead	Oncorhynchus mykiss	Threatened
Warner Sucker	Catostomos warnerensis	Threatened
Hood Canal Chum Salmon	Oncorhynchus keta	Threatened
Columbia River Chum Salmon	Oncorhynchus keta	Threatened
Klamath River Bull Trout	Salvelinus confluentus	Threatened
Columbia River Bull Trout	Salvelinus confluentus	Threatened
Coastal/Puget Sound Bull Trout	Salvelinus confluentus	Threatened
Bliss Rapids Snail	Taylorconcha serpenticola	Threatened

Figure 3-7 Federally Listed Aquatic Species Occurrence



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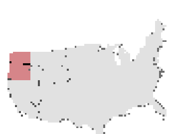

0 20 40 80 120 Miles

0 30 60 120 180 Kilometers

Albers Equal Area Projection centered on 120 degrees 30 minutes west
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Both "critical habitat" and species have protection under the ESA. Critical Habitat is designed as:

> *The specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features (constituent elements) that are essential to the conservation of the species and which may require special management considerations or protection; and*
>
> *Specific areas outside the geographical area occupied by the species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species [ESA 3 (5)(A)].*

Critical habitat has been designated for the Lost River sucker, shortnose sucker and Warner sucker and is proposed for the Klamath and Columbia River bull trout.

As demonstrated in the discussion of the Japanese knotweed example in the "Aquatics" section, invasive plants can contribute to reducing habitat quality and complexity for threatened, endangered, and sensitive fish.

Reduction of trees along streams reduces recruitment of large woody debris into streams and reduces the size, quality, and quantity of pool habitat. Loss of shade and stream structure provided by native trees can adversely affect stream temperatures and can decrease available rearing habitat for endangered, threatened, or sensitive juvenile salmon and steelhead.

Increases in fine sediments can adversely affect endangered, threatened, or sensitive salmonids via reduced egg survival and fry emergence. Reductions in pool volume and frequency are also pathways through which sediment introduction can adversely affect endangered, threatened, or sensitive fish species.

Grout et al. (1997) indicated that endangered salmon in the Region might be negatively affected by purple loosestrife because the plant could disrupt the detritus-based food web upon which the salmon depend by changing the amount and timing of nitrogen input.

Several other pathways through which invasive plants could affect endangered, threatened, or sensitive fish species are possible, but have not been demonstrated. For example, allelopathic compounds produced by invasive plants may be delivered to aquatic systems, and have adverse affects on resident aquatic plants and animals. Little is known concerning the chemistry of invasive plant decomposition, or subsequent effects on aquatic systems. Terrestrial insects and leaves falling into streams are fundamental to the aquatic food web. Invasive plant infestations may cause shifts in terrestrial insect species present, altering the aquatic food web. It is not known if invasive plants affect the Bliss Rapids snail, or its habitat.

3.2.8 Social and Economic

The social component of an ecosystem is comprised of a host of complex social and economic elements. These elements are interrelated, interdependent, and ultimately inseparable from the elements that comprise the biophysical environment. As Force and Machlis state, “People are an integral part of ecosystems, similar to other fauna, water, soil, flora, and so forth. Thus, indicators of human socioeconomic conditions are as necessary for ecosystem management as indicators of water quality, wildlife populations, and plant communities” (1997). Changes in National Forest management may affect individuals and/or the families, groups, and communities to which they belong.

More lengthy explorations of social considerations for a related project area can be found in the *Interior Columbia Basin Supplemental Draft Environmental Impact Statement* (ICBEMP, 2000) and *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basin* (Quigley and Arbelbide, 1997). Other key social elements including economics and recreation are explored elsewhere in this EIS.

In decision making for both short and long term futures, natural resource managers must simultaneously consider local concerns and national environmental and economic issues (Force and Machlis, 1997). Of the four critical scales for ecosystem management noted by Force et al (communities, counties, states, and regions), the “affected community” of this EIS refers to the multi-state region of impact. As direction in this EIS is implemented, more focused definitions of “affected community” will need to be explored at the site-specific levels, such as forest, watershed, county, city, community, group, etc. levels.

This section briefly describes some population attributes for Oregon and Washington, as these populations are those most likely to be directly impacted by the management actions outlined in this document. Other populations (states, national, international) and individuals outside of these states are also likely to experience impacts or effects resulting from these actions, yet those populations are beyond the reasonable scope of this demographic briefing. Also, small portions of two national forests covered in this EIS extend into California or Idaho. It should be noted that those most directly impacted would likely be those who live in close proximity to the National Forests and those who depend on or visit the forests most often. Data for this section came from Census 2000 results (U.S. Census Bureau, 2003; Censusscope, 2003) unless otherwise noted.

Of Oregon's 61.4 million total acres, about 60 percent (37 million) are under federal and state ownership; of which the Forest Service manages about 15.6 million acres. Of Washington's 42.6 million total acres, about 42 percent (17.8 million acres) are under federal and state ownership; of which the Forest Service manages about 9.3 million acres.

The Pacific Northwest tends to have a dual east/west identity shaped by the Cascade mountain range that bisects the region. Generally the region has a wet-side (west) and a dry-side (east). The eastern portion of the region contains more rural and dispersed human settlement, while the westside is more urban, containing the regions most dense population centers: the Seattle and Portland metropolitan areas. Eighty-eight percent of the population lives on the 24 percent of land that comprises the "west side" of Oregon and Washington.

In 2000 the two-state region had a total population of about 9,315,520 people, with 3,421,399 and 5,894,121 people in Oregon and Washington respectively.

Between 1990 and 2000 the population grew by 20.4 percent in Oregon and 21.1 percent in Washington. Relatively, the United States population grew by 13.2 percent overall during that time period. Washington and Oregon ranked number 10 and 11, respectively, for growth rates in the United States during that decade. Growth in the western United States is projected to continue to grow at even faster rates in the next 25 years (Burchfield et al. date unknown).

Oregon had an overall population density of 35.6 people per square mile in 2000. Washington had an overall population density of 88.6 people per square mile that year. A broad spectrum of population densities is represented throughout the two-state region, with the lowest county population density at 0.8 people per square mile in Harney County, Oregon and the highest county population density at 1,517.6 people per square mile in Multnomah County Oregon.

Both states are predominantly white, followed by Hispanics, American Indians, and Asians. The number of Hispanics, as percent of population, nearly doubled in both states between 1990 and 2000. In 2000 Hispanics represented 8.05 percent of Oregon population and 7.49 percent of the Washington population. Oregon and Washington had unemployment rates of 6.8 percent and 6.1

percent respectively as of May 2004; both higher than the national rate of 5.6 percent (U.S. Department of Labor, Bureau of Labor Statistics, 2004).

Just as the biophysical impacts of invasive plants do not end at the forest boundary, the socioeconomic effects of invasives also extend far beyond federal lands. For instance, public lands can act as a seed bank for invasive plants that can, through a variety of mechanisms, make their way onto other public and non-public lands (and vise versa), sometimes resulting in significant socioeconomic impacts.

Invasive plants have particularly significant impact on the agricultural sector. Invasive plants (and seeds) in harvested crops can result in direct monetary loss to farmers due to reduced crop values, increased spoilage rates, and prohibition of national and international trade of infested farm products. Invasive plants and other weeds can add significant expense to hand and mechanical harvesting of crops by making harvesting more difficult and adding unnecessary wear on machinery. Valuable irrigation water can be lost as invasive plants consume water intended for crops, cause water loss by seepage, and as plant mater slows water flow increasing evaporation. Invasive plants and other weeds can also reduce land values (both public and private) as a related loss of productive potential is recognized in appraisal (Westbrooks, 1998). In the U.S. agricultural sector alone, invasive plants cause an estimated $20 billion in loss of productivity annually (Oregon Department of Agriculture, 2000). One preliminary analysis of economic impact of noxious weeds in Oregon estimated that Oregonians experience forgone income of $67 million annually from just 12 species of plants (Oregon Department of Agriculture, 2000). Farmers spend billions of dollars each year on herbicides to protect crops from invasive plants and other weeds (Westbrooks, 1998). Additionally, millions of dollars are lost each year in the unnecessary transport of invasives and other weeds in crop shipments and in additional costs to clean the product of unwanted plant material.

Some direct socioeconomic impacts of invasive plants on National Forest lands include increased risk of wildfires and suppression costs and reduced productivity of forest nurseries and tree plantations.

Invasive plants can also interfere with recreational opportunities, an increasingly demanded product of public lands. Since these lands are usually managed by public agencies, costs can be passed on to society in the form of higher taxes or fees or through access limitation. Invasive plants can have a negative effect on observation-based tourism, as the wildlife and wildflowers that people come to enjoy and photograph are crowded out by invasive plants (Westbrooks, 1998). Similar negative impacts to hunting and fishing revenues can be expected as invasive plants displace wildlife or impede access to wildlife and fish related recreation.

Tribes and Treaty Rights

Within Region Six, 26 Indian tribes have treaty reserved or Executive Order rights outside the bounds of their respective Indian reservations (see Table 3-11). These rights include: fishing, hunting, gathering, grazing livestock, and trapping. The areas of interest to Indian tribes with off-reservation rights are the lands ceded to the U.S., often called "ceded lands." Additionally, there are 13 Indian tribes without off-reservation reserved rights who continue to gather natural resources for traditional or cultural purposes. The land area includes most of the National Forests in Washington and Oregon.

Invasive plants may interfere with treaty rights granted to Native American Tribes of the Pacific Northwest. Invasive plant can crowd out plants traditionally gathered for food, dress, or ceremonial purposes and can influence wildlife and fish behavior. Scoping comments for this EIS expressed that at least one tribe feels that invasive plants may be negatively impacting their ability to fully exercise their treaty rights. Additionally, invasive plants may have negative impacts on other groups or individuals that hunt or gather non-timber forest products and forest users seeking floral communities that are within the historic range of variability.

Table 3-11 Tribes and Treaty Rights

Tribes with Off-Reservation Rights	Tribes without Off Reservation Rights
1. **Hoh** Indian Tribe	25. Confederated Tribes of the **Warm Springs** Reservation of Oregon
2. Confederated Tribes of the **Colville** Reservation	26. Confederated Tribes and Bands of the **Yakama** Nation
3. **Jamestown** S'Klallam Tribe of Indians	27. Burns **Paiute**
4. The Klamath Tribes	28. Tribe Confederated Tribes of the **Chehalis** Reservation
5. **Lower Elwha** Tribal Community	29. Confederated Tribes of **the Coos, Lower Umpqua and Siuslaw** Indians of Oregon
6. **Lummi Tribe** of the Lummi Reservation, Washington	30. **Coquille** Indian Tribes
7. **Makah** Indian Tribe of the Makah Indian Reservation	31. **Cow Creek** Band of Umpqua Tribe of Indians
8. **Muckleshoot** Indian Tribe	32. **Cowlitz** Indian Tribe
9. **Nez Perce** Tribe (reservation in Idaho)	33. Confederated Tribes of the **Grand Ronde** Community of Oregon
10. **Nisqually** Indian Community	34. **Kalispel** Indian Community of the Kalispel Reservation
11. **Nooksack** Indian Tribe	35. **Samish** Indian Tribe
12. **Port Gamble** Band of S'Klallam Indians	36. **Shoalwater Bay** Indian Tribe of the Shoalwater Bay Indian Reservation
13. **Puyallup** Tribe of the Puyallup Reservation of the State of Washington	37. Confederated Tribes of **Siletz** Indians of Oregon
14. **Quileute** Tribe of the Quileute Reservation	38. **Snoqualmie** Tribal Organization
15. **Quinault** Indian Nation	39. The **Spokane** Tribe
16. **Sauk-Suiattle** Indian Tribe	
17. **Skokomish** Indian Tribe	
18. **Squaxin** Island Tribe	
19. **Stillaguamish** Tribe of Indians	
20. **Suquamish** Tribe of the Port Madison Reservation, Washington	
21. **Swinomish** Indian Tribal Community	
22. The Tulalip Tribes	
23. Confederated Tribes of the **Umatilla** Indian Reservation	
24. **Upper Skagit** Indian Tribe	

3.2.9 Congressionally Designated Areas

Congress has designated several areas unique for their special characteristics and the opportunities they offer. There are eighty-one congressionally designated areas (CDA) in Region Six. These include fifty-nine Wilderness Areas (4.6 million total acres), thirty-nine Wild and Scenic River corridors, and thirteen other areas including, National Recreation Areas, National Volcanic Monuments, National Scenic Areas, National Scenic and Research Areas, Special Management Areas, a Watershed Management Area, and a National Scenic Highway. CDAs provide unique values and experience opportunities, and they are managed under a suite of similarly unique laws and management policies. Figure 3-8 shows CDAs in Region Six.

Although human-caused ground disturbing activities (such as those associated with motorized or mechanized vehicles) may be limited within some CDA boundaries, these areas are still at risk of invasive plant infestation. This risk is amplified in that the unique natural features and social values for which the CDA was originally designated, may be adversely affected by invasive plants, and that protection of these unique features and values is among the statutory responsibilities of CDA management.

CDA land allocations do not change among the alternatives. This EIS does not alter statutory direction provided by congress and does not alter Forest Service regulations and policy for CDA. Management of CDAs will continue to follow applicable existing plans, except as those plans are specifically amended by this EIS.

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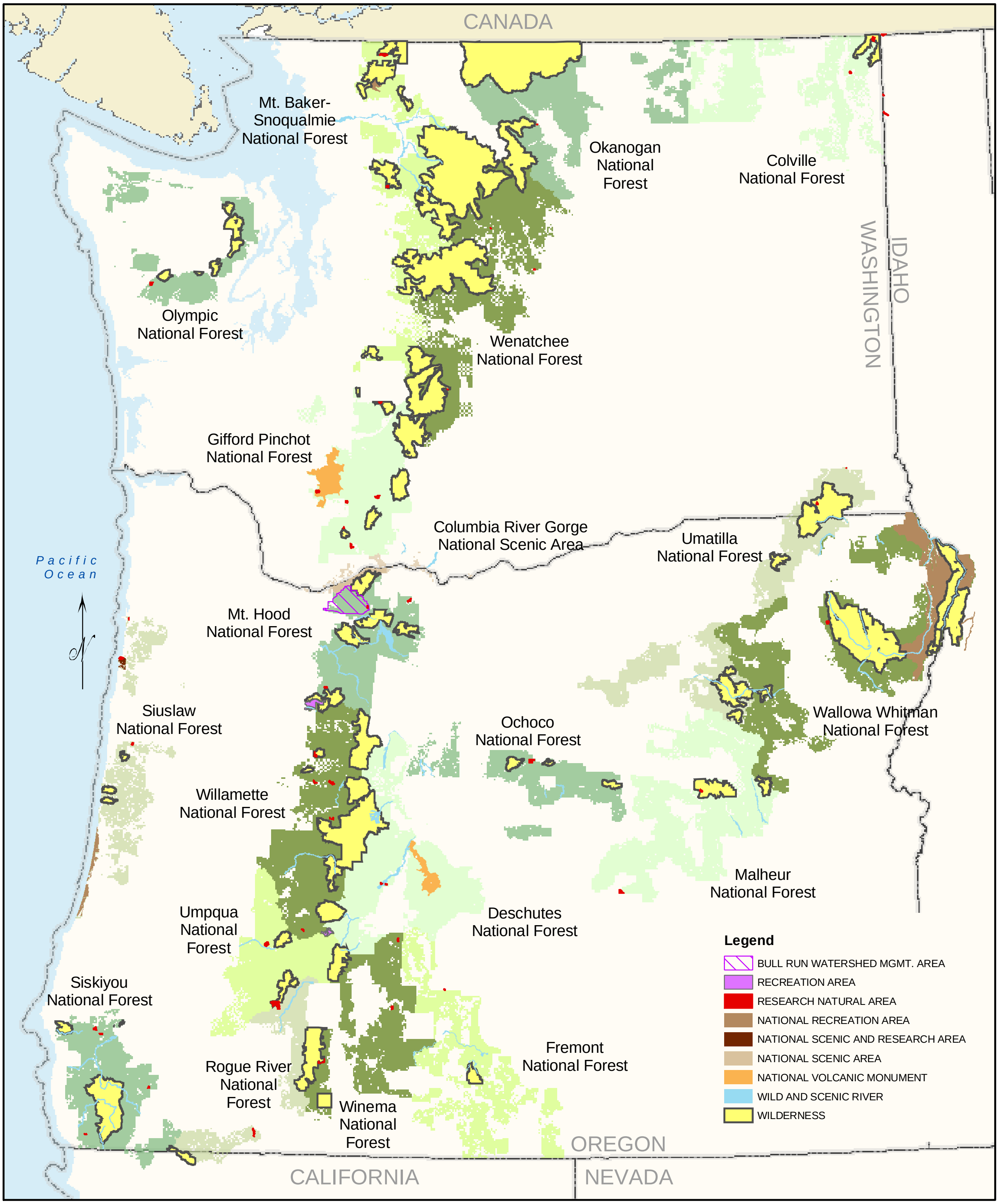
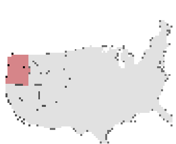
Figure 3-8 Congressionally Designated Areas



Invasive Plants EIS Project
USDA Forest Service
PO Box 3623
Portland, OR 97208



0 20 40 80 120 Miles

0 30 60 120 180 Kilometers

Albers Equal Area Projection centered on 120 degrees 30 minutes west
Standard parallels: 43 degrees 10 minutes north and 50 minutes north.

No warranty is made by the US Forest Service as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This product was developed through digital means and may be updated without notification.

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3.3 Invasive Plant Management

Invasive plant management should be based on ecological principles. Simply focusing on killing infestations, without considering the cause of invasion or successional processes occurring may not lead towards a desired plant community. Plant communities are dynamic; using methods that enhance natural processes and regulate vegetation change are the most likely to succeed. Moving an undesirable plant community towards a desired state takes a repeated, sequential process of:

- designing a disruption to the undesired successional pathway,
- controlling invasive species performance, and
- controlling invasive colonization (Sheley et al., 1996).

This means an effective strategy should include: (1) prevention of the conditions that favor invasive plants and encouragement of conditions that resist them (controlling invasive colonization), (2) treatments that not only control the invasive species (controlling invasive species performance), but also purposefully manage for desired vegetation (designing a disruption to the undesired successional pathway).

The following describes how prevention, treatment and restoration techniques work to deter the introduction, establishment and spread of invasive plants.

3.3.1 Prevention

Prevention means limiting, managing or sometimes eliminating activities on National Forests so that invasive plants do not become established within un-infested areas, and the potential for reproduction and spread of existing invasive plants is reduced. In addition to implementing specific standards to prevent initial introduction, prevention involves developing management goals to prevent the spread of existing infestations to new sites (Mullin et al., 2000).

The primary goal of prevention is to keep un-infested land from becoming infested (Asher, 1998). Executive Order 11312 and Forest Service direction (FSM 2080.2) emphasize the priority of prevention in managing invasive plants. The recently released National Strategy and Implementation Plan for Invasive Species Management (USDA FS, 2004) also emphasizes the importance of prevention.

One way to keep uninfested land from becoming infested is by altering the scale and scope of land management and use activities, that promote invasive plant establishment, especially in the most susceptible habitats. Another way is to implement proactive prevention practices such as washing of equipment and off highway vehicles, restricting livestock feed to weed-free feed only, and eliminating invasive plant seed from gravel and rock before use on roads.

3.3.2 Treatment and Restoration

Treatment methods emphasized in this EIS include manual, mechanical, biological, cultural, prescribed fire, and herbicides. In many cases, these methods are most effective when used in combination with one another, as well as in combination with prevention activities. The location and size of the infestation, environmental factors, management objectives, and treatment costs all factor into the choice of treatment method(s); the wider the range of available methods, the more effective the alternative in treating invasive plants.

Prioritization of infestation treatments should be based on the following decision pathway. Highest priority treatments should be focused on new invaders and early treatment of new infestations, followed in priority by containment, then control of larger established infestations. Moody and Mack (1988) demonstrated in a simple geometric model that small, new outbreaks of invasive plants eventually would occupy an area larger than the spread of the main population. Control efforts that focus on the large, main population rather than the new small satellites reduced the chances of overall success. The ability to detect and destroy the new, small infestation was crucial to control of invasive species and should be combined with efforts to control established populations.

One model being used is to apply the fundamentals of wildfire management to invasive plant control. Thinking of weeds as a slow-moving wildfire can provide a valuable perspective and generate useful ideas when developing and implementing invasive plant strategies (Dewey, 2003). Prevention, early detection, rapid response, contain/control, and site restoration are terminologies that are interchangeable in wildfire management and invasive plant control. Focusing on spot fires (or new infestations), containing the size around the perimeter and mopping up (or returning to ensure all controlled sites are eradicated) may be a means to help focus planning efforts.

Infestations need to be assessed when developing a treatment strategy as to whether they can be eradicated, controlled, contained, suppressed or tolerated. These terms are defined below.

Terminology

The following terms may be found in the text when discussing treatment methods. They may be used as targets or objectives for developing site specific treatment strategies. Definitions are taken from the Lolo National Forest Noxious Weed Management FEIS ROD (USDA, 1991) and the Frank Church-River of No Return Wilderness Noxious Weed Treatments FEIS (USDA, 1999). Some expansion of these definitions for this document is included.

Eradication: Attempt to totally eliminate an invasive plant species from a Forest Service unit, recognizing that this may not actually be achieved in the short term since re-establishment/re-invasion may take place initially.

Control: Reduce the infestation over time; some level of infestation may be acceptable.

Contain: Prevent the spread of the weed beyond the perimeter of patches or infestation areas mapped from current inventories.

Suppress: Prevent seed production throughout the target patch and reduce the area coverage. Prevent the invasive species from dominating the vegetation of the area; low levels may be acceptable.

Tolerate: Accept the continued presence of established infestations and the probable spread to ecological limits for certain species. Try to exclude new infestations through prevention practices. This is for species where other levels of effort have not been successful.

Manual and Mechanical

Manual and mechanical treatments physically remove and destroy, disrupt the growth of, or interfere with the reproduction of invasive plants. These treatments can be accomplished by hand, hand tool (manual), or power tools (mechanical); and include pulling, grubbing, digging, hoeing, tilling, cutting, mowing, and mulching of the target plants.

Manual methods can be effective on small infestations if the entire root is removed. With new, small infestations, hand pulling can be the easiest and quickest method. Even larger populations, though, can be controlled with hand pulling if the workforce is available. The Bradley Method is one sensible approach to manual control of invasive plants (Fuller and Barbe, 1985). This method consists of hand weeding selected small areas of infestation in a specific sequence, starting with the best stands of native vegetation (those with the least extent of infestation) and working towards stands with the worst infestation.

Manual methods are usually not as effective for deep-rooted or rhizomatous[17] perennials such as leafy spurge where hand-pulling and hoeing often leave root fragments that can generate new plants. Hand-pulling or hoeing also disturbs the soil surface, which may increase susceptibility of a site to reinvasion by weeds (Brown et al., 2001; Duncan et al., 2001). Manual methods are labor-intensive and usually ineffective for the treatment of large, well-established infestations of perennial invasive plants with long term viable seed such as knapweeds (Brown et al., 2001). Hand-pulling trials conducted on spotted knapweed in western Montana and on diffuse knapweed in west-central Colorado were 35 percent and 0 percent effective, respectively. The treatments were completed twice per year for two consecutive years, were found to significantly increase bare ground, and were expensive (Duncan et al., 2001).

Test plots established on Blue Mountain (Lolo National Forest) and the Lee Metcalf National Wildlife Refuge near Stevensville, Montana, measured effects of hand-pulling on spotted knapweed. Spotted knapweed covered 76 percent and 53 percent of the two sites, respectively. Hand-pulling provided 100 percent flower control and 56 percent plant control at Blue Mountain, but resulted in an increase in bare ground from 2.7 percent to 13.7 percent during the first year after treatment (Brown et al., 2001). Local efforts where larger community support or funding for hand crews exists do show promise, if efforts can be sustained (Henry 2004).

Mowing or cutting is more effective on tap-rooted perennials such as spotted knapweed compared to rhizomatous perennials (Brown et al., 2001). Cutting or mowing plants can reduce seed production if conducted at the right growth stage. For example, a single mowing at late bud growth stage can reduce the number of seeds produced on spotted knapweed (Watson and Renny, 1974). Mowing can also weaken an invasive plant’s competitive advantage by depleting root carbohydrate reserves, but mowing must be conducted several times a year for consecutive years to reduce the competitive ability of the plant.

Oregon Department of Agriculture staff compared mowing and pulling mature plants to no treatment in two western Oregon spotted knapweed infestations. They applied one treatment annually at the optimum time for each of four consecutive years, and concluded that neither method was effective in reducing population density or cover. They recommend consideration of pulling and mowing only, where the goal is to contain spotted knapweed infestations or to suppress seed production (Isaacson et al., 1997).

[17] Rhizomes are horizontally creeping, underground stems, which bear roots and leaves. Rhizomatous species tend to spread very quickly because of these growth structures.

Because invasive plants flower throughout the summer, it is difficult to time mechanical treatments to prevent flowering and seed production. Repeated mechanical treatment too early in the growing season can result in a low growth form that is still capable of producing flowers and seed (Benefield et al., 1999; Goodwin and Sheley, 2001). Mechanical treatments on some rhizomatous weeds, such as leafy spurge, can encourage sprouting and result in an increase in stem density (Goodwin and Sheley, 2001).

Tillage methods are most effective for controlling tap-rooted invasive plant species on small acreages and level terrain, where infestations can be revisited on a regular basis to remove new germinants and resprouts over time. Tillage removes all vegetation and should be combined with seeding or planting of desirable species. Invasive plant seeds may remain viable in soil for several years (Davis et al. 1993; Selleck et al., 1962) and often may reinfest a tilled site, thus requiring continued follow-up treatments. Mulching with plastic or organic materials can be used on relatively small areas (less than 0.25 acre), but will also stunt or stop growth of desirable native species. Mulching prevents seeds and seedlings from receiving sunlight necessary to survive and grow, and can smother some established invasive plants. Hay mulch was used in Idaho to reduce flowering of Canada thistle (Tu et al., 2001), but most rhizomatous perennial invasive plants cannot be controlled by this method or by shading because extensive root reserves allow regrowth through and around mulch or shade materials.

Total acres of invasive plants treated in the Region with manual method were 11,167 in 2000, and 4,351 in 2001. Total acres of invasive plants treated in the Region using mechanical equipment were 555 in 2000, and 641 in 2001.

Cultural

Cultural methods of invasive plant management are generally targeted toward enhancing desirable vegetation to minimize invasion. Common cultural treatments include planting or seeding desirable species to shade or out-compete invasive plants, applying fertilizer to desirable vegetation, and controlled grazing.

Native plant species usually do not out-compete invasive plants in disturbed habitat. Herbicide application after invasive plants have emerged, followed by tillage and drill seeding, can be effective in establishing desirable species on some sites (Sheley et al., 1999). This process, however, can lead to increased soil compaction (DiTomaso, 1999), and cannot be conducted on steep, remote, or rocky sites.

Seeding risks introduction of non-native and/or invasive species, but use of certified weed-free seed reduces this risk. The magnitude of the risk varies and may be determined by seed source, cleaning practices, and other factors (see Site Restoration/Revegetation).

Grazing can be used to manage several invasive plant species successfully. Grazing animals prefer certain forage, and selective use of preferred forage can shift the competitive balance of plant communities (Crawley, 1983; Lukan, 1990). For example, goats and sheep have been used in various areas for controlling knapweed and leafy spurge. Controlled, repeated grazing of spotted knapweed by sheep has been found to reduce the number of 1 and 2-year old spotted knapweed plants within an infestation (Olson et al., 1997). Appropriate grazing by animals preferring invasive species can shift the plant community toward more desired grasses (Lacey et al., 1989). Conversely, indiscriminate grazing can selectively reduce grass competitiveness, thereby shifting the community in favor of invasive plants (Svejcar and Tausch, 1991).

Use of grazing animals as an invasive plant management tool must be based on selecting the appropriate grazer for the target invasive plant species. Managers must also determine when, how much, and how often to graze animals to have maximum impact on the invasive plant with minimum impact on desirable plant species (Olson, 1999). Grazing to manage weeds on roadsides, trailheads, and larger infestations on the forest is limited because of the difficulty of maintaining and managing the animals. A long-term commitment to small ruminant grazing is necessary for effective invasive plant management. Invasive plants can compensate quickly after the grazing pressure is removed because their seeds are long-lived in the soil, and because they can rapidly increase flower stem production once grazing pressure is removed (Olson et al., 1997 cited in Sheley et al., 1999).

Total acres of invasive plants treated with cultural methods were 317 in 2001 and none were reported for 2000.

Prescribed Fire

Use of prescribed burning for treatment of invasive plants has had limited application. Fire is sometimes necessary to prompt the germination of some plants, including a number of rare and endangered species. Fire can also cause sprouting of invasive plants, and create site conditions that are optimum for the spread of invasive plants. On the other hand, fire can also sharply reduce the abundance of some species. The weather, topography, and available fuel will determine the temperature and intensity of the prescribed burn, and this along with the timing of the treatment, largely determine how the burn impacts the vegetation and the abundance of particular species.

The most effective fires for controlling invasive plant species are typically those administered just before flower or seed set, or at the young seedling/sapling stage. This timing may interfere with important growth periods for native species, though. Sometimes prescribed burns suppress an invasive species only as a side effect. In some cases, prescribed burns can unexpectedly promote an invasive, such as when their seeds are specially adapted to fire, or when they resprout vigorously.

Most successful invasive plant control efforts that result from prescribed fire are closely related to the restoration of disrupted natural fire regimes. Many prescribed burn programs are, in fact, designed to reduce the abundance of certain native woody species that spread into unburned pinelands, savannas, bogs, prairies, and other grasslands. Repeated burns are sometimes helpful in controlling invasive plants. Herbicide treatments may be required as a follow-up treatment to kill the flush of seedlings that germinate following a burn.

Use of prescribed fire will also change soil chemistry and composition. High temperatures could kill seeds of invasive plants. Likewise, invasive seeds may germinate and some invasives will aggressively sprout after fire. Fire may encourage invasive plants even in communities that have evolved with fire. This could happen because plant communities evolve not in association with fire per se, but with a particular fire regime. If the fire regime has been altered, vulnerability to exotic plant invasion increases (Keeley, 2001). Given these confounding factors, a combination of treatments (such as fire and herbicide or fire and manual) would be most successful. Total acres of invasive plants treated in the Region with prescribed fire were 1,149 in 2000 and 174 in 2001.

Biological

Biological control is the deliberate use of natural enemies (parasites, predators, or pathogens) to reduce weed densities. Biological management is self-perpetuating, selective, energy self-sufficient, economical, and well suited to integration in an overall invasive plant management program (Wilson and McCaffrey, 1999). Biological control is based on the idea that one of the reasons introduced plants become invasive is their natural enemies were left behind (Rees et al., 1996). Many of the nonnative plants that become invasive in this country are not invasive in their native lands and are only minor components of their native plant communities (Rees et al., 1996). Introducing predators, parasites, or pathogens from the country of origin does not eradicate, but controls any given invasive plant. Biological control is used when invasive plant populations have become so large that eradication or control is no longer deemed possible. The use of biological control agents reduces invasive plant vigor, and is an attempt to make an invasive plant a minor component of its newly adopted community. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted for biological control (Center et al. 1997; Hasan and Ayres, 1990).

APHIS must approve the entry of all biological control agents into the United States. A Technical Advisory Group (TAG); consisting of representatives from all federal agencies with interests in invasive plant biological control) assists researchers and APHIS officials responsible for issuing permits for proposed biological control agents, throughout the biological testing and agency approval process. Once APHIS has approved entry into the United States, individual state departments of agriculture may also require permits for entry (all four states in the Pacific Northwest Region require permits).

All agents considered for use in the United States undergo rigorous testing, designed to ensure that introduced biological control agents are limited in range and do not threaten native, nursery, or crop plants. This testing also helps to limit the introduction of organisms that will not survive or be ineffective on the target invasive plant, identifies non-target plants likely to become impacted, and examines the host-specificity of organisms closely related to the proposed agent. For more information see Appendix H and Test Plant Lists at www.aphis.usda.gov/ppq/permits/tag.

Climatic and biotic constraints on proposed agents are examined by studying the native habitat of the agent and that of the target invasive plant in the United States (including studies on exposure, elevation, temperature, humidity and host density, size or availability). If a proposed agent affects native or agricultural plants, it must be demonstrated that the candidate agent will not harm the population of desirable plants based on growth habit, climate, or geography (see, for example, Spencer and Prevost, 1993; USDA, 2000- APHIS).

Management with biological agents is a slow process that reduces the vigor of the target and does not eradicate the invasive plant population. Biological agents may be ineffective without being integrated with other strategies. Researchers estimate 15 to 29 percent of biological control programs have been successful (DeLoach, 1991; Meyers et al., 1988). An invasive plant infestation may increase in density and area faster than the newly released biological agent populations; therefore, other control methods may need to be used in conjunction with the release of biological agents, such as herbicide spraying along the perimeter of the infestation. Total acres of invasive plants in the Region treated with biological control methods were 1,813 in 2000 and 889 in 2001.

Herbicides

Refer to the following terminology box for terms and concepts about herbicides and risk assessments.

Terminology

Allometric= pertaining to allometry; the study of growth of one part in relation to growth of the whole organism**.**

Bioconcentration = the net accumulation of a substance by an aquatic organism as a result of uptake directly from aqueous solution (i.e. water with other stuff mixed in).

Bioaccumulation = the net accumulation of a substance by an organism as a result of uptake directly from all environmental sources and from all routes of exposure (primarily from food or water that is ingested).

Gavage = a method of dose administration; the substance is placed directly in the stomach, sometimes in a gelatin capsule.

LOAEL = Lowest-observed-adverse-effect level; lowest exposure associated with an adverse effect.

NOEL = No-observed-effect level; no effects attributable to treatment.

NOAEL = No-observed-adverse-effect level; effects attributable to treatment, but do not impair ability to function and clearly do not lead to such an impairment.

NOEC = No-observed-effect concentration; synonymous with NOEL.

RfD: *Reference Dose,* a numerical estimate of a daily exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or minimum dose for producing effects.

Surfactant = surface acting agent; any substance that when dissolved in water or an aqueous solution reduces its surface tension or the interfacial tension between it and another liquid.

Surrogate = a substitute; lab animals are substituted for humans or other wildlife in toxicity testing.

a.e. = acid equivalent

a.i. = active ingredient

kg = kilogram, equivalent to 2.2 pounds

g = gram, equivalent to about 0.03 ounce (28 g = 1 ounce)

ppm = part(s) per million; equivalent to mg/L

mg/L = milligrams per liter; equivalent to ppm

ppb = part(s) per billion

Herbicide treatment consists of applying chemicals, usually of a manufactured or synthetic origin, to a plant or to soil. The plant absorbs the herbicide through roots, leaves, or stems. The herbicide interferes with plant metabolic processes, stopping growth and usually killing the plant. A suite of available herbicides is needed to help meet the variety of long-term site goals and address the complex resource issues at the Forest level. Different herbicides vary in effectiveness and length of control on different invasive plants. Herbicides also vary in their effects to the environment and suitability to different environmental conditions.

Herbicides vary in their environmental activity, physical form, and the equipment used to apply them. In combination with other site and biological factors, these characteristics influence both the probability of meeting site-specific goals for invasive plant control, and the potential of impacting non-target components of the environment. Soil properties impact the effectiveness of invasive plant treatment and restoration actions as well.

Herbicides may control all types of vegetation, or they may kill some types of plants while not affecting other types. Some herbicides may control only actively growing vegetation at the time of application, or they may provide invasive plant control through root uptake from the soil (short-term to over a few years). In soil and water, herbicides may persist or decompose by sunlight, microorganisms, or other environmental factors.

Physical form of herbicides varies. Some may be oil- or water-soluble molecules dissolved in liquids, or attached to granules for dry application to soil surface. Herbicides may move from their location of application through leaching (dissolved in water as it moves through soil), volatilization (moving through air as a dissolved gas), or adsorption (attached by molecular electrical charges to soil particles that are moved by wind or water).

Herbicides may be applied with a variety of equipment and techniques. The techniques vary in effectiveness, environmental effects, and costs. Helicopters or fixed-wing aircraft are used for aerial application of sprays or granules for rapid broadcast coverage of large or inaccessible areas.

Herbicides may be sprayed from wheeled vehicles with hose sprayers or pump-driven booms using an array of spray nozzles. This equipment is most commonly used for broadcast spraying of roads, but can also be used on all-terrain vehicles for broadcast or spot spray in remote areas.

Some application equipment is often used for selective treatment and/or to minimize non-target effects. Backpack sprayers are most frequently used to spray the foliage, stem, and/or surrounding soil of target invasive plants. Other equipment includes herbicide-soaked wicks or paintbrushes for wiping target vegetation, and lances, hatchets, or syringes for injection of herbicide into stems of target plants. Granular herbicides may be applied using hand-held seeders, or other specialized dispensing devices.

Herbicides vary in selectivity of control for various plant groups. These differences in selectivity are the basis for developing effective invasive plant control prescriptions while minimizing adverse effects and facilitating native plant community maintenance or restoration. Another variation among herbicides is the duration of control of the target invasive plant. Label application restrictions can also limit the number of herbicides available to control any site-specific invasive plant infestation.

Each herbicide is sold as one or more commercial products, called formulations. The product label for herbicide formulation provides legally binding direction on its use, including safe handling practices, application rates, and practices to protect human health and the environment.

Table 3-12 lists the herbicides included in this EIS and analyzed in Chapter 4. These herbicides, or formulations are registered by the EPA for use in forestry applications, right-of-ways, or rangelands and are appropriate for use against invasive plant species in Oregon and Washington. The characteristics listed are meant to give a general overview of the capabilities of each herbicide. More details on these herbicides can be found in the commercial labels provided on all EPA approved products and the Pacific Northwest Weed Management Handbook (Oregon State University, 2002). Also a document developed for this analysis, Common Control Measure for Invasive Plants of the Pacific Northwest Region (Mazzu, 2004) summaries the vast information available on invasive plants control using resources from numerous authorities such as the Nature Conservancy, State noxious weed programs or county noxious weed coordinators is available in the EIS project file.

Table 3-12 Herbicides Analyzed, Some Representative Formulations and Characteristics

Chemical Name	Formulations in Risk Assessments	Characteristics/Selectivity/Some Examples of Species
Chlorsulfuron	Telar, Glean, Corsair	Selective against many annual, biennial and perennial broadleaf species (e.g. toadflaxes, houndstongue). No effect on most perennial native grasses, conifers.
Clopyralid	Transline	Selective against species in the Sunflower, Pea, Knotweed families (e.g. knapweeds, yellow starthistle, Canada thistle, hawkweeds). Provides control of new germinants for one to two growing seasons.
Dicamba	Banvel, Vanquish	Selective against many annual and perennial broadleaf species including woody and vine species.
Glyphosate*	RoundUp, Rodeo, Aquamaster	Non-Selective. Will damage or kill species from nearly all plant families. Aquatic forms are effective on Japanese knotweed, purple loosestrife.
Imazapic	Plateau	Selective against some annual and perennial broadleaf and grass species (e.g. cheatgrass, medusahead, toadflaxes, leafy spurge). No effects on most woody species.
Imazapyr*	Arsenal, Chopper, Stalker, Habitat**	Non-selective. Controls many annual and perennial broadleaf and grass species (e.g. tamarisk, cheatgrass, blackberries)

Table 3-12 Herbicides Analyzed, Some Representative Formulations and Characteristics

Chemical Name	Formulations in Risk Assessments	Characteristics/Selectivity/Some Examples of Species
Metsulfuron methyl	Escort	Selective against broadleaf and woody species (e.g. perennial pepperweed, houndstongue, tansy ragwort). No effects on most woody species.
Picloram	Tordon	Selective against many annual and perennial broadleaf and woody species, including conifers (e.g. knapweeds, yellow starthistle, Canada thistle, hawkweeds) Restricted Use herbicide. Provides control of new germinants for two to three growing seasons.
Sethoxydim	Poast	Selective against many annual and perennial grasses (e.g. cheatgrass, medusahead).
Sulfometuron methyl	Oust	Non-selective against both broadleaf and grass species (e.g. reed canarygrass).
Triclopyr*	Garlon, Pathfinder, Remedy, Renovate	Selective against woody and perennial broadleaf species (e.g. scotch broom, blackberry, English ivy, Japanese knotweed).
2,4-D*	Weedone, Weedar, many more	Selective against broadleaf species (e.g. Canada thistle, sulfur cinquefoil). Safe for grasses.

* has formulations registered by EPA for aquatic use.
** not yet analyzed in Forest Service risk assessments.

Herbicide Risk Assessments

As herbicides have the potential to adversely affect the environment, the U.S. Environmental Protection Agency (EPA) must register all herbicides prior to their sale, distribution, or use in the United States. In order to register herbicides for outdoor use, the EPA requires the manufacturers to conduct a safety evaluation on wildlife including toxicity testing on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. An ecological risk assessment uses the data collected to evaluate the likelihood that adverse ecological effects may occur as a result of herbicide use.

The Forest Service conducts its own risk assessments, focusing specifically on the type of herbicide uses in forestry applications. The Forest Service contracts with Syracuse Environmental Research Associates, Inc. (SERA) to conduct human health and ecological risk assessments for herbicides that may be proposed for use on National Forest System lands. The information contained in this EIS relies on these risk assessments. All toxicity data, exposure scenarios, and assessments of risk are based upon information in the FS/SERA risk assessments unless otherwise noted. Estimates of potential environmental and human health risks for each herbicide as proposed for use in this EIS are based on herbicide risk assessments prepared for the Forest Service by SERA. Forest Service/SERA risk assessments use peer-reviewed articles from the open scientific literature and current EPA documents, including Confidential Business Information. Specific methods used in preparing the Forest Service/SERA herbicide risk assessments are described in SERA, 2001-Preparation. Only information that is not derived from the relevant Forest Service/SERA Risk Assessments is specifically cited in this section. The risk assessments and associated documentation is available in total in the administrative record for this EIS. Estimates of risk are not absolute; rather, they are relative and based on assumptions and evolving toxicity data. Risk assessments have inherent limitations; these are discussed later in this chapter.

The effects from the use of any herbicide depends on the toxic properties (hazards) of that herbicide, the level of exposure to that herbicide at any given time, and the duration of that exposure. The risk from herbicide use can be reduced by reducing exposure through the use of streamside buffer zones, personal protective equipment for applicators, and posting of treated areas. Treatments under all alternatives would be accomplished according to strict safety and health standards.

The hazards associated with each herbicide active and inert ingredient, impurity or metabolite were determined by a thorough review of available toxicological studies. For a background discussion of all toxicological tests and endpoints considered in Forest Service Risk Assessments, refer to SERA, 2001-Preparation.

Toxicity studies were evaluated individually for scientific quality, and cumulatively for all similar studies to identify the No observed adverse effects level (NOAEL) and Reference Dose (RfD) for each potential effect. Each Forest Service/SERA herbicide risk assessment contains citations for all studies that are reviewed.

In addition to the analysis of potential hazards to human health from every herbicide active ingredient, Forest Service/SERA risk assessments evaluate potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert ingredients and adjuvants.

Impurities and Metabolites

Virtually no chemical synthesis yields a totally pure product. Technical grade herbicides contain some impurities. The EPA defines an impurity as "…any substance…in a pesticide[18] product other than an active ingredient or an inert ingredient, including unreacted starting materials, side reaction products, contaminants, and degradation products" (40 CFR 158.153(d)). Toxicity studies generally account for impurities, except in the case of carcinogens associated with the following impurities:

- Hexachlorobenzene (HCB) in both clopyralid and picloram.
- Ethylene oxide in nonylphenol polyethoxylate (NPE)-based surfactants.
- 1,4-dioxane in some formulations of glyphosate containing NPE-based surfactants.

Analyses of the carcinogenic risk of these three impurities are presented in the corresponding Forest Service/SERA herbicide risk assessments. In addition to the carcinogenic risks, acute and other chronic risks from exposure to HCB are specifically analyzed.

From USDA, 2003, the risk of cancer from exposure to ethylene oxide in NPE-based surfactants was considered negligible for workers, based on the EPA standard of acceptable risk of less than 1 in 1 million.

[18] References to pesticides in this context also apply to herbicide use.

From Borrecco and Neisess (1991) the risk of cancer from exposure to 1,4-dioxane in glyphosate was considered negligible for workers, based on the EPA standard for acceptable risk of less than 1 in 1 million.

Similar to impurities, the potential health effects of herbicide metabolites are often accounted for in the available toxicity studies, assuming that the toxicological effects of metabolism in the test animal species would be similar to those in humans. Uncertainties in this assumption are encompassed in the uncertainty factor used in calculating the RfD and may sometimes influence the selection of the study used to derive the RfD.

Inert Ingredients

Forest Service/SERA Risk Assessments analyze the effects of inert ingredients and full formulations by the process described below:

- Compare acute toxicity data between the formulated products (includes inert ingredients) and their active ingredients alone;
- Disclose whether or not the formulated products have undergone chronic toxicity testing; and
- Identify, with the help of EPA and the herbicide registrants, ingredients of known toxicological concern in the formulated products and assess the risks of those ingredients.

Researchers who have studied the relationships between acute and chronic toxicity have found that relationships do exist and acute toxicity data can be used to give an indication of overall toxicity (Zeise, et al., 1984). The court in *NCAP v. Lyng*, 844 F.2d 598 (9th Cir 1988) decided that this method of analysis provided sufficient information for a decision maker to make a reasoned decision. *In SRCC v. Robertson*, Civ.No. S-91-217 (E.D. Cal., June 12, 1992) and again in *CATs v. Dombeck*, Civ. S-00-2016 (E.D. Cal., Aug 31, 2001) the district court upheld the adequacy of the methodology described above for disclosure of inert ingredients and additives.

The EPA has categorized approximately 1,200 inert ingredients into four lists. Lists 1 and 2 contain inert ingredients of known or suspected toxicological concern. List 4 contains non-toxic substances such as corn oil, honey and water. List 3 includes substances for which EPA has insufficient information to classify as either hazardous (List 1 and 2) or non-toxic (List 4). Use of formulations containing inert ingredients on List 3 and 4 is preferred for invasive plant treatment under current Forest Service policy and in all alternatives considered in the EIS.

Most information about inert ingredients that is submitted to EPA for pesticide registration is classified as "Confidential Business Information" (CBI). CBI is not generally released or available for public review. The Forest Service asked the EPA to review herbicide formulations and advise if they contain inert ingredients of toxicological concern. In addition, SERA risk assessors have reviewed the identity and data on inerts in the CBI files when preparing herbicide risk assessments. Publicly released information from registrants of herbicides has also been reviewed in Forest Service/SERA risk analyses. Comparison of acute toxicity (LD_{50} values) data between the formulated products (including inert ingredients) and their active ingredients alone shows that the formulated products are generally less toxic than their active ingredients.

Forest Service/SERA risk assessments review the acute toxicity comparisons, the EPA review, and examine the toxicity information on inert ingredients in each formulated product. For all formulated products that have been reviewed in the Forest Service/SERA risk assessments, the reviews have concluded that the inert ingredients in these formulations do not significantly increase the risk to human health and safety over the risks identified for the active ingredients.

Additives

Adjuvants include surfactants, drift reduction agents, and dyes or colorants. Some herbicide formulation labels direct the use of particular adjuvant types when applying the herbicide. Surfactants increase the ability of the herbicide to be absorbed into plant tissues. Dyes and colorants are used to indicate whether a plant or area has been treated.

Limitations of Risk Assessments

Risk assessments concentrate on information from laboratory and field sciences to describe the likelihood of risk. While often used in decision-making processes, risk assessments have inherent biases. When used in conjunction with other information and field knowledge, risk assessments become a more useful tool. There are advantages and disadvantages to the formal risk assessment process as it relates to natural resources.

Risk assessments attempt to separate the scientific process of estimating the magnitude and probability of effects from choosing among alternatives and determining the acceptability of risks. Advantages include providing a quantitative basis for comparing and prioritizing risks of alternatives, and providing probabilities of an adverse effect under different scenarios (Fairbrother et al., 1995).

Advantages include providing quantitative bases for comparing and prioritizing risks of alternatives with single event probabilities, providing a series of probabilities of the occurrence of an adverse effect under different scenarios, and an attempt at separating the scientific process of estimating the magnitude and probability of effects from the process of choosing among alternatives and determining the acceptability of risks (Fairbrother et al., 1995).

Disadvantages include a high degree of uncertainty with the collection and interpretation of data. Unavoidable human biases that creep into the process; from study design, questions asked (and questions avoided), data collection, data interpretation, and extreme variability and synergy associated with ecological relationships. Numbers, particularly in ecological realms, are uncertain, and there are limits on our ability to understand or demonstrate causal relations. Because of data gaps, assessments rely heavily on extrapolation from laboratory animal tests, high doses to low doses, and short-term effects to conclusions about long-term effects (Funke, 1995).

Regardless of disadvantages and limitations of ecological and human health risk assessments, the data provided by FS/SERA risk assessments are the most current and best available. The bottom line is that risk analyses can never prove absolute safety and the absence of risk can never be guaranteed (SERA, 2001-Preparation).

Appendix G is a source of information for every herbicide considered for use in this EIS. A website containing links to the actual herbicide risk assessments is available in this Appendix. Environmental effects, toxicological data, human health effects, and safety precautions are summarized in these documents.

Typical application rates of these herbicides and nonlyphenol polyethoxylate (NPE) surfactant used in this analysis can be found in Table 3-13.

Table 3-13 Herbicide and Nonylphenol Polyethoxylate Application Rates

Herbicide	Typical Application Rate lb ai/ac*	Lowest Application Rate lb ai/ac	Highest Application Rate lb ai/ac
Chlorsulfuron	0.056	0.0059	0.25
Clopyralid	0.35	0.1	0.5

Table 3-13 Herbicide and Nonylphenol Polyethoxylate Application Rates

Herbicide	Typical Application Rate lb ai/ac*	Lowest Application Rate lb ai/ac	Highest Application Rate lb ai/ac
Dicamba	0.3	0.25	2
Glyphosate	2	0.5	7
Imazapic	0.13	0.031	0.19
Imazapyr	0.45	0.03	1.25
Metsulfuron Methyl	0.03	0.013	0.15
Picloram	0.35	0.1	1.0
Sethoxydim	0.3	0.094	0.38
Sulfometuron Methyl	0.045	0.03	0.38
Triclopyr	1.0	0.1	10
2,4-D	1.0	0.5	2.0
Nonylphenol Polyethoxylate	1.67	0.167	6.68
Hexachlorobenzene#	0.000004	0.0000024	0.000012

* pounds of active ingredient per acre
#These application rates reflect the incidental rates of application of the impurity hexachlorobenzene.
Source: USDA Forest Service 2003, SERA 1998, 2001, 2003

Summary of Treatment Methods

Table 3-14 summarizes some key points regarding the treatment methods.

Table 3-14 Summary of Treatment Methods

Treatment Method	Discussion/Considerations
Cultural	
Competitive seeding	Most effective after weed populations have been reduced by other control actions.
Grazing Animals	Must match the species with the appropriate grazer for best success; treatment must occur during proper phenological stage; herding required; sometimes nonselective.
Fertilization	Could improve the success of desirable species; may be limited depending on species/soil characteristics.

Table 3-14 Summary of Treatment Methods	
Treatment Method	**Discussion/Considerations**
Manual/Mechanical	
Mowing-Weed Whipping	Limited to level and gently sloping smooth-surface terrain. Must be conducted for several consecutive years; treatment timing critical.
Hand-Pulling /Grubbing	Labor intensive; not effective on deep-rooted or rhizomatous perennials; causes ground disturbance that may increase susceptibility of site to reinvasion by weeds; effective on single plants or small, low-density infestations.
Biological	
Parasites, Predators, and Pathogens	Most effective when integrated with other strategies; does not achieve eradication; not effective on all invasive plants; long term process required.
Herbicides	
Ground Application	Not cost-effective on steep slopes; application timing limited based on plant phenology and weather conditions. Most appropriate for small, relatively accessible infestations, and areas where controlling off-site drift is critical.
Aerial Application	Potential for off-site drift must be considered; application timing limited based on plant phenology and weather conditions. Most appropriate for large, relatively inaccessible infestations.

Prioritizing Sites and Selecting Treatment Methods

The methods and factors for prioritizing invasive plant sites for treatments on the Forests in Region Six, generally follow a similar decision-making model. Table 3-15 is an example based on a Forest Service guide for prioritizing sites for treatment and selecting the appropriate treatment method (USDA 2001).

Table 3-15 Priorities for Treatment and Selection of Treatment Methods.

Priority	Description	Treatment – choice based on site-specific conditions
Highest Priority for Treatment	* Eradication of new species (focus aggressive species with potential for significant ecological impact including but not limited to State listed high priority noxious weeds) * New infestations (e.g. populations in areas not yet infested; “spot fires”; any State or Forest priority species). * Areas of concern such as: * Areas of high traffic and sources of infestation (e.g. parking lots, trailheads, horse camps, gravel pits) * Areas of special concerns: (e.g. botanical areas, wilderness, research natural areas, adjacent boundaries/access with national parks)	1. Manual/mechanical - isolated plants or small populations. 2. Herbicide treatment if manual/mechanical is known to be ineffective or population too large. 3. Remove seed heads. This is an interim measure if cost/staff is an issue. 4. Seed to restore treated areas; use native species when possible.
Second Priority of Treatment	* Containment of existing large infestations (e.g. focus on State-listed highest priority species or Forest priority species) – focus on boundaries of infestation. * Roadsides – focus first on access points leading to areas of concern.	1. Manual/mechanical - isolated plants or small populations in spread zones. 2. Herbicide treatment for larger populations along perimeter. 3. Seed to restore treated areas to create a buffer from spread; use native species when possible.
Third Priority of Treatment	* Control of existing large infestations (e.g. State-listed and Forest second priority species)	1. Disperse biocontrol agents on large infestations 2. Livestock grazing 3. Mechanical 4. Herbicide application
Fourth Priority of Treatment	* Suppression of existing large infestations – when eradication/control or containment is not possible.	1. Biocontrol on large infestations 2. Livestock grazing 3. Mechanical 4. Herbicide application along perimeters

Of important note is the prioritization of species. While state listed noxious weeds are always of high priority for control, the threat of species not necessarily on State lists, but that are known to cause substantial ecological impact should also be considered. An example would be a species known to alter fire regimes. Cheatgrass or medusahead may not necessarily be listed by a State. Their range is expansive and therefore beyond eradication in many locations, but if new infestations are detected in relatively intact native plant communities, such populations should be of highest priority for control due to their potential to alter the fire regime.

A system for prioritizing invasive species for control and restoration of pre-invasion conditions at various stages of the invasive plant fire regime cycle is discussed in Brooks et al., (2004). This system is broken into four phases based on the potential of a species to cause significant ecological impact. Such a system could be used to direct prioritization decisions on any species and emphasizes the point that newly detected species must be assessed for their potential to naturalize, become invasive and alter ecosystem functioning. Such a system is not limited to fire regime-altering species, but could be used for any ecosystem where the potential for shifts in function could occur (such as riparian systems).

Site Restoration/Revegetation

Promoting the establishment of desirable plant communities through the manipulation of species composition, plant density, and growth rate is a critical component of invasive plant management (Masters et al., 1996; Masters and Nissen, 1998; Masters and Shelly, 2001; Brooks et al., 2004). Although single control tactics, such as treatment with herbicides, may eliminate or suppress invasive species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the same or other undesirable plant species. On degraded sites where desirable species are absent or in low abundance, revegetation with competitive grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-management objectives in a reasonable timeframe.

The selection of appropriate species for revegetation is dependent on a number of factors, including management objectives and site characteristics such as soil texture, precipitation/temperature regimes, and shade conditions. Seed availability and cost, ease of establishment, seed production, and competitive ability are also important considerations and, as a consequence, resource managers in the western United States have historically relied on introduced species that have been selectively bred and marketed for these attributes.

Although some introduced species will continue to be used in site restoration, the extensive past use of highly competitive and persistent non-natives (e.g., smooth brome, orchardgrass, timothy, and crested wheatgrass) has had adverse impacts on the diversity and health of our native forest, rangeland, and aquatic ecosystems (Bartos and Campbell, 1998; Brown, 1995; Covington and Moore, 1994; Cetwyler, 1971; Kaufmann et al., 1994; Kay, 1994; Lesica and DeLuca, 1996; Mills et al., 1994).

Numerous annual or sterile cereal grasses could be used instead of the above persistent non-natives. For example, cereal wheat, barley, annual ryegrass or sterile wheatgrass have been used in restoration efforts. In the case of wildfire recovery (Burned Area Emergency Rehabilitation (BAER) programs, some studies are being done to assess the success of seeding with these species. Keeley (2003) found that seeding with cereal wheat, at high seeding rates, reduced invasive species after two years. The study also found decreases in species richness and ponderosa pine seedlings. The dense stands of wheat did appear to reduce erosion, but left thick thatch which increased fire hazard at least initially. Such studies suggest determining if seeding is necessary and the amount of seed per acre considered crucial for reducing disruption to ecosystem processes.

In order to conserve and enhance the biodiversity and sustainability of wildland ecosystems, numerous authorities and policies are in place to promote the use of native species in restoration and revegetation. There is debate among restoration practitioners on how close in distance and genetics a seed source should be to the restoration site (Kaye, 2001). The definition of what is 'local' varies and should be defined through specific project objectives. Genetically similar seed may have an advantage because it is from locally adapted plants, but could be more costly than using seed from a broader genetic pool such as a watershed or even an ecoregion that can be used for many projects.

The successful use and incorporation of native species, in revegetation of impacted sites will require extensive ecological and biological knowledge and expertise in order to meet both short-term objectives of attaining adequate amounts and levels of competitive plant cover, and long-term objectives of physical and biological site recovery. Although agency knowledge and experience base is growing, education and training is still needed. There is also a critical need for research efforts that more broadly explore the array and combinations of native grasses and forbs that may be useful in restoration/revegetation. The effects of the timing, as well as the rate and methods of seeding on sites previously infested with invasive plants, have also not been fully examined for most species.

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CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

The environmental consequences section focuses on the key issues (Chapter 1.6), but also includes other issues and required NEPA disclosures. These analyses predicts future response to a suite of new management direction. The uncertainty in these predictions is relatively high given the complexity of the relationships between land management; uses on and off National Forest; the rate of introduction, establishment, and spread of diverse invasive plants; and unknown future funding scenarios. Each of the sections in this document discuss methodologies used to respond to the uncertainty inherent in the analysis.

Chapter 4 discloses the direct, indirect and cumulative effects of the alternatives on the environmental components described in Chapter 3. Direct effects are those that occur as a direct result of the alternatives within the project area. Indirect effects are those that occur away from the action in time or space. Cumulative effects are those that occur as a result of the alternatives in combination with past, present and future foreseeable actions within Region Six.

4.1.1 Basis for Cumulative Effects Analysis

The National Forests are intermixed with other federal, state, county and private ownerships. Herbicides are commonly applied on lands other than National Forest System land. The small contribution that Forest Service use of herbicide for invasive plant control makes to the statewide totals [19] for herbicide use indicates that the potential cumulative effect from Forest Service actions is very small.

No central source exists for compiling invasive plant management information off National Forests within Oregon and Washington. There is no requirement for private or corporate land owners, or counties to report invasive plant treatment information, thus an accurate accounting of the total acreage of invasive plant treatment for all land ownerships is unavailable. It is estimated that invasive plant control occurs on over 1,250,000 acres in Oregon and Washington[20].

19 National Center for Food & Agricultural Policy (NCFAP). 1997 Pesticide Use Database available online at http://www.ncfap.org/database/state/default.asp

20 Based on informal discussions w/state and county agriculture and weed personnel. Includes all land ownerships, not including small-scale private use. The overwhelming majority of the weed control work occurring off National Forest system lands is with herbicides

Even the highest use estimates of herbicide from Alternative D would amount to less than three percent of the total acres treated with herbicides in Oregon and Washington. Some of the herbicides proposed in this EIS are frequently applied on much larger acreages of agricultural lands. The herbicides imazapic, imazapyr, and sulfometuron methyl are not registered for agricultural uses other than rangeland and forestry. Landscaping use of some herbicides is another major source of exposure. Other herbicide use occurs on other federal, State, and county ownerships, State and private forestry lands, rangeland, utility corridors, and road rights of way.

Table 4-1 displays the relative rate of use for different herbcides included in the alternatives compared to projected use within the two-state region of Oregon and Washington. All of the cumulative effects analyses apply this information.

Table 4-1 Relative Rate of Use For Various Herbicides in Oregon and Washington

Herbicide	Rate-Typical Lb ai/ac	Rate-Highest Lb ai/ac	Maximum acres in any alternative	Maximum lbs. herbicide applied for alternatives	Estimated total herbicide used (lbs) in WA+OR agriculture in 1997	Typical and worst-case percentages of total agricultural use for 1997
2,4-D	1.0	2.0	13,765	27,530	2,226,331	0.6%/ 1.2%
Chlorsulfuron	0.056	0.25	1,147	286	9,358	0.7%/ 3.1%
Clopyralid	0.35	0.5	4,648	2,324	3,486	5.2%/ 7.4%
Dicamba	0.3	2.0	688	1,376	245,907	0.1%/ 0.6%
Glyphosate	2	7	4,649	32,543	1,443,217	0.6%/ 2.3%
Imazapic	0.1	0.19	3,441	654	0	n/a
Imazapyr	0.45	1.25	930	1,163	0	n/a
Metsulfuron Methyl	0.03	0.15	1,147	172	2,771	1.2%/ 6.2%
Picloram	0.35	1.0	11,050	11,050	17,422	22.2%/ 63.4%
Sethoxydim	0.3	0.38	930	353	20,569	1.3%/ 1.7%
Sulfometuron Methyl	0.045	0.38	1,147	435	0	n/a
Triclopyr	1.0	10	930	9,300	94,075	1.0%/ 9.9%
Nonylphenol Polyethoxylate	1.67	6.68			n/a	n/a

Source: The National Center for Food and Agricultural Policy (NCFAP) Agricultural Pesticide Use Database for 1997. Washington DC. 1998.

The proposed use of herbicides could result in cumulative doses of herbicides to workers, the general public, non-target plant species, and/or wildlife. Cumulative doses of the same herbicide result from (1) additive doses via various routes of exposure resulting from a single invasive plant treatment project and (2) additive doses if an individual is exposed to other herbicide treatments. Additional sources of exposure include private use of herbicides.

The potential for synergistic effects (where exposure to a combination of two or more chemicals could result in impacts that are greater than the sum of the effects of each chemical alone) were considered. Instances of chemical combinations that cause synergistic effects are relatively rare. Review of the scientific literature on toxicological effects and toxicological interactions of agricultural chemicals indicate that exposure to a mixture of pesticides is more likely to lead to additive rather than synergistic effects (Kociba and Mullison, 1985; Crouch et al. 1983; U.S. EPA, 1986). Based on the limited data available on chemical combinations involving the twelve herbicides considered in this EIS, it is possible, but unlikely, that synergistic effects could occur as a result of exposure to the herbicides considered in this analysis. Synergistic or additive effects, if any, are expected to be insignificant. More information is included in the specialist reports located in the project analysis file.

Amendments to National Forest Plans in Region Six have been recently implemented. In March, 2004, the Secretaries of Agriculture and the Interior amended Forest Plans within the range of the northern spotted owl by removing the Survey and Management Mitigation measure and changing language related to the Aquatic Conservation Strategy. The cumulative effects of invasive plant management alternatives were considered in light of these other amendments. All invasive plant management alternatives are compatible with the other recent Forest Plan amendments.

One National Forest recently amended its Forest Plan in light of new information related to management of Port-Orford-cedar. All invasive plant alternatives are compatible with the Port-Orford-cedar management strategy. The cumulative effects of invasive plant management and Port-Orford-cedar management are discussed in this chapter where appropriate.

4.1.2 Risk Assessments

The analysis in Chapter 4 refers extensively to Forest Service risk assessments (prepared by SERA, Inc.) for every herbicide considered in the alternatives. Risk assessments use information from laboratory and field studies of herbicide toxicity, exposure, and environmental fate to estimate the risk of adverse effects to non-target organisms. Risk assessments are often used to inform decision makers, notwithstanding the presence of some degree of bias inherent in any methodology used to assess risk. In general, the use of risk assessments to predict ecological effects of treating invasive plants is less certain than their use to predict effects to human health. When used in conjunction with information on local conditions and specific treatments, risk assessments become a more precise tool. There are advantages and disadvantages to the risk assessment process as it relates to natural resources.

Advantages of ecological risk assessment include: providing quantitative bases for comparing and prioritizing risks of alternatives with single event probabilities; providing a series of probabilities of the occurrence of an adverse effect under different scenarios; and separating the scientific process of estimating the magnitude and probability of effects from the process of choosing among alternatives and determining the acceptability of risks (Fairbrother et al., 1995).

Disadvantages include a high degree of uncertainty in interpretation and extrapolation of data. There are unavoidable human biases that enter into the process; from study design, questions asked (and questions avoided), data collection, data interpretation, and extreme variability associated with aggregate effects of natural and synthesized chemicals on organisms, including humans, and with ecological relationships. Numbers used, particularly in ecological realms, are uncertain, and there are limits on our ability to understand or demonstrate causal relationships. Because of data gaps, assessments rely heavily on extrapolation from laboratory animal tests (Funke, 1995).

Regardless of disadvantages and limitations of ecological and human health risk assessments, the analysis provided by FS/SERA risk assessments is the most current and thorough that is available. The bottom line for all risk analyses is that absolute safety can never be proven and the absence of risk can never be guaranteed (SERA, 2001-Preparation).

4.2 Effectiveness of Preventing and Reducing the Spread of Invasive Plants

4.2.1 Introduction

The ability of the Forest Service to meet the purpose and need for action, achieve desired future conditions, and contribute to cooperative efforts throughout Oregon and Washington is directly correlated to the effectiveness of invasive plant prevention and control strategies in each alternative. Public comments associated with this issue focused on whether invasive plant treatments would actually succeed in making a difference, given the current level of infestation. People requested the Forest Service investigate various land management activities that could be causing the introduction and spread of invasive plants. To address this issue, white papers were developed to display the latest knowledge regarding prevention and treatment effectiveness (see Appendix D).

Each action alternative adds a unique set of invasive plant management standards to Forest Plans in Region Six. The alternatives vary in their potential to prevent or reduce the spread of invasive plants, because they vary by degree of emphasis on prevention, treatment, and restoration. This analysis focuses on characteristics of the standards and how they influence the prevention and overall reduction of invasive plants.

The measuring factors used for comparing the alternatives are:

- Estimated annual rate of invasive plant spread.
- Estimated acreage of invasive plants treated annually.
- Number of years until invasive plants are controlled.

The results of the analysis indicate continuing with the current approach (No Action alternative) is not a successful strategy for reducing invasive plants. Alternative B is potentially the most effective at preventing the spread of invasive plants, but because of its emphasis on non-herbicide methods, is the least effective of the action alternative in treating and controlling invasive plants. The Propose Action is less effective at preventing the spread of invasive plants than Alternative B, but more effective in treating and controlling invasive plants. Alternative D is the least effective action alternative in preventing, but the most effective in treating and controlling invasive plants. (Chapter 4.2.3)

4.2.2 Background

Past and Current Efforts

The prevention and management of invasive plants is not new to the Forest Service or other federal agencies. As early as 1939, the Federal Seed Act required reporting of percent noxious weed seed in seed mixes and listed invasive species of concern in seed mixes (7 USC 1551-1611). The Federal Noxious Weed Act of 1974 (PL 93-629, Sec. 15) outlined the duties of federal agencies including the development of cooperative agreements with state agencies to coordinate integrated management of undesirable plant species. In 1998, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) was formed from 17 agencies. The committee's goal is to facilitate the development of biologically sound techniques to manage invasive plants on federal and private lands through partnerships, national strategies and promotion of weed management programs (FICMNEW 1998). The Committee sponsored the "Pulling Together" national srategy that highlights as a national goal effective prevention through partnerships, education and research. In response to Executive Order 13112 on Invasive Species (1999), the National Invasive Species Council was established. It developed the National Invasive Species Management Plan "*Meeting the Invasive Species Challenge"* (National Invasive Species Council, 2001), which emphasized prevention, early detection, rapid response, control, and restoration. It called for international cooperation in the prevention of invasions.

Other federal agencies have been active in prevention, treatment and restoration efforts. National guidance for the BLM includes using weed-free straw mulch (IM 99-076). The BLM has developed prevention education programs on invasive plants (e.g. How to Prevent the Spread of Noxious Weeds, USDI BLM 1996). The National Park Service has established a nationwide program of Exotic Species Management teams for rapid response to infestations. The Federal Highway Administration has developed a policy statement to proactively implement Executive Order 13122, encourages and funds the use and development of native plant materials for roadside landscaping, and recommends that state Departments of Transportation (DOT) to be involved with state invasive species councils. Some actions taken by state level departments of transportation, include: use of weed-free mulches on construction and upgrade projects in Wyoming, use of weed-free sod in Florida, and the requirement to wash heavy equipment moving into and out of construction projects in Oregon (Turner-Fairbank Highway Research Center 2000).

Other state efforts are underway in the western states surrounding Region Six. For example, certified weed-free forage and mulch programs have been established in 13 western states and Canadian provinces including Nevada, Idaho, and Montana (Schoenig, 2002). California is currently working on developing a weed-free forage and mulch program. In Oregon, Wallowa County, has developed its own weed free hay program. Oregon has statutes involving the cleaning of agricultural machinery in weed management districts (ORS 570.515 – 570.600).

Current direction for the prevention and management of invasive plants on National Forests in Region Six comes to a large degree, but not exclusively, from the 1988 EIS and 1988 ROD for

Competing and Unwanted Vegetation, and the associated 1989 Mediated Agreement.[21] These documents require consideration of invasive plant prevention, but specific direction on how to actually prevent the spread of invasive plants is not provided.[22] The 1988 ROD specified and limited the tools available for the treatment of competing and unwanted vegetation, but did not provide administrative mechanisms for adapting their requirements and adopting new technologies. Specific guidance on how to actually prevent invasive plant introduction, establishment, and spread has been provided to National Forests as optional guidance in the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E).

Social Acceptability and Effectiveness

Management actions must be physically possible (consistent with ecological processes) and economically feasible, but they must also be socially acceptable; that is, they must be consistent with prevailing social norms (Firey, 1960). During scoping, many people expressed that use of herbicides is not socially acceptable, regardless of the effectiveness of the chemical, if its use poses any risk to human health or the environment. Some people are likely to resist any use of herbicides, particularly herbicides perceived to be more potentially harmful (e.g. 2,4-D).

Partnerships and Collaboration in Invasive Plant Management

Invasive plants spread across landscapes, unimpeded by municipal, state, international, and other physical and political boundaries. Behaviors of forest users and neighboring landowners influence the effectiveness of Forest Service actions to control invasive plants. Partnership and cooperation with forest users, neighboring landowners, and other stakeholders increases invasive plant prevention program effectiveness. Scoping comments applauded partnership and collaboration efforts in invasive plant management, and indicated that such efforts should be increased. The 2004 "*USDA Forest Service, Pacific Northwest Region Strategy for Supporting Invasive Plant Management on State and Private Forest Lands*" clarifies and supports partnership and collaborative effects (Appendix I).

4.2.3 Direct and Indirect Effects

The relative effectiveness of each alternative is compared using "years to control," a measure determined by two indicators: (1) the emphasis on prevention and its likelihood to slow the

[21] These documents have been incorporated into the Forest Plans within the Region.
[22] A few National Forests, most notably the Mt. Baker-Snoqualmie, have moved forward in recent years to amend their Forest Plan to include specific direction for the prevention of invasive plants; most Forests have not.

spread of invasive plants and (2) the estimated acreage that would be effectively treated annually. Invasive plants are considered effectively controlled when annual acres of invasive plant spread is less than or equal to the annual acres successfully treated.

All of the action alternatives are likely to decreased rates of spread compared to the current rate of 8-12 percent (Chapter 3.1) for No Action. The actual rate of spread resulting from the implementation of any of the action alternatives is not known. The rate of spread of invasive plants is a complex combination of effective prevention, treatment and site restoration. The change in the rate of spread for the action alternatives relative to No Action is predicted using professional judgment. See the Methodology section (Chapter 4.2.5) for details. Future rate of spread would be monitored in accordance with the monitoring plan framework (Appendix M).

The estimates of rate of spread for the alternatives are based on the type and extent of prevention standards that would be applied to within each alternative. Alternative B includes the most stringent and comprehensive set of prevention standards and is presumed most likely to result in the lowest spread rates (3-4 percent). Alternative D, has fewer, less prescriptive standards, and is presumed to result in relatively less change in rate of spread (6-9 percent). The Proposed Action has more prescriptive prevention standards than Alternative D, but less than Alternative B. The rate of spread is estimated at 4-6 percent for the Proposed Action.

Annual treatment acreage projections are consistent with estimates used in the cost analysis for each alternative (Chapter 4.6.2). These estimates are based on the mix of herbicides approved for use and the relative emphasis on herbicide use in each alternative. For example, Alternative D treats more acreage annually because it allows the use of less expensive herbicides such as 2,4-D.

The combination of rate of spread and annual treatment acreage is an estimate of the number of years until invasive plants would be controlled (acres of spread is less than or equal to acres of treatment each year). More information on methodology is available later in this section and in the project analysis file.

No Action

As discussed in Chapter 3.1, the current extent of invasive plants on National Forests in Region Six is estimated at 420,000 acres. Invasive plants are currently estimated to spread at a rate of 8 to 12 percent annually (USDA FS, 1999-Stemming). Invasive Plant treatment currently occurs at a rate of approximately 25,000 acres per year on National Forest System land in Region Six.

Under No Action, no new prevention standards would be added to Forest Plans in Region Six, and only a limited array of tools for invasive plant control would be available. Some Forests have developed their own prevention strategies and best management practices for invasive plants (e.g. Mt. Baker-Snoqualmie, Okanogan and Wenatchee), however, these standards and practices are not consistently applied across all Forests in the Region. The current rate of spread would likely continue (8 – 12 percent per year) and the acreage of invasive plants would continue to increase by an average of 42,000 acres per year (using a median of 10 percent).

Under No Action, invasive plant populations would especially increase within the potential vegetation groups considered most susceptible to invasion. Ineffective prevention practices could increase habitat available for invasion and result in fewer healthy native ecosystems.

The No Action alternative could indirectly reduce the effectiveness of other agencies involved in invasive plant management in the Pacific Northwest. There are several recent examples with yellow starthistle where the inability of the Forest Service to implement cooperative treatment projects on National Forest land has diminished the value and effectiveness of yellow starthistle control on adjacent private land (personal communications, Dr. Larry Larsen, OSU, and Gary Dade, Union County).

At the current rate of spread (8 to 12 percent) and the current annual treatment acreage (25,000), invasive plants would never be controlled under the No Action alternative (more information on methodology below). Even if treatment budgets in the Region were increased by 25 percent, without increased prevention effectiveness, the rate of invasive plant spread would likely never be less than the rate of treatment.

Action Alternatives

The following discussion compares the standards that are included in the action alternatives and discusses the relationship between the standards and the projected rate of spread for each of the action alternatives. Please refer to Table 2-4 for the specific language of each of the standards (Chapter 2.5).

Prevention Standards

All action alternatives are projected to reduce the rate of spread of invasive plants relative to No Action. The prevention measures under Alternative B are potentially the most effective of the four alternatives, followed by the Proposed Action, Alternative D, and No Action (in that order).

The following section discusses the direct and indirect effects of the prevention standards for the action alternatives. For specific wording of each standard, please refer to Table 2.4.

Standard #1 would tend to reduce seed introduction or spread during Forest Service management activities and reduce the creation of conditions that for invasive plants. By planning to prevent invasive plants, the current rate of spread caused by land management activities would be reduced. The added language in Alternative B is probably negligible because healthy ecosystem management is a current management principle.

Standard #2 would reduce the amount of seed brought in by heavy equipment. Studies have shown (Schmidt, 1989; Hodkinson and Thompson, 1997, Rooney, unpublished) that motor vehicles can pick up and move invasive species seeds and that these seeds will germinate. Since heavy equipment moves between disturbed sites, it is an important vector of invasive species from outside sources. Although vehicle washing studies are not plentiful, Goheen et al. (2004) sampled the effectiveness of vehicle washing in decreasing Port-Orford cedar root rot spores. It showed that the washing of vehicles significantly reduced infection from 41.2 percent to 3.7 percent in sample trees and the washing of a road grader from 27.8 percent infection to 2.2 percent infection. This standard would reduce spread of invasive plants from outside National Forest lands, but will not necessarily reduce the spread within National Forest lands. This could negate any substantial decrease in rate of spread.

Alternative B includes the additional requirement to clean vehicles other than heavy equipment authorized to operate outside the road in Region Six. Vehicle cleaning would be required before leaving the project site or use area. Support vehicles that could accompany heavy equipment would need to be washed more frequently, because they are generally used to access worksites, going in and out of National Forests on a daily basis, while the heavy equipment is moved in and out far less often. Although implementation and enforcement may be challenging, these additional requirements could substantially reduce the rate of spread both in and outside Forest Service land.

Standard #3 in all action alternatives requires use of weed-free straw or mulch to reduce introduction of invasive seeds from outside sources. The use of straw or mulch is common during timber, road construction, livestock or wildland fire rehabilitation, when bare soil is covered to protect it from erosion or when re-seeded areas need protection from the elements. Non-native straw could lead to germination of invasive species in rehabilitated wildfire areas (Penn State Cooperative Extension, 2004).

An indirect effect would be reduced competition for resources between invasive and native plants within and adjacent to mulched areas. Another indirect effect would be an increasing market for weed-free straw and mulch, making supplies easier to obtain, and encouraging other land management entities to use this product. A reduction in rate of spread at the regional scale could occur.

Standard #4 varies between the Proposed Action and Alternative B, and does not apply to Alternative D. For the Proposed Action, weed free feed would be required for horses, livestock and all packstock using Wilderness areas. A similar standard already applies to about 1 million acres of Wilderness on the Mt. Baker-Snoqualmie National Forest, this would not change if No Action or Alternative D are selected.

The Proposed Action requires weed free feed on about 4.6 million additional acres. Consistent use of weed free feed in Wilderness areas would reduce invasive plant introduction along trails and in relatively undisturbed habitat. A substantial positive effect would be the protection of some of the most intact native plant communities in Region Six.

Alternative B includes the weed free feed requirement on all National Forest lands. Alternative B also emphasizes keeping project staging areas, livestock and packhorse corrals, and OHV areas free of invasive plants. These areas would be inspected annually to detect any establishment or spread of invasive plants. These areas have high concentrations of invasive plant seed, therefore more focus on early detection in these areas should reduce rate of spread inside and outside of National Forest System land more substantially than the Proposed Action.

Standard #5 applies solely to Alternative B[23]. It would require that vegetation and forest canopies be maintained in and around project areas. This standard does not clearly specify the extent of these areas, therefore, no estimates can be made about the extent of the impact. Cadenasso and Pickett (2001) demonstrated that an edge of intact vegetation could function as a physical barrier to invasive plant seed dispersal, especially to reduce movement of windblown seed into interior forest. Gelbard and Belnap (2003) also suggested that many invasive species had a low potential for spread away from road prisms into undisturbed habitat. Both studies concluded that healthy native communities could be used as barriers to spread of invasive plants. This standard could reduce the movement of windblown seed in places where this method of dispersal has caused substantial new spread.

[23] Maintaining vegetation as a barrier to the expansion of invasive plant population is addressed as Objective 2.2 under both the Proposed Action and Alternative D.

Standard #6 requires that annual operating plan instructions and grazing allotment management plans incorporate invasive plant prevention measures in cooperation with the permit holder. This standard would likely reduce the introduction and transport of invasive plant seed as a result of change in grazing practices. Prevention measures regarding cattle grazing have been published and are being used in other western states (Sheley in Montana Cooperative Extension, 2002; Center for Invasive Plant Management, 2003; Sheley et al., in Sheley and Petroff, 1999; Wilson et al., in Nevada Cooperative Extension, 1999).

This standard could be interpreted and implemented differently across the Region since specific prevention actions are not required. This standard allows the flexibility for grazing managers and grazing permittees to work together to choose effective prevention measures under their specific circumstances.

Under Alternative B, this standard differs in that it is more specific in prescribing prevention measures, such as altering season of use, resting pastures, retiring allotments and restoring native plant communities in grazing allotments. This added specificity would likely improve the effectiveness of the standard.

The indirect effect of reducing the spread of invasive plants is healthier native plant communities and improved grazing allotment productivity, since livestock benefit from improved native forage.

Standard #7 is in all alternatives. It would reduce the introduction of invasive plant seed by reducing the use of contaminated fill materials. This measure would reduce the rate of spread of invasive plants on National Forests. The effectiveness of this standard would be negated somewhat if the top layer of contaminated fill is not stripped and stockpiled. Annual inspections (Alternative B) increase the likelihood that new infestations are caught in early stages and reduce the rate of spread from maintenance activities the most.

Standard #8 would improve the Region's ability to manage infested roadsides and reduce the spread of invasive plants to uninfested areas along road corridors. This measure should substantially reduce rate of spread from Forest Service land and will improve on early detection/rapid response. The additional requirement in Alternative B would improve its likelihood of preventing spread along road corridors.

Standards #9 and #10[24] apply solely to Alternative B. Roads are conduits for invasive species and these standards would reduce invasive plant movements along these conduits. Road improvements along non-essential roads or where invasives are a problem could exacerbate the invasion process. Gelbard and Belnap (2003) demonstrated in semi-arid landscape that roads improved from four-wheel drive tracks to paved roads tend to become wider and contain an increasing number of exotic plant species. Their results suggested that improving 10 kilometers of four wheel drive tracks to paved roads converted an average of 12.4 hectares of interior native habitat to roadside plant communities that typically contain a substantially greater richness and cover of non-native species. While focused on road paving, this study suggests that road improvement or maintenance can be considered a major agent of land cover change. Minimizing the construction of new roads and minimizing the improvement or widening of existing roads is a viable means of preventing invasive plants. Limiting off road travel would reduce the chances of invasive plant spreading from transportation corridors into less disturbed environments.

Treatment and Restoration Standards

The effectiveness of an alternative to treat the diverse group of invasive plants in Region Six depends to a large degree on the variety of tools available. Each alternative essentially allows for the same group of mechanical, manual, cultural and biological techniques, but has a different array of herbicides. The aggregate number of herbicides available for consideration in each alternative, criteria for selecting herbicide use, and any restrictions on application method imposed by the alternative lead to differences in effectiveness.

The treatment/restoration standards in Alternative B are most limited in the range of herbicides allowed, thus Alternative B may never effectively control certain invasive plants. For instance, under Alternative B, Standard 19 would minimize herbicide application and prohibit broadcast herbicide application methods in riparian areas. This would decrease the effectiveness of riparian treatments for some of the most aggressive invasive plants. If such treatment is avoided in cases where other methods are proven ineffective, the detrimental effects to riparian ecosystem function resulting from invasive plants would likely outweigh the risk of short-term negative impacts to aquatic species. This standard, as written, could lead to an increase in rate of invasive plant spread in riparian areas.

[24] Closing roads and allowing use of OHVs only on designated routes or designated areas are addressed as Objectives 2.4 and 2.5 under both the Proposed Action and Alternative D.

Table 4.2 displays some beneficial aspects of specific herbicides and discusses the problems associated with limiting tools to control invasive plants.

Table 4-2 Beneficial Aspects of Specific Herbicides

Herbicide	Comments
Chlorsulfuron, metsulfuron methyl, and sulfometuron methyl,	Formulations of these herbicides may be useful on some aggressive species that have not been effectively treated by other methods or herbicides. These herbicides would not be used in Alternative B.
Imazapic	The Nature Conservancy reported success in the use of imazapic for restoring native prairie habitats. Imazapic successfully controlled downy brome (cheatgrass) (Shinn and Thill, 2002). It was also successfully controlled a combination of aggressive invasive plants including downy brome, Russian knapweed and perennial pepperweed (Whitson, 2003). This herbicide would not be used in Alternative B.
Picloram	Picloram has been used successfully by the Nature Conservancy (Tu et al., 2001) on several invasive species, although one project did document reduction in forb densities in treated versus untreated areas. An eight year study done by Rice et al., (1997) using herbicides containing picloram, clopyralid and 2,4-D, has shown that using low application rate and specific timing, picloram can be effective in maintaining levels of species diversity in grasslands invaded by spotted knapweed. Because of its persistence in soils, helped suppress spotted knapweed seedlings (along with clopyralid) for at least the first post-treatment growing season. Only a single treatment was used for the entire 8-year period, which did not successfully control the knapweed due to its long-term seed viability. This herbicide would not be used in Alternative B.
Clopyralid	The Nature Conservancy found clopyralid to be effective on numerous invasive species (Tu et al., 2001). DiTomaso et al. (1999) found clopyralid provided effective pre- and post-emergent control of yellow starthistle at very low application rates in tests conducted at several sites in California. This herbicide would be used under all alternatives.
2,4-D	2,4-D was included in plant community diversity studies where its use, in combination with other herbicides, was effective and did not significantly change species diversity. The Nature Conservancy (TNC) has had some success with 2,4-D on their preserves. In Oregon, hoary cress was effectively treated on TNC preserves. In Montana, TNC found that 2,4-D plus picloram was cheaper, but less effective against leafy spurge than higher rates of picloram alone. However, the lower application rates may cause less environmental damage (Tu et al., 2001). This herbicide would not be used in Alternative B or the Proposed Action.

Projected Treatment Acreage

The predicted mix of treatments associated with each alternative and their cost-effectiveness strongly influences the annual effective treatment acreage. The annual treatment acreage is based on current budgets and the costs of various types of chemical and non-chemical treatments (see economic report in the analysis file for detailed methodology). Given current budgets, the alternatives would effectively treat between 20,000 and 40,000 acres per year. Table 4-3 displays the projected annual treatment by alternative.

Table 4-3 Projected Treatment Acreage

	Projected Acres Treated Annually Based on Current Budgets
No Action	25,000
Proposed Action	30,000
Alternative B	20,000
Alternative D	40,000

These figures do not account for differences between the alternatives that may influence the effectiveness of treatments. Effectiveness of treatment may be reduced by standards that limit flexibility and use of effective herbicides in Alternative B, and to a lesser extent, the Proposed Action. For instance, the feasibility and effectiveness of restoration could be reduced in Alternative B by limiting efforts until local native seed becomes available. Delaying revegetation may encourage re-infestation.

Alternative B requires reducing herbicide use over time and limits the use of herbicides as tools of last resort. This standard would require the use of other methods first until they are shown ineffective. The time used in determining ineffectiveness may cause an infestation to increase to the point control is more difficult and, in extreme cases, impossible.

The lack of social acceptability of certain chemicals could influence how effective treatments are, particularly in Alternative D. The public expressed specific resistance to 2,4-D. Indicated treatment acres may be reduced for Alternative D if public resistance effectively limits the use of these chemicals. The limited number of chemicals in Alternative B may also be socially unacceptable and limit partnership cooperation because some of the most aggressive species in Region Six (such as houndstongue, perennial pepperweed, rush skeletonweed) would not be effectively treated. The Proposed Action was designed to include a balance of effective and socially acceptable chemicals.

The increased treatment acreage in Alternative D may less effectively reduce spread because of the lack of the standard requiring prioritization of treatment. Large-scale prioritization of treatments, given limited budgets, is a crucial first step in any integrated weed management program. A suggested prioritization strategy is presented in Chapter 3. Without prioritization, funding may be spent on the wrong species or site. Naturalized species or species with little chance for control may be treated over more aggressive species. For example, a large infestation where populations are scattered could be more effectively controlled from spread if outer perimeter populations are treated first. Without the prioritization of sites, interior populations may be treated first, which will not contain spread outward.

The desire for cost effectiveness in Alternative D may lead to the use of herbicides (which are relatively cheaper than most other methods) instead of a more integrated approach where herbicides could be used in combination with other methods. Site management may be more costly in the long-term than if an integrated approach were used initially. Rate of spread may be reduced where infestations are successfully controlled, but new introductions and spread from uncontrolled infestations would occur at a higher rate than the other action alternatives because there are fewer prevention standards, potentially reducing any net gain from increased treatment effectiveness.

Herbicide resistance could increase under Alternative B because there are fewer herbicide choices. For example, glyphosate is considered more socially acceptable because it is less toxic and less persistent, it usually requires repeated application. Some characteristics of herbicides that lead to resistance include requiring multiple applications during a growing season or over several consecutive growing seasons (Gunsolus, 1999). Characteristics of invasive plants could also favor resistance.

Effectiveness Indicator: Years to Control

Given the projected rates of spread and annual treatment area estimates described above, the years to control invasive plants was calculated in Table 4-4. These relative comparisons indicate that the Proposed Action and Alternative D have more potential to control invasive plants within the foreseeable future than Alternative B, and all action alternatives have more potential than No Action to effectively control invasive plants.

Table 4-4 Years to Control at Current Funding Levels			
	Projected Rate of Spread	**Projected Acres Treated Annually**	**Estimated Years to Control Invasive Plants**
No Action	8 - 12 %	25,000	never
Proposed Action	4 - 6 %	30,000	21 - 32 years
Alternative B	3 - 4 %	20,000	34 – 47 years
Alternative D	6 - 9%	40,000	18 - 34 years

Given current spread rates, invasive plant control could not be achieved by any of the alternatives if invasive plant treatment budgets decline as little as 25 percent. Table 4-5 demonstrates the relationship between spread rate, treatment acreages and years to control invasive plants.

Table 4-5 Years to Control 420,000 Acres of Invasive Plants

Acres Successfully Treated Annually	Annual Spread Rate					
	0%	4%	6%	8%	10%	12%
15,000	29	never	never	never	never	never
20,000	22	47	never	never	never	never
25,000	18	29	never	never	never	never
30,000	15	21	32	never	never	never
35,000	13	17	22	42	never	never
40,000	12	14	18	24	never	never
45,000	11	12	15	18	29	never
50,000	10	11	13	15	20	never
55,000	9	10	11	13	16	22
60,000	8	9	10	11	13	17
65,000	8	9	10	11	12	14
70,000	7	8	9	10	11	12
75,000	7	8	9	9	10	11

4.2.4 Cumulative Effects

Under all alternatives, present and reasonably foreseeable future action will continue to cause ground disturbance on a landscape scale, resulting in introduction and spread of invasive plants. Roads will continue to be a major conduit for invasive plants. Forest Service projections suggest that recreation uses of National Forests will continue to increase. Ground disturbing land management and use activities such as grazing and vegetation management, fuels management (Healthy Forest Initiative), fire suppression, road construction and maintenance, agricultures, and development on other ownerships will continue to cause ground disturbance on National Forests and adjacent lands are likely to present challenges to invasive plant management.

The use of invasive plants by landowners for landscaping, while individually small, collectively result in significant impacts, especially along riparian corridors. All of these activities contribute to creation of conditions favoring invasive plant introduction, spread and establishment. In turn, activities outside National Forest boundaries decrease the effectiveness of Forest Service invasive plant management programs.

Positive cumulative effects could occur as Forest Service efforts are combined with other federal, state, county and private landowner efforts, reducing the rate of spread on a regional level.

Actions proposed in all alternatives would complement the efforts of state control programs and community volunteer efforts. For example, the inclusion of English ivy on the state of Oregon noxious weed list has helped to reduce sale of this species in nurseries and prioritized funding for control of this species by the state. Local volunteer efforts to remove the species has not only decreased the extent of the species, but also educated the public on the problems associated with it, which in turn elicits control on the individual level in private backyards.

Mack et al. (2001) found that effective prevention and control of biotic invasions require a long-term, large-scale strategy, rather than a tactical approach focused on battling individual invaders. Multiple species of invasive plants have spread throughout the region. Focusing solely on a single species or invasion site has the potential to trade one pest for another. By adding to the current efforts, the Forest Service would enhance the current Regional movement to prevent and control invasive plants.

4.2.5 Methodology

The following discussion summarizes the process used to determine effectiveness of the alternatives.

Rate of spread has been modeled for some invasive plant species (Higgins and Richardson, 1996; Richard and Dean, 1998; Bergelson et al., 1993). All invasive plant species have unique strategies for spread and resistance to certain treatment methods. Additionally, the relative success of invasive plant species varies under different site and environmental conditions. Attempting to calculate the rate of spread of over 100 invasive plants operating independently under a wide variety of environmental conditions is not feasible. At this point we can only rely on estimates published in the literature, and the professional judgment and observations of invasive plant specialists.

The current rate of spread for invasive plants on National Forest land in the western United States is estimated to be 8-12 percent (USDA FS, 1999-Stemming). This rate of spread is used in the Forest Service Strategy for Noxious and Non-native Invasive Plant Management (USDA FS, 1999-Stemming) and has been validated as applicable for Region Six by the Regional Noxious Weed Program Manager and field-level botanists.

To proceed with analysis, a set of assumptions related to rate of spread was developed:

- Rate of spread is influenced by the amount of invasive plant seed introduced and the amount of favorable conditions available for seed germination;
- The consistent reduction of activities that promotes favorable conditions or introduce invasive plant seed will reduce the potential for invasion;
- Natural vectors, such as wind, water and wildlife transport, will continue to spread invasive plant seeds; reduction to no spread is not possible; and
- The rate of spread of 8-12 percent is valid for our current condition or the No Action Alternative.

The change in rate of spread for the action alternatives was estimated by developing a relative ranking of prevention effectiveness by alternative. Following the above assumptions, the team evaluated every standard for individual contribution to reducing spread, and then evaluated these standards as a group for each alternative. Prevention effectiveness was ranked for each group of standards based on effectiveness in reducing invasive plant seed introduction and survival (Table 4-6). The potential for effective implementation of each standard was also considered.

Table 4-6 Relative Ranking of Prevention Effectiveness by Alternative

Current Rate of Spread (No Action)	25% Reduction in Rate of Spread (Alternative D)	50% Reduction in Rate of Spread (Proposed Action)	60% Reduction in Rate of Spread (Alternative B)
8 – 12%	6 – 9%	4 – 6%	3 - 4%

Treatment acreages by alternative for this analysis are consistent with those from the Economic Analysis contained in the project analysis file. Acreages were estimated using best professional judgment based on effectiveness of each method of control. The following assumptions were made:

- The effectiveness of the various treatment methods included in the EIS are well documented in the literature;
- Treatment costs would be a factor in the amount of acreage that could be treated by alternative (costs from the Economic Analysis were used);
- The more expensive a treatment, the less acreage could be treated;
- The more viable treatment options available for eradicating new infestations, controlling established infestations and restoring treated areas, the more reduction in infestation size would occur;
- The amount of treatment done annually affects the number of years to control current infestations (i.e. the more treatment done per year, the less amount of years needed to get a handle on the current problem);
- As an infestation is reduced in size, there will be less seed being produced and less vegetative spread; and;
- The most viable treatment options available combined with the most reduction in seed introduction or spread should most effectively reduce infestation sizes and rate of spread.

Over time, as the chosen alternative is implemented, it is expected that the acres of invasive plants in Region Six will change. If appropriate prevention, treatment and restoration standards are implemented, it is reasonable to assume that the combined action of these measures will eventually reduce the overall size of the invasive plant infestations in Region Six.

4.2.6 Incomplete and Unavailable Information

Information on the effectiveness of prevention measures is incomplete or unavailable. While conclusive research regarding the effectiveness of specific prevention practices is sometimes weak or lacking, enough basic information or studies are available to make professional judgments regarding likely effectiveness. For example, studies have shown motor vehicles can pick up and move invasive species seeds and that these seeds will germinate (Schmidt, 1989; Hodkinson and Thompson, 1997; Rooney, unpublished). Since heavy equipment moves between disturbed sites, the professional judgment can be made that heavy equipment is a likely vector for invasive species from outside sources and for the movement of seeds. Studies regarding prevention techniques are cited under each alternative in the analysis above. In addition, evidence linking ground disturbing activities or transportation corridors and the establishment of invasive plants has been gathered (Kimberling et al., 2003; Parks et al., 2003) (Appendix D).

4.3 Effects on Non-target Plants and Native Plant Communities

4.3.1 Introduction

The following section addresses the effects of the herbicides on non-target plants and native plant communities. Concerns about the effects of herbicides to non-target plant species and native plant communities were raised during the public scoping process. Non-herbicide treatments can also harm non-target plants and plant communities, but the impacts are not substantial and are not a significant issue. These effects are disclosed in a specialist report located in the analysis files.

Herbicides have the potential to shift species composition and reduce diversity of native plant communities, as less herbicide-tolerant species are replaced by more herbicide-tolerant species. Certain herbicides and the methods by which they are applied could also harm plant pollinators. If reduction or shift in pollinator species occurs, changes to plant species composition or diversity could follow.

The measuring factors used for comparing the alternatives are:

- Number of herbicides included in each alternative that have a relatively higher potential to harm non-target plants;
- Number of herbicides included in each alternative that have known potential to cause toxic effects to honey bees; and
- Acres of annual herbicide treatment with these herbicides that have a relatively higher potential to harm non-target plants.

The results of the analysis indicate Alternative D has the highest potential to harm non-target plants and native plant communities, as Alternative D includes the most herbicides with a higher potential for harm (5) and would treat the most acres with these herbicides. The No Action has the next highest potential for harm to non-target plants, followed by the Proposed Action and

Alternative B (in that order). Both Alternative D and No Action include three herbicides that have high potential to harm honey bees.

4.3.2 Background

The basis for protecting native plant species and habitats is found in Forest Service regulations. Department Regulation 9500-4 directs the Forest Service through Forest Service Manual 2620.1 to:

1. Manage habitats for all existing native and desired non-native plants, fish and wildlife species in order to maintain at least viable populations of such species.

2. Habitat must be provided for the number and distribution of reproductive individuals to ensure the continued existence of a species generally throughout its current geographic range.

In relation to the use of native plants, a draft policy for the use of native plant materials is currently under internal review. It was developed in response to Executive Order 13148 (the Greening of Government Agencies) and interagency, administration and congressional interest in developing native plant materials to meet the rising demand for restoration plant materials.

Forest Service Manual 2523.2 under Watershed Protection and Management sets priorities for burned area emergency response treatments stating that natural recovery by native species is preferred. It states that when practical, use seeds and plants in these project areas that originate from genetically local sources on native species or when native materials are not available or suitable, give preference to non-native species that meet the treatment objectives, are non-persistent and are not likely to spread beyond the treatment area.

4.3.3 Direct and Indirect Effects

Herbicide Effects on Non-Target Plants

All of the alternatives allow for the use of some herbicides. Twelve active ingredients are considered for use in the alternatives. All have potential to harm non-target plants, in general:

- Herbicides are designed to kill plants; some damage to non-target plant species is probable despite cautious planning and implementation.

- The potential to harm non-target species is dependent on herbicide characteristics. Potency, selectivity, and persistence all play a role in how much harm can occur.

- Herbicide spray, drift, runoff, leaching, or groundwater movement may result in mortality to individuals, reduce their productivity, or lead to abnormal growth patterns.

- For ground and aerial spray applications of herbicides, the closer the non-target species is to the application site, the greater is the likelihood of damage.

- After broadcast application of herbicides, the level and extent of damage to non-target plants depends on site-specific conditions, including wind speed and foliar interception.

- Herbicides can move off-site in water, soil and wind. Site-specific soil and water characteristics, as well as herbicide formulation characteristics, affect this movement. Effects from herbicide movement are plausible for either ground or directed foliar application.

- Measures taken to limit exposure, such as selective application methods (wiping or daubing), could reduce herbicide movement off-site.

This section summarizes the effects to plants by active ingredient. Effects are grouped by the mode of action (how the ingredient kills a plant). Commercial formulations shown in parenthesis are examples of these analyzed in the risk assessments.

Acetolactate Synthase (ALS) Inhibitors – Chlorsulfuron, metsulfuron methyl, sulfometuron methyl, imazapic, and imazapyr work by inhibiting the activity of an enzyme called acetolactate synthase, which is necessary for plant growth. These five active ingredients are very potent herbicides; only a small concentration is necessary to damage plants. In some circumstances, these ingredients could damage non-target species more readily than the other groups of herbicides proposed. On the other hand, lower concentrations mean smaller amounts of toxic substances are released into the environment.

Chlorsulfuron, metsulfuron methyl, and sulfometuron methyl are relatively new herbicides. The active ingredients and commercial formulations could be difficult to use in areas where native plants are a large component of a treatment area. These ingredients could be useful though, in situations where an invasive plant is the dominant cover species or on some aggressive species that have not been effectively treated by other methods or herbicides.

Chlorsulfuron

Chlorsulfuron (used in Telar or Glean) is both a pre-emergent and post-emergent herbicide (i.e. it effectively inhibits seed germination and damages fully emerged plants). It could affect annual, biennial and perennial broadleaf species. Drift could cause damage to non-target plants at distances greater than 900 feet from the application site during a ground based broadcast application.

Chlorsulfuron is very potent relative to the application rate. The typical application rate proposed by the Forest Service for chlorsulfuron is greater than 6,000 times higher than the No Observed Effect Concentration (NOEC) in vegetative vigor studies on less tolerant species (sugarbeets and onions) (SERA, 2003-chlorsulfuron). This means that extremely small amounts will cause observable damage in these species. The risk assessment stated that a very broad range of sensitivities could occur, with grasses appearing far more tolerant than most other species.

The NOEC values for soil exposure used for seedling emergence testing were found to be substantially higher than the vegetative vigor studies (i.e. it would take a higher concentration of the ingredient to cause an observable effect on emerging seedlings than on vegetative vigor of older plants). Nonetheless, offsite movement of chlorsulfuron in runoff could damage non-target plants under conditions that favor runoff. In arid regions, wind erosion if treated soil could also result in damage to non-target plants (SERA, 2003-chlorsulfuron).

Chlorsulfuron has been shown to reduce non-target plant reproduction in a study done on cherry trees (Fletcher et al., 1993). The authors asserted that cherry tree reproduction displayed high sensitivity even when exposed to small quantities of chlorsulfuron, such as might be found in airborne particles traveling long distances, without altering vegetative growth. They postulated that drifting sulfonylureas might severely reduce both crop yields and fruit development on native plants. The same authors in another study compared four herbicides, atrazine, chlorsulfuron, glyphosate and 2,4-D, at low application rates (within the range of reported herbicide drift levels) to four other crop plants. Only chlorsulfuron was found to cause reduction in the yields of these crops if subjected to exposure at critical stages of development (Fletcher et al., 1996).

Metsulfuron methyl

Metsulfuron methyl (used in Escort XP) is also a potent herbicide. It affects many broadleaf and woody species. This ingredient could cause damage to non-target plants at distances of up to 500 feet using a ground based broadcast application. For metsulfuron methyl, the typical application rate is greater than 800 times higher than the NOEC for less tolerant plants (onions) (SERA, 2003).

The offsite movement of this ingredient in runoff could damage non-target plants under conditions favorable to runoff, although this less likely with metsulfuron methyl than chlorsulfuron. In arid regions, wind erosion could also result in damage to non-target species (SERA, 2003).

Sulfometuron methyl

Sulfometuron methyl (used in Oust) is a broad-spectrum pre- and post-emergent herbicide. It is less selective than chlorsulfuron or metsulfuron methyl and is effective against broadleaf and grass species. Sulfometuron methyl drift could cause damage to non-target plants at distances greater than 900 feet from the application site during a ground based broadcast application. Typical application rate is greater than 1875 times higher than the NOEC for less tolerant plants.

The offsite movement of this ingredient in runoff could damage non-target plants under conditions favorable to runoff. This kind of offsite movement is more likely with sulfometuron methyl than with chlorsulfuron and metsulfuron methyl. In arid regions, wind erosion could also result in damage to non-target species (SERA, 2003).

Imazapic

Imazapic (used in Plateau) is a selective herbicide, but even tolerant plants that are directly sprayed at normal application rates are likely to be damaged (SERA, 2003). Affected plants include annual, perennial broadleaf and grass species. Many native bunchgrasses are not affected. Less tolerant species can be affected by drift up to 50 feet from ground applications and up to 100 feet from aerial applications. In clay soils in areas of relatively high rainfall rates, conditions in which runoff is favored, there could be a slight risk to some sensitive terrestrial plants.

Imazapic is more selective than imazapyr. It is less likely to harm native plants or plant communities.

Imazapyr

Imazapyr (used in Arsenal, Chopper and Stalker®) is a non-selective herbicide. Tolerant plants that are directly sprayed at normal application rates are likely to be damaged (SERA-Imazapyr, 2003). Less tolerant species can be affected by drift up to 500 feet by imazapyr. Imazapyr can also "leak" out of the roots of treated plants, and therefore can adversely affect the surrounding native vegetation (Nature Conservancy, 2001).

When applied in areas in which runoff is favored, damage from runoff appears to pose a greater hazard than drift. Residual soil contamination could be prolonged in some areas. In arid areas, residual toxicity to sensitive plant species could last for several months to several years. Residual contamination could be much shorter in areas of relatively high rainfall (SERA, 2003-Imazypyr).

Synthetic auxins – Picloram, clopyralid, triclopyr, 2,4-D, and dicamba mimic naturally occurring plant hormones called auxins. They kill plants by destroying tissue through uncontrolled cell division and abnormal growth.

Picloram

Picloram (used in Tordon®) is selective for broadleaf and woody plants. It could impact sensitive species at distances of nearly 1000 feet from the application site (SERA, 2003-Picloram).

In their Pesticide Re-registration Fact Sheet (1995), the EPA noted that picloram poses very significant risks to non-target plants. Estimated concentrations of picloram in the environment are hundreds to thousands of times the "level of concern" at which 25 percent of seedlings fail to emerge. The EPA also noted that picloram is highly soluble in water, resistant to biotic and abiotic degradation processes, and mobile under both laboratory and field conditions. They stated that there is a high potential to leach to groundwater in most soils. Plant damage could occur from drift, runoff, and distant areas where ground water is used for irrigation or is discharged into surface water (EPA, 1995). Labeling restrictions from these findings were implemented to reduce effects.

Because picloram persists in soil, non-target plant roots can take up picloram (Nature Conservancy, 2001) and could impact revegetation efforts.

Lym et al. (1998) recommended that livestock not be transferred from treated grass areas onto sensitive broadleaf crop areas for 12 months or until picloram has disappeared from the soil without first allowing seven days of grazing on an untreated green pasture. Otherwise, urine may contain enough picloram to injure sensitive plants. To a lesser degree, this can occur with other active ingredients such as 2,4-D, glyphosate and imazapic.

Clopyralid

Clopyralid (used in Transline) is more selective than picloram. As with picloram, clopyralid has little effect on grasses, but also does little harm to members of the mustard family. It is effective on the sunflower, legume, nightshade, knotweed and violet families. It is less persistent than picloram. Off-site drift may cause damage to sensitive plant species at distances of about 300 feet from the application site. Wind erosion of treated soil in arid climates could also cause damages in the range of 200 to 900 feet.

Use of clopyralid in a roadside revegetation project had mixed results (Tyser et al., 1998). Native grasses increased while native forbs decreased, which is typical for an ingredient that is selective against forbs. However, non-native annual grasses increased in this study.

Triclopyr

Triclopyr (used in Garlon) is a selective systemic herbicide. It is used on broadleaf and woody species. It is commonly used against woody species in natural areas (Tu et al., 2001). Sensitive species could be impacted by drift from 100 feet (typical Forest Service application rate) to 1000 feet (maximum US Forest Service application rate) (SERA, 2003-Triclopyr).

Two forms of triclopyr could be used with differing degrees of effects. Triclopyr BEE (butoxyethyl ester) is more toxic to plants than triclopyr TEA (triethylamine salt). Triclopyr BEE formulations are more apt to damage plants from runoff than other formulations.

Both formulations have been found to decrease the relative long-term abundance and diversity of lichens and bryophytes. Newmaster et al. (1999) stated drift from triclopyr could affect the sustainability of populations of lichens and bryophytes, where these ingredients reduced abundance. Normal application rates in aerial spraying were found to reduce abundance by 75 percent, variable by species. Colonists and drought-tolerant species were more resistant than the mesophytic forest species, which means that herbicide treatments could essentially push back the successional stage on a non-vascular community.

Triclopyr was found to inhibit growth of four types of ectomychorrhizal fungi associated with conifer roots at concentrations of 1,000 parts per million (Estok et al., 1989).

2,4-D

2,4-D (used in 20 commercial formulations) is a selective herbicide that kills broadleaf plants, but not grasses. It has a long history of use and is relatively inexpensive. Direct spraying of non-target plant species is the highest potential for damage due to 2,4-D application. Drift could damage to non-target species at a distance close to the application site (much less than 100 feet).

Dicamba

Dicamba (used in Vanquish or Banvel®) is a selective, systemic herbicide that can affect some annual, biennial, perennial broadleaf and woody species as well as annual grasses. Some tolerant plants directly sprayed at normal application rates are likely to be damaged. The greatest risks are associated with runoff but are highly site specific. In areas in which runoff is not likely, risks to offsite plants is minimal. Wind erosion may cause impacts in arid regions. Drift may cause damage to sensitive species at distances less than 100 feet from the application site.

Vaporized or volatilized dicamba can affect non-target plants. Vaporization does impact vegetation, but much more study in air concentration-duration relationships needs to be done to quantify the level of effects. The impacts should be less pronounced with Vanquish than with Banvel (SERA, 2003-Dicamba). Vaporization potential will be dependent on atmospheric stability and temperature. Dicamba vapor has been known to drift for several miles following application at high temperatures (NCAP, 1995).

EPSP Synthase Inhibitors – Glyphosate preventing plants from synthesizing three aromatic amino acids. The key enzyme inhibited by glyphosate is called EPSP.

Glyphosate

Glyphosate (used in 35 formulations including RoundUp and Rodeo®) is a non-selective systemic herbicide that can damage all groups or families of non-target plants to varying degrees, most commonly from off-site drift. Plants sensitive to glyphosate can be damaged by drift up to 100 feet from the application site at the highest rate of application proposed. More tolerant species are likely to be damaged at distances up to 25 feet (SERA, 2003-glyphosate).

Non-target species are not likely to be affected by runoff based on the NOEC for pre-emergent vegetation. Glyphosate strongly adsorbs to soil, and has a low potential to leaching into groundwater systems (SERA, 2003-glyphosate). Because it adsorbs readily to soils, plant roots do not readily absorb it. Non-target species will not be impacted through their roots.

Some field studies have been conducted using glyphosate. Miller et al. (1999) found no effects to plant diversity in an 11-year study on site preparation using herbicides, though the structural composition and perennial species presence were changed. Such differences in overstory and understory vegetation may have ecological implication. For instance, reductions in several species (*Vaccinium* and *Prunus* species) in the understory could affect wildlife species dependent on them for food, and could also affect traditional gathering of these species. As discussed in the effects summary of triclopyr, Newmaster et al. (1999) raised concern that drift from glyphosate could affect long term sustainability of populations of lichens and bryophytes.

Acetyl CoA Caroxylase (ACCase) Inhibitors – Sethoxydim inhibits acetyl CoA carboxylase, the enzyme responsible for catalyzing an early step in fatty acid synthesis. Non-susceptible species have a different CoA carboxylase binding site, rendering them immune to the effects.

Sethoxydim

Sethoxydim (used in Poast®) kills post-emergent annual and perennial grasses by preventing the synthesis of lipids. Because sethoxydim is water-soluble and does not bind strongly with soils, it can be highly mobile in the environment. Rapid degradation generally limits extensive movement. In water, sethoxydim can be degraded by sunlight within several hours (Tu et al., 2001).

For relatively tolerant species, there is no indication that damage from drift would result at distances more than 25 feet from application sites. For sensitive species, there is a possibility of damage no greater than 50 feet from application sites. Runoff could cause damage to sensitive plants in areas of high rainfall (SERA, 2001-sethoxydim).

Herbicide Effects on Pollinators

Pollinators can be impacted, directly or indirectly, by any herbicide. This in turn can cause indirect effects on native plant communities. Plants that are dependent on a particular insect for pollination may experience a decrease in reproductive capabilities if their pollinator is impacted by herbicides.

It is estimated that there may be between 130,000 and 200,000 invertebrate and vertebrate species that regularly visit the flowers of higher plants, which depend on these animals to assure cross-pollination. The majority of flowering plants in the world (88 percent) are pollinated by beetles. Bees are the third most common pollinator (16.6 percent of flowering plants) after the Hymenoptera or wasp group, (18 percent) (Buchman and Nabhan, 1996).

Very little information is available on the effect of herbicides on native pollinators. Most information is about the non-native honey bee. It is known that pollinators can be directly affected by spray or indirectly when plants needed as food for adults or larvae are eliminated by herbicides. The only known quantified effects are from direct spray. The active ingredients used in the Proposed Action are not expected to have toxic effects when directly sprayed on honey bees at the typical Forest Service application rate. Table 4-7 lists the potential herbicide doses for bees in a direct spray scenario.

Table 4-7 Potential Herbicide Doses for Bees in a Direct Spray Scenario

Herbicide	Typical Application Rate	Potential Dose for Bee	Toxic Level for Bee
Chlorsulfuron	0.056 lb/ac	8.98 mg/kg	>25 mg/kg (LD_{50})
Clopyralid	0.35 lb/ac	56.1 mg/kg	909 mg/kg (no mortality)
Dicamba	0.3 lb/ac	48.1 mg/kg	1000 mg/kg (no mortality)
Glyphosate	2.0 lb/ac	321 mg/kg	540 mg/kg (NOAEC)
Imazapic	0.13 lb/ac	16 mg/kg	387 mg/kg (no mortality)
Imazapyr	0.45 lb/ac	72.1 mg/kg	1000 mg/kg (no mortality)
Metsulfuron Methyl	0.03 lb/ac	4.81 mg/kg	270 mg/kg (NOEC)
Picloram	0.35 lb/ac	56.1 mg/kg	1,000 mg/kg (no mortality)
Sethoxydim	0.3 lb/ac	60.1 mg/kg	107 mg/kg (NOAEL)
Sulfometuron Methyl	0.045 lb/ac	7.21 mg/kg	1,075 mg/kg (NOEC)
Triclopyr BEE	1.0 lb/ac	160 mg/kg	>1,075 mg/kg (LD_{50})
Triclopyr TEA	1.0 lb/ac	160 mg/kg	>1,075 mg/kg (LD_{50})
2,4-D	1.0 lb/ac	163 mg/kg	124 mg/kg (LD_{50})
NP9E	1.67 lbs/ac	268.00 mg/kg	unknown

Table 4-7 shows that 2,4-D (included in Alternative D) may have toxic effects on bees if direct application occurs under the typical Forest Service application rate. Two ingredients, glyphosate and triclopyr, may have some toxic effects if applied at the maximum application rate proposed by the Forest Service (SERA, 2003-glyphosate; SERA, 2003-Triclopyr).

Using broad spectrum herbicides to control weeds and restore native plant communities can indirectly harm pollinators by removing either caterpillar host plants or foraging flowers that provide pollen and nectar to existing populations (Shepherd et al., 2003). Herbicide treatments could be beneficial to pollinators if native plants are returned to the treatment areas.

Herbicide Effects on Plant Diversity

Some studies cited in this EIS found that species diversity was not affected by herbicide treatment. Species diversity was determined using the number, or richness, of species found on a site. Diversity was then evaluated by comparing the distribution of the number of species by total cover of the plant community using diversity indices. More species distributed across an area equates with higher species diversity.

The number of species on a site may not significantly change, but the composition of these species could change. For example, replacing perennial natives with the same number of non-native annuals may not change species diversity, but could change composition enough to affect other components of the ecosystem. Naeem et al. (1999) summarized studies related to biodiversity and ecosystem functioning. Recent theoretical models predict that decreasing plant diversity leads to lower plant productivity. These models also show diversity and composition are equally important determinants of ecosystem functioning.

DiTomaso (2001) points out that continuous broadcast use of one or a combination of herbicides will often select for tolerant plant species. When broadleaf selective herbicides are used, noxious annual grasses such as medusahead, cheatgrass or barbed goatgrass may become dominant. Population shifts through repeated use of a single herbicide may also reduce plant diversity and cause nutrient changes. For example, legume species are important components of rangelands, pastures, and wildlands, and are nearly as sensitive to clopyralid as yellow starthistle. Repeated clopyralid use over multiple years may have a long-term detrimental effect on legume populations. Thus, multiple herbicides should be included in a completely integrated invasive plant strategy.

Alternative Comparison

The following summarizes and compares the effects of the alternatives on non-target plants and native plant communities. Herbicide choice, application method and extent of herbicide use determine the relative risk.

No Action

Under No Action, the use of herbicides is the most common means of treating invasive plants, followed by manual treatments (see Chapter 4.5). The combination of glyphosate, picloram, dicamba, triclopyr and 2,4-D (as a last resort) does not provide as wide a range of tools as the Proposed Action or Alternative D. The combination is relatively non-selective, with no herbicide useful on non-native grasses.

Because of the heavy reliance on Picloram under No Action, the threat of off site damage to native plants and plant communities under No Action would be higher than in the Proposed Action and Alternative B. Picloram was the most commonly used herbicide over a four year period in Region Six (Forest Service Pesticide Use Reports, 2004). Picloram is one of the more persistent herbicides. It can move readily to non-target native plants through root translocation or runoff.

No Action could degrade the health of native plant communities near herbicide treatments where runoff or drift has occurred. Native plant families affected by these herbicides would be harmed, decreasing their dominance. Healthy native plant communities would continue to decrease in acreage, especially in highly susceptible plant communities (described in Chapter 3) such as grasslands, westside dry forests and eastside dry forests.

Proposed Action

Under the Proposed Action, herbicide use (including aerial spraying) is still the most common means of treating invasive plants. Standard 16 provides a 'toolbox' of ten herbicides under the Proposed Action. It offers more choice in regards to selectivity, potency and persistence than No Action or Alternative B, which directly affects the potential to harm non-target species. For example, selective herbicides could be used where the density of non-target, desirable species is high. Herbicides that are more potent would also be available for treating highly aggressive species. Herbicides that remain persist in soil would be available to decrease re-infestation of invasive species with long-term viable seed, when the potential for other environmental impacts is minimized. Infestations found in highly susceptible vegetation groups (e.g. grasslands, shrublands, dry forest or woodland communities of the east and west side) could be controlled before they become large.

Standard 16 restricts aerial applications for the more powerful ingredients of the sulfonylurea group to mitigate effects from offsite drift. It also restricts triclopyr to selective applications, which will also reduce direct effects to woody species. There are fewer direct impacts to native non-target plants in the Proposed Action due to these restrictions.

Alternative B

Alternative B restricts the number of available herbicides more than the other alternatives. Standard 16 restricts the use of the five acetolactate synthase-inhibiting herbicides. While potentially reducing direct effects on non-target plants from these potent herbicides, this restriction could indirectly impact native plant communities because more aggressive invasive plant species could not be controlled.

Alternative B does not provide the range of selectivity, potency, and persistence needed to tackle the number of invasive plants found in Region Six. For example, glyphosate, may not have the potency of other herbicides, but it is non-selective, and can potentially harm non-target species.

While Alternative B could control small infestations in those potential vegetation groups that are less susceptible to invasion, such as moist forests, it would not control infestations in highly susceptible vegetation groups to the detriment of the native plant communities.

Alternative D

Under alternative D, herbicide use could occur more frequently than under the other alternatives. Treatment Standard 16 under this alternative allows for the largest number of herbicides, adding the substantially lower cost herbicide, 2,4-D. It allows for all application techniques and does not limit aerial spraying for the sulfonylurea group or broadcast spraying for triclopyr, as in the Proposed Action. Allowing these application techniques could lead to more direct effects on non-target plants and plant communities than the other alternatives due to the increased potential for drift of the more potent, non-selective or persistent herbicides.

Sprayed directly, pollinators could be affected by 2,4-D at the typical Forest Service application rate, or glyphosate or triclopyr at the maximum Forest Service application rate. Pollinators could be indirectly affected by reduction in plants required by the larvae of the pollinators. Indirect effects of changes to pollinators would also lead to changes in species composition of native plant communities. Plant species with limited pollinators may be more apt to decrease in numbers; some rare plants fall in this category. Those plant species with a larger variety of pollinators would thrive. Overall, species diversity could change and most likely decrease.

Alternative D could more quickly control new infestations of invasive species in highly susceptible vegetation groups. Increased use of herbicides may damage native plants and plant communities more than other alternatives.

The effects of the alternatives by the comparison factors are summarized in Table 4-8. As stated earlier, all herbicides have the potential to harm non-target species. The determination of "relative potential for harm" was based on potency, selectivity, persistence, and application method variations between alternatives. For instance, the lack of restriction on aerial spraying of the sulfonylurea ingredients in Alternative D is the reason they have "relatively higher potential to harm" under that alternative. Glyphosate has "relatively higher potential to harm" due to non-selectivity and lack of aerial spray restrictions for any alternative. The herbicide use ratios in Chapter 4.5 were used to calculate estimated acres treated by herbicide per year in each alternative. As stated in Chapter 4.5, herbicide use ratios are not exact. The acreages presented in this table are considered estimates only and are meant as a means for relative comparison only.

Table 4-8 Summary of Effects by Measuring Factors

Comparison Factor	No Action	Proposed Action	Alternative B	Alternative D
Number of herbicides in each alternative that have a relatively higher potential to harm non-target plants.	4 – picloram, glyphosate, triclopyr, dicamba	3 – glyphosate, imazapyr, picloram[25]	1 - glyphosate	5 –chlorsulfuron, metsulfuron methyl, sulfometuron methyl, picloram, glyphosate, triclopyr, dicamba
Acres of annual treatment with these herbicides that have a relatively higher potential to harm non-target plants.	12,956	8,369	2,031	15,428

[25] Implementing standard 16 would mitigate potential effects of chlorsulfuron, metsulfuron methyl, sulfometuron methyl, which prohibits these agents from being applied aerially in the Proposed Action. Potential effects of triclopyr would be mitigated by implementing standard 16, which restricts application to selective methods in the Proposed Action and Alternative B.

Table 4-8 Summary of Effects by Measuring Factors				
Comparison Factor	**No Action**	**Proposed Action**	**Alternative B**	**Alternative D**
Number of herbicides included in each alternative that have known potential to cause toxic effects to harm honey bees.	3 – 2,4-D, glyphosate and triclopyr[26]	2 – glyphosate and triclopyr	1-glyphosate	3 – 2,4-D, glyphosate and triclopyr

Although the use of herbicides represent potential risks to non-target plants and native plant communities, direction included in all the alternatives would tend to minimize actual impacts. At the project scale, choices can be made to avoid situations that could potentially cause harm. For instance, certain herbicides can be avoided in specific areas or times of the year when/where these non-target plants may be at most risk, or more specific application methods can be used. Actual adverse effects are therefore not likely to occur or will be minimal. Any short-term adverse effects would be largely offset by the long-term benefits to native plant communities from protecting them from invasion of invasive plants.

4.3.4 Cumulative Effects

Herbicide use on all land ownerships in Oregon and Washington pose risks to non-target plants. The choice of any alternative in this EIS would do little to affect the cumulative, ongoing risk because the number of acres treated in Region Six is very small relative to other ownership treatments. The level of risk associated with Alternative D, which has the highest potential for herbicide use and drift, would be a minor component of the total herbicide use across the states of Oregon and Washington.

The Proposed Action, with its balance of effective prevention, treatment, and restoration standards, could lead to an eventual reduction in herbicide use on a larger scale. Adjacent lands would need less treatment as new infestations and sizes of large infestation are reduced in the Proposed Action. If chemicals and application methods that are less damaging to non-target plants are demonstrated to be cost-effective, adjacent landowners are more likely to use the less damaging tools.

[26] Toxic effects for glyphosate and triclopyr show up only at the highest application rate.

4.3.5 Methodology

Risk assessments provided the basis for the analysis of effects on non-target plants. In these assessments, the potential for non-target effects through off-site drift from ground spray, aerial spray, and runoff were disclosed for each herbicide. Effects on pollinators were derived from risk assessment information on effects from direct spray on honey bees.

Herbicide labels were also used for more species-specific information. Using label information about controlled species, effects to closely related species could be extrapolated.

Effects were summarized based on the species groups used in the risk assessment. These groups are typically used on herbicide labels and weed management handbooks when describing the selectivity of various commercial formulations. These groups are broadleaf, grass and woody species. Broadleaf species, also known as dicots, are non-grasslike species. Grass-like species included all monocots. Monocots and dicots move water and nutrients in different ways, which can vary plant response to herbicides. Woody species are also dicots, but this group can also react differently.

Herbicides were compared by their selectivity. The ability to damage a broad spectrum of plant species, families or groups would make an herbicide non-selective. The ability to damage only some species or families within a group makes an herbicide selective. The more selective an herbicide is, the less impacting it would be on non-target plants.

Herbicides were compared by their potency. Potent herbicides, which take a very small amount of active ingredient to cause damage, were considered to have the potential to affect non-target plants when application methods did not restrict drift.

Herbicides were also compared by the persistence in the environment and their ability to move off-site from where they were applied. An herbicide known to persist over more than a year would have the ability to affect non-target plants more than a non-persistent herbicide either directly through off site movement or indirectly through impeding native or desirable seed germination. This persistence characteristic could also benefit native plant communities by reducing the ability of the invasive plants to germinate.

4.3.6 Incomplete and Unavailable Information

Uncertainty exists regarding the effects on non-target species and pollinators because native species are not the usual test species for EPA toxicity studies. The EPA performs studies predominantly on crop species. Boutin et al. (2004) concluded that it was likely that the current suite of tested species were not representative of the habitats found adjacent to agricultural treatment areas, and suggested the current suite of tested species and might cause an unacceptable bias and underestimated risk.

Information is incomplete on effects to native species, so impacts were extrapolated from the risk assessment or herbicide labels. Using herbicide labels to identify close relatives of native or desirable species does help to reduce this uncertainty. Herbicide effects on native plant species studies are cited in the analysis.

4.4 Effects of Herbicides to Certain Birds, Mammals and Amphibians

4.4.1 Introduction

The following terminology from Chapter 3.3 are repeated here for easy reference, these definitions apply to Sections 4.4 and 4.5.

Terminology

NOAEL – *No-observed-adverse-effect level*: Dose that results in effects that do not appear to impair the organism's ability to function and clearly do not lead to impairment.

LOAEL – *Lowest-observed-adverse-effect level*: The lowest dose associated with an adverse effect.

***toxicity index*:** The benchmark dose used in this analysis to determine a potential adverse effect when it is exceeded. Usually a NOAEL, but when data are lacking other values may be used.

RfD: *Reference Dose,* a numerical estimate of a daily exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or minimum dose for producing effects.

Results of numerous field studies indicate the likelihood for actual adverse effects to wildlife from herbicide use is low (Rice et al., 1997; Sullivan et al., 1998; Cole et al., 1997; Johnson and Hansen, 1969) but the use of herbicides to treat invasive plants does have the potential to harm free-ranging wildlife. Certain herbicides have the potential, for example, to affect the vital organs of some wildlife species, change body weight, reduce the number of healthy offspring, increase susceptibility to predation, or cause direct mortality. Birds and mammals may ingest vegetation or insects that have been sprayed with some herbicides and potentially experience these types of effects. Herbicides may also cause some malformations or mortality to amphibians that have been exposed to herbicides or surfactants in water.

The results of the herbicide analysis indicate that birds or mammals that eat grass or insects are most susceptible to harm from herbicides. Birds or mammals that eat vegetation (primarily grass) that has been sprayed with herbicides, have relatively greater risk for these effects because herbicide residue is higher on grass than it is on other herbaceous vegetation or seeds (Kenaga, 1973; Fletcher et al., 1994; Pfleeger et al., 1996). Because of their small size and relatively larger surface area, herbicide residues on insects may also be higher (Kenaga, 1973). For these animals to be exposed to potentially harmful doses, herbicides would have to be broadcast sprayed over a large enough area that the animal could forage exclusively within the treatment area for one day. Some birds and mammals that eat grass include grizzly bears, elk, rabbits and hares, chukar, California quail[27], and geese. Insect-eating mammals include bats and shrews. Insect-eating birds include a huge number of species, such as bluebirds, flycatchers, swallows, wrens, and others.

The alternatives are evaluated for their potential to result in harmful doses, by comparing the different suites of herbicides allowed in each alternative. The measuring factors used for comparing the alternatives are:

- The total number of plausible exposure scenarios in each alternative that exceed the toxicity indices for birds and mammals that eat vegetation or insects[28].
- The number of acres projected to be treated with an herbicide that results in at least one plausible scenario, exceeding the lowest-observed-adverse-effect level (LOAEL) at typical or highest application rates.
- The number of herbicides in each alternative that could adversely affect amphibians.

The results of the analysis indicate that Alternative D poses the highest potential risk to wildlife. It includes the greatest number of plausible scenarios (31 at typical application rates, and an additional 19 at highest rates[29]) that exceed the toxicity indices. Under Alternative D, approximately 27,300 acres are projected for annual treatment with herbicides[30] where estimated doses exceed LOAEL's for birds and mammals that eat vegetation or insects. Alternative D also includes use of three chemicals that could harm amphibians.

In contrast, Alternative B poses the lowest potential risk to wildlife. It is associated with 5 plausible exposure scenarios at typical application rates, and an additional 8 at highest rates, that

[27] Some bird species (like quail) are primarily herbivorous as adults but require insects as a primary food source as chicks.
[28] The calculation of number of plausible scenarios for typical and highest application rates includes any scenario where the estimated dose exceeds the "No-observable-adverse-effect-level (NOAEL)" or other benchmark dose, known as a *toxicity index*.
[29] The "typical application rate" is the most common rate used for Forest Service applications. The "highest application rate" is the highest allowable rate printed on the herbicide label.
[30] The number of acres predicted to be treated with herbicides comes from the economic analysis done for this DEIS.

exceed the toxicity indices for birds and mammals; and includes one chemical that may harm amphibians. Under Alternative B, we predict that 2,539 acres will be treated with herbicides where estimated doses exceed LOAEL's.

These differences seem substantial, however in practice, the management direction included in all alternatives (including No Action), as well as environmental conditions and animal behavior, would tend to minimize actual impacts. At the project scale, choices can be made to avoid scenarios that could cause harm to wildlife. For instance, certain chemicals can be avoided in specific areas or times of the year, where/when grass-eaters or amphibians may be at risk.

4.4.2 Background

All invasive plant treatment methods have the potential to temporarily disturb, displace, or directly harm various wildlife species. However, the focus of this issue is the effects from herbicides on wildlife. The public expressed specific concern about chemicals and their effects on animals. Little concern was expressed about the effects of other kinds of treatment (manual/mechanical and biological). The effects of these other methods were considered and documented in "The Effects of Non-herbicidal Methods of Invasive Plant Treatment on Wildlife, Fish and Plants" report in the analysis file for this EIS. The report concludes that these effects do not differ substantially between the alternatives, and that management direction common to all alternatives would effectively prevent significant effects from occurring.

This analysis considers how animals may be exposed to herbicides (*exposure routes*), and the likelihood that this exposure might actually occur (*plausible exposure scenarios*). A plausible exposure scenario is used as a measure of potential effects to individual animals. The size and distribution of treatment areas, the dispersed populations of terrestrial wildlife, and the foraging area and behavior of individual animals eliminate the potential for direct effects at the population level. Herbicide effects analysis relies on information in the FS/SERA Risk Assessments (1998, 2001, 2003) unless otherwise noted. The risk assessments used peer-reviewed articles from public scientific literature, current Environmental Protection Agency (EPA) documents available to the public, and Confidential Business Information[31] to evaluate toxicity and risk from the herbicides analyzed. Detailed information on the herbicide analysis conducted for this EIS,

[31] Confidential Business Information (CBI) is defined as information that contains trade secrets, commercial or financial information, or other information that has been claimed as confidential by the submitter (EPA/OPP website 2004). Individuals must apply for and be granted access to CBI.

including the potential for endocrine disruption and synergistic effects, is documented in the "Summary of Herbicide Effects to Wildlife" report in the analysis file for this EIS.

Quantitative estimates of worst-case doses of herbicide have been calculated using information such as body size, diet, and water concentrations to calculate the potential dose a certain type of animal might receive. Acute doses were evaluated against the chronic toxicity index, which likely over-estimates risk. Data on toxicity of herbicides to amphibians are more limited than data for mammals and birds. Consequently, quantitative estimates of dose from exposure scenarios for all chemicals have not been created for amphibians in the Forest Service/SERA risk assessments.[32] Toxicity data and exposure scenarios for fish provide a reasonable surrogate for effects on amphibians. With a few exceptions, the toxicity index for each herbicide represents a sub-lethal effect. Tables 4-9 and 4-10 show that herbicides considered for use in this EIS may result in the following effects to wildlife.

Potential effects to Federally listed and Forest Service Sensitive species are discussed later in Chapter 4.7.3).

Table 4-9 LOAELs Reported for Mammals

Classified by Herbicides Included in this EIS (SERA 1998, 2001, 2003)

Herbicide	Duration*	Species	Effect Noted at LOAEL
Chlorsulfuron	Acute	Rabbit	Decreased weight gain
	Chronic	Rat	Weight changes
Clopyralid	Acute	Rat	Decreased weight gain
	Chronic	Rat	Thickening of gastric epithelium
Dicamba	Acute – larger mammal	Rabbit	Weight loss, increased post-implant losses, decreased number of live young
	Acute – smaller mammal	Rat	Neurotoxic effects (e.g. impaired gait)
	Chronic – all sizes	Rabbit	Weight loss, increased post-implant losses, decreased number of live young
Glyphosate	Acute	Rabbit	Diarrhea
	Chronic	Rabbit	Diarrhea
Imazapic	Acute	Rabbit	Decreased body weight

[32] Amphibian exposure scenarios are available for sulfometuron methyl.

Table 4-9 LOAELs Reported for Mammals

Classified by Herbicides Included in this EIS (SERA 1998, 2001, 2003)

Herbicide	Duration*	Species	Effect Noted at LOAEL
	Chronic	Dog	Microscopic muscle effects
Imazapyr	Acute	Dog	No effects at highest doses
	Chronic	Dog	No effects at highest doses
Metsulfuron methyl	Acute	Rat	Decreased weight gain
	Chronic	Rat	Decreased weight gain
Picloram	Acute	Rabbit	Decreased weight gain
	Chronic	Dog	Increased liver weight
Sethoxydim	Acute	Rabbit	Reduced number of viable fetuses, some maternal mortality
	Chronic	Dog	Mild anemia
Sulfometuron methyl	Acute	Rat	Decreased body weight
	Chronic	Rat	Effects on blood and bile ducts
Triclopyr	Acute	Rat	Malformed fetuses
	Chronic	Dog	Effect on kidney
2,4-D	Acute	Rat & Dog	Effects on kidney, blood, and liver
	Chronic	Rat & Dog	Effects on kidney, blood, and liver

* An acute dose is one large dose. A chronic dose is a smaller amount given repeatedly over time.

Table 4-10 LOAELs Reported for Birds

Classified by the Herbicides Included in this DEIS. (SERA 1998, 2001, 2003)

Herbicide	Duration*	Species	Effect Noted at LOAEL
Chlorsulfuron	Acute	Quail	Decreased weight gain
	Chronic	Quail	No effect at highest dose
Clopyralid	Acute	Mallard & Quail	No signs of toxicity reported, LOAEL not determined
	Chronic	Rat	Thickening of gastric epithelium
Dicamba	Acute	Quail	Neurotoxic effects
	Chronic	Quail	Neurotoxic effects
Glyphosate	Acute	Mallard & Quail	No effects at highest dose
	Chronic	Mallard & Quail	No effects at highest dose
Imazapic	Acute	Quail	No effects at highest dose
	Chronic	Quail	Decreased weight gain in chicks

Table 4-10 LOAELs Reported for Birds

Classified by the Herbicides Included in this DEIS. (SERA 1998, 2001, 2003)

Herbicide	Duration*	Species	Effect Noted at LOAEL
Imazapyr	Acute	Quail	No effects at highest dose
	Chronic	Mallard & Quail	No effects at highest dose
Metsulfuron methyl	Acute	Quail	Decreased weight gain
	Chronic	Mallard & Quail	No effects at highest dose
Picloram	Acute	Chicken & Pheasant	Changes to reproduction
	Chronic	Dog	Increased liver weight
Sethoxydim	Acute	Mallard & Quail	No or low mortality at highest doses tested
	Chronic	Mallard	Decreased number of normal hatchlings
Sulfometuron methyl	Acute	Mallard	Decreased weight gain
	Chronic	Rat	Effects on blood and bile ducts
Triclopyr BEE	Acute	Quail	Mortality
	Chronic	Mallard & Quail	Decreased survival of offspring, reduced eggshell thickness
Triclopyr TEA	Acute	Quail	Mortality
	Chronic	Mallard & Quail	Decreased survival of offspring, reduced eggshell thickness
2,4-D	Acute	Mallard & Quail	Mortality
	Chronic	Rat & Dog	Effects on kidney, blood, and liver

* An acute dose is one large dose. A chronic dose is a smaller amount given repeatedly over time.

4.4.3 Direct and Indirect Effects

All of the alternatives are associated with plausible scenarios that exceed the toxicity indices for birds and mammals that eat grass or insects, acres treated that exceed a LOAEL, and herbicides that may adversely affect amphibians. The number of plausible scenarios is a worst-case estimate. All toxicity indices used in this analysis are the lowest dose from the species most sensitive to herbicide effects.

The number of acres estimated to be treated by herbicides that could exceed LOAEL doses at label rates indicates plausible risk to wildlife. Individual projects conducted are likely to involve small total acreages, or long narrow road shoulders. A review of existing Environmental

Assessments for invasive plant treatment in the region, indicated that many treatment sites are less than one acre in size while projects exceeding 200 acres were not typical. There could be rare projects exceeding 1,000 acres during the time frame of this EIS.

Indirect mortality is possible from sublethal effects that could increase susceptibility to predation. Indirect effects to wildlife from cumulative herbicide exposure are not likely to occur, because all the herbicides in this EIS are excreted rapidly (often within 24-48 hours), and do not accumulate up the food chain.

The alternatives are discussed from least number of acres and plausible exposure scenarios to most.

Alternative B

The combination of herbicides in Alternative B has the least number of scenarios that exceed toxicity indices for birds or mammals that eat insects or vegetation (Table 4-11). The four herbicides (clopyralid, glyphosate, sethoxydim, and triclopyr) permitted in this alternative could result in five scenarios that may exceed the toxicity indices at typical application rates (Table 4-1). At the highest labeled application rates, an additional eight scenarios exceed the toxicity indices.

Alternative B also has the least amount of acres treated with herbicides that exceed LOAELs. Sethoxydim use at the typical application rates may pose a risk to insectivorous birds and mammals. Glyphosate exceeds reported LOAELs only at the highest application rate. At that rate, adverse effects to large grass-eating mammals, small insect-eating mammals, large grass-eating birds, and small insect-eating birds are plausible. The LOAEL for mammals represents a sub-lethal effect of increased incidence of diarrhea. For birds, there was no effect reported at the highest doses tested for glyphosate, so the mammal LOAEL is used as a surrogate, which likely over-estimates risk to birds.

Approximately 508 acres are projected for treatment with sethoxydim and 2,031 with glyphosate under this alternative, for a total of 2,539 acres annually of plausible risk to wildlife. This likely over-estimates risk to wildlife because not all acres treated with glyphosate would be treated at the highest application rate, nor would they all be treated with large broadcast spray applications. In relation to the total acres of habitat available for insect and vegetation-eating birds and mammals within the project area (24.9 million acres on National Forest Land), and the wide distributions of most of their populations, 2,539 acres represents a negligible potential risk to wildlife.

All other scenarios in this alternative exceed only the toxicity indices, and do not approach a dose known to cause any adverse effect. The potential for some effects to occur, cannot however be ruled out.

Potentially harmful scenarios from triclopyr are not plausible due to management direction in this alternative restricting use to selective application methods (Standard 16). Triclopyr scenarios are therefore not counted. All other bird and mammal scenarios that exceed the toxicity indices do not approach a dose known to cause any adverse effect (i.e. greater than NOAEL but less than LOAEL). But the potential for some effects to occur cannot be ruled out.

Under Alternative B, only glyphosate has the potential for harmful doses to amphibians. The surfactant found in some glyphosate formulations is particularly toxic to aquatic species. At the highest application rate, formulations of glyphosate that contain surfactant could be lethal to amphibians if the worst-case scenario of runoff from the treatment site were to occur (SERA, 2003-Glyphosate, p. 4-45). However, management direction in this alternative severely restricts herbicide use in amphibian habitat, so this scenario is not likely to occur.

Although the use of herbicides represent potential risks to wildlife, in practice, the management direction included in this alternative, as well as environmental conditions and animal behavior, would tend to minimize actual impacts. At the project scale, choices can be made to avoid situations that could cause harm to wildlife. For instance, certain herbicides can be avoided in specific areas or times of the year where/when grass-eaters or amphibians may be at risk, or more specific application methods can be used. Actual adverse effects are therefore not likely to occur. Any short-term adverse effects would be largely offset by the long-term benefits to these species from protecting their habitat from loss due to invasive plants.

Table 4-11 Exposure Scenarios Exceeding Toxicity Indices for Birds and Mammals (Alternative B)					
(acres exceeding LOAELs are in bold)		**Number of Plausible Exposure Scenarios (Blank cells equal zero scenarios)**			
		Above NOAEL		**Above LOAEL**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Rate**	**Highest Rate+**	**Typical Rate**	**Highest Rate**
Clopyralid	2030	2	3		
Glyphosate	**2031**	1	7		6
Sethoxydim	**508**	2	3	2	2
Triclopyr*	508				
Total	5077	5	13	2	8
Total acres >LOAEL	**2,539**				

+ Highest dose = total scenarios exceeding toxicity indices at the highest dose rate, which includes all those exceeded at the typical rate, plus the additional scenarios that are exceeded when the highest application rates are used.

* Triclopyr not counted because restrictions on use in this standard make exposures exceeding the NOAEL or LOAEL very unlikely.

Proposed Action

The Proposed Action includes the second lowest number of plausible exposure scenarios that may cause harm to birds and mammals that eat grass or insects (Table 4-12). The ten herbicides permitted in this alternative could result in 9 scenarios that may exceed the toxicity indices at typical application rates. At the highest labeled application rates, an additional 13 scenarios exceed the toxicity indices. Herbicides permitted in the Proposed Action include chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr.

The Proposed Action also has the second lowest amount of acres treated with herbicides that exceed LOAELs. The scenarios that exceed the toxicity indices for some animals for sethoxydim and glyphosate are the same as discussed for Alternative B. Estimated doses of picloram exceed chronic LOAEL at typical application rate for insectivorous birds. At the highest rate, picloram exceeds the chronic LOAEL for insectivorous birds and mammals. Sulfometuron methyl exceeds the LOAEL for insectivorous birds at the highest application rate.

We predict that 8,989 acres would be treated annually with glyphosate, picloram, sethoxydim and sulfometuron methyl in this alternative, posing a plausible risk to some wildlife on these acres. This likely over-estimates risk to wildlife because not all acres treated with glyphosate would be treated at the highest application rate, nor would all acres be treated by large broadcast spray applications. This is more than a threefold increase in higher risk acres compared to Alternative B. However, in relation to the total acres of habitat available for insect and vegetation-eating birds and mammals within the project area (24.9 million acres on National Forest Land), and the wide distributions of most of their populations, 8,989 acres per year represents a negligible risk to wildlife.

All other scenarios in this alternative exceed only the toxicity indices and do not approach a dose known to cause any adverse effect. The potential for some effects to occur cannot be ruled out, however.

Potentially harmful scenarios from triclopyr are not plausible due to management direction in this alternative restricting use to selective application methods (Standard 16). Triclopyr scenarios are therefore not counted. All other bird and mammal scenarios in this alternative exceed only the NOAEL and do not approach a dose known to cause any adverse effect (LOAEL). The potential for some effects to occur cannot be ruled out, however.

High application rates of glyphosate with surfactant could be lethal to amphibians, as discussed in Alternative B. Management direction in this alternative requires the consideration of appropriate formulations to reduce or eliminate negative effects to aquatic biota, so this effect is not likely to occur.

The above measures represent potential risk to wildlife. In practice, the management direction included in this alternative, as well as environmental conditions and animal behavior, would tend to minimize actual impacts. At the project scale, choices can be made to avoid situations that could cause harm to wildlife. For instance, certain chemicals can be avoided in specific areas or times of the year where/when grass-eaters or amphibians may be at risk, or more specific application methods can be used. Actual adverse effects are therefore not likely to occur. Any short-term adverse effects would be largely offset by the long-term benefits to these species from protecting their habitat from loss due to invasive plants.

Table 4-12 Exposure Scenarios Exceeding Toxicity Indices for Birds and Mammals (Prop. Action)					
(**acres exceeding LOAELs are in bold)**		**Number of Plausible Exposure Scenarios (blank cells indicate zero scenarios)**			
		Above NOAEL		**Above LOAEL**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Rate**	**Highest Rate+**	**Typical Rate**	**Highest Rate**
Chlorsulfuron	620				
Clopyralid	4,648	2	3		
Glyphosate	**4,649**	1	7		6
Imazapic	1,860				
Imazapyr	930				
Metsulfuron methyl	620				
Picloram	**2,790**	2	5	1	2
Sethoxydim	**930**	2	3	2	2
Sulfometuron methyl	**620**	2	4		1
Triclopyr*	930				
Total	18,579	9	22	3	11
Total acres > LOAEL	**8,989**				

+ Highest dose = total scenarios exceeding toxicity indices at the highest dose rate, which includes all those exceeded at the typical rate, plus the additional scenarios that are exceeded when the highest application rates are used.

* Triclopyr not counted because restrictions on use in this standard make exposures exceeding the NOAEL or LOAEL very unlikely.

No Action

The combination of herbicide in No Action has the second highest total potential for adverse effects to birds or mammals that eat insects or vegetation (Table 4-13). The four herbicides used in this alternative (dicamba, glyphosate, picloram, and triclopyr) could result in 15 scenarios that may exceed the toxicity indices at typical application rates. At the highest labeled application rates, an additional 14 scenarios exceed the toxicity indices.

Under No Action, 2,4-D is considered an herbicide of "last resort" and is not to be used unless the other herbicides are ineffective. Since 1989, 2,4-D has not been used, or has been used on less than 1 acre in the Region. Therefore, effects from use of 2,4-D are not considered plausible in this alternative.

No Action also has the second highest amount of acres treated with herbicides that exceed LOAELs. Estimated doses exceeding the LOAEL for glyphosate are discussed for Alternative B. Estimated doses exceeding the LOAEL for picloram are discussed in the Proposed Action. Under No Action, there are no restrictions on use of triclopyr. Estimated doses of triclopyr and dicamba exceed LOAELs for large grass-eating mammals, insectivorous mammals, and large grass-eating and small insect-eating birds at the typical and highest application rates.

Three of the four herbicides permitted in this alternative exceed LOAELs when used in broadcast applications at the typical application rate. Glyphosate exceeds LOAELs only at the highest application rate. We predict that 13, 646 acres will be treated annually with herbicides annually under the No Action alternative. This likely over-estimates risk to wildlife because not all acres treated with glyphosate would be treated at the highest application rate, nor would all acres be treated by large broadcast spray applications. This represents a fivefold increase in higher risk acres compared to Alternative B, and 50 percent increase compared to the Proposed Action. However, in relation to the total acres of habitat available for insect and vegetation-eating birds and mammals within the project area (24.9 million acres on National Forest Land), and the wide distributions of most of their populations, 13,646 acres annually represents a negligible risk to wildlife.

All other scenarios in this alternative exceed only the toxicity indices and do not approach a dose known to cause any adverse effect. The potential for some effects to occur cannot be ruled out, however.

For amphibians, triclopyr use at the highest application rate could adversely affect responsiveness of tadpoles, subjecting them to increased risk of predation. High application rates of glyphosate with surfactant could be lethal to amphibians, as discussed in Alternative B. Management direction in this alternative requires the consideration of appropriate formulations to reduce or eliminate negative effects to aquatic biota, so this effect is not likely to occur.

The above measures represent potential risk to wildlife. In practice, the management direction included in this alternative, as well as environmental conditions and animal behavior, would tend to minimize actual impacts. At the project scale, choices can be made to avoid situations that could cause harm to wildlife. For instance, certain chemicals can be avoided in specific areas or times of the year where/when grass-eaters or amphibians may be at risk, or more specific application methods can be used. Actual adverse effects are therefore not likely to occur. Any short-term adverse effects would be largely offset by the long-term benefits to these species from protecting their habitat from loss due to invasive plants.

Table 4-13 Exposure Scenarios Exceeding Toxicity Indices for Birds and Mammals (No Action)

(acres exceeding LOAELs are in bold)		**Number of Plausible Exposure Scenarios (blank cells indicate zero scenarios)**			
		Above NOAEL		**Above LOAEL**	
Herbicide Included*	**Estimated Acres Treated Per Year**	**Typical Rate**	**Highest Rate+**	**Typical Rate**	**Highest Rate+**
Dicamba	**182**	5	8	5	5
Glyphosate	**1365**	1	7		6
Picloram	**11,050**	2	5	1	2
Triclopyr	**409**	7	9	4	7
Total	13,646	15	29	10	20
Total acres >LOAEL	**13,646**				

+ Highest dose = total scenarios exceeding toxicity indices at the highest dose rate, which includes all those exceeded at the typical rate, plus the additional scenarios that are exceeded when the highest application rates are used. An acute dose is one large dose. A chronic dose is a smaller amount given repeatedly over time.

* 2,4-D not counted in No Action because of the very rare and minor use over the last 15 years.

Alternative D

The combination of herbicide in Alternative D has the highest total potential for adverse effects to birds or mammals that eat insects or vegetation (Table 4-14). The 12 herbicides used in this alternative could result in 31 scenarios that exceed the toxicity indices at typical application rates. At the highest labeled application rates, an additional 19 scenarios exceed the toxicity indices. Herbicides permitted in the Alternative D include chlorsulfuron, clopyralid, dicamba, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, triclopyr, and 2,4-D. There are no restrictions on use of triclopyr or the sulfonylurea group of herbicides in this alternative.

Alternative D also has the highest amount of acres treated with herbicides that exceed LOAELs. Estimated doses exceeding LOAELs for dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, and triclopyr are as discussed above. For 2,4-D, there is an unusual amount of variability in the data for potential toxic effects to mammals, making it difficult to determine a specific NOAEL or LOAEL. Effects noted on page 3-52 of the 2,4-D risk assessment (SERA, 1998) were counted as LOAELs for purposes of this analysis. Estimated doses of 2,4-D exceed LOAELs for all insect-eating and vegetation-eating birds and mammals evaluated in this analysis at typical and highest application rates.

We predict that 27,299 acres would be treated annually with dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, triclopyr, and 2,4-D in this alternative. This likely over-estimates risk to wildlife because not all acres treated with glyphosate would be treated at the highest application rate, nor would all acres be treated by large broadcast spray applications. This is more than double the number of higher risk acres in No Action, more than triple the number of higher risk acres in the Proposed Action, and more than 10 times the number of higher risk acres in Alternative B. However, in relation to the total acres of habitat available for insect and vegetation-eating birds and mammals within the project area (24.9 million acres on National Forest Land), and the wide distributions of most of their populations, 27,299 acres represents a negligible risk to wildlife.

All other scenarios in this alternative exceed only the toxicity indices do not approach a dose known to cause any adverse effect. The potential for some effects to occur cannot be ruled out, however.

For amphibians, the effects of glyphosate and triclopyr are as discussed above. 2,4-D is likely to adversely affect amphibians only in the case of an accidental spill, in which case mortality could occur.

The above measures represent potential risk to wildlife. In practice, the management direction included in this alternative, as well as environmental conditions and animal behavior, would tend to minimize actual impacts. At the project scale, choices can be made to avoid situations that could cause harm to wildlife. For instance, certain chemicals can be avoided in specific areas or times of the year where/when grass-eaters or amphibians may be at risk, or more specific application methods can be used. Actual adverse effects are therefore not likely to occur. Any short-term adverse effects would be largely offset by the long-term benefits to these species from protecting their habitat from loss due to invasive plants.

Table 4-14 Exposure Scenarios Exceeding Toxicity Indices for Birds and Mammals (Alternative D)

(acres exceeding LOAELs are in bold)		**Number of Plausible Exposure Scenarios (blank cells indicate zero scenarios)**			
		Above NOAEL		**Above LOAEL**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Rate**	**Highest Rate+**	**Typical Rate**	**Highest Rate**
Chlorsulfuron	1,147				
Clopyralid	688	2	3		
Dicamba	**688**	5	8	5	5
Glyphosate	**3,441**	1	7		6
Imazapic	3,441				
Imazapyr	688				
Metsulfuron methyl	1,147				
Picloram	**6,882**	2	5	1	2
Sethoxydim	**688**	2	3	2	2
Sulfometuron methyl	**1,147**	2	4		1
Triclopyr	**688**	7	9	4	7
2,4-D	**13,765**	10	11	8	9
Total	34,410	31	50	20	32
Total acres >LOAEL	**27,299**				

+ Highest dose = total scenarios exceeding toxicity indices at the highest dose rate, which includes all those exceeded at the typical rate, plus the additional scenarios that are exceeded when the highest application rates are used.

Alternative Comparison

Table 4-15 compares the alternatives by the measuring factors.

Table 4-15 Summary of Effects by Measuring Factors

Measuring factor	Alternative B	Proposed Action	No Action	Alternative D
The number of plausible exposure scenarios in each alternative that could result in harmful doses to birds and mammals	13	22	29	50
Acres of annual herbicide treatment for each alternative where a plausible scenario could occur	2,539	8,989	13,646	27,299
Number of herbicides approved that may harm amphibians	1	1	3	3

4.4.4 Cumulative Effects

Herbicide use occurs on lands other than National Forest System land (see Chapter 4.1 for more information). Herbicide use occurs on other federal, state, and county ownerships, state and private forestry lands, rangeland, utility corridors, and road rights of way, agricultural lands and private residences.

Because wildlife move and migrate, they can be exposed to herbicides on adjacent lands or along their migration routes. They can be exposed to the same herbicide on multiple ownerships, or a combination of different herbicides within the National Forests or among different ownerships. Wildlife can also be exposed to other chemicals, such as insecticides, rodenticides, fungicides, and others. This project does not include the use of any other chemicals and therefore will not contribute to cumulative effects from any chemicals other than the herbicides included in this document.

Eight of the twelve herbicides in this EIS are used for agricultural crops in Washington and Oregon. Over 2 million pounds of 2,4-D and over 1 million pounds of glyphosate were applied to agricultural land in these two states in 1997 (NCFAP, 1998). These totals do not include uses such as lawncare, road maintenance, utility corridors, or private forest land. The maximum estimated use on National Forest land of these two herbicides for any alternative would be less than one percent of the agricultural use (see Chapter 4.5). For herbicides that have limited or no agricultural uses, Forest Service use would constitute a higher percentage of total use in the project area.

Herbicide use for invasive plant control is estimated to occur on over 1.125 million acres annually outside of National Forest land within Oregon and Washington, based on informal discussions with State and county agriculture agency personnel. Even the highest use estimates of herbicide from Alternative D would only amount to about three percent of the total acres treated with herbicides in Oregon and Washington. More precise estimates of non-cropland use of herbicides do not exist because there are no mandatory reporting requirements.

A three percent increase in land treated with herbicides, spread across the two state project area will not significantly increase potential adverse effects to wildlife. Additive effects from herbicide exposure are not likely to occur, or would be minimal, because herbicides considered in this EIS do not accumulate in the body, do not concentrate up the food chain, and adverse effects would occur to a small number of individual animals, rather than populations.

The small contribution that FS use of herbicide for invasive plant control makes to the statewide totals for herbicide use indicate that the potential cumulative effect is very small. Likewise, the relatively small differences between the alternatives, in comparison to the totals, make any differences in potential for cumulative effects to wildlife insignificant

4.4.5 Methodology

The methodology for identifying this issue and narrowing the analysis to these animals and exposure routes is discussed in more detail in “Analysis Methods and Issue Identification Regarding Effects to Wildlife for the Invasive Plant EIS” located in the project analysis file.

The calculation of number of plausible scenarios for typical and highest application rates includes any scenario where the estimated dose exceeds the “No-observable-adverse-effect-level (NOAEL)” or other benchmark dose, known as the toxicity index. Usually, the toxicity index is a NOAEL. However, data for some herbicides is insufficient to determine a NOAEL, so an

LD50 or other value may be use. When an LD50 is used, the potential adverse effect is determined to occur at any dose above 0.1 of the LD50. This value is typically used for regulatory purposes and appears to be a reasonably conservative level (Hill, 1994). Doses below this level would presumably not have any effects. Doses above this level may cause sub-lethal responses in the most sensitive bird or mammal species tested. The level at which effects begin to be discernable is called the "Lowest-observable-adverse-effect-level (LOAEL);" this level may be ten times higher than the NOAEL. Therefore, using NOAELs as the toxicity indices, and determining that an adverse effect may occur whenever the NOAEL is exceeded is a cautious approach and constitutes a true "worst-case scenario" analysis. Worst-case analysis is appropriate when there is a lack of data, as is the case for herbicide toxicity data and free-ranging wildlife species.

The most sensitive sub-lethal effect noted for the most sensitive species was used as the "benchmark" value, or toxicity index, for each herbicide. Toxicity indices and LOAEL values used are located in the "Summary of Herbicide Effects to Wildlife" report (analysis file). When enough data was available, quantitative estimates of dose were calculated using exposure scenarios. An example of an exposure scenario used for this analysis is as follows:

> A 70 kg mammal consumes one-day's worth of contaminated (with herbicide residue) grass; daily food consumption is 20 percent of the body weight; and one day's diet is 100 percent contaminated.

This type of scenario allows a quantitative estimate of dose from the herbicide, using information from the literature on levels of herbicide residue found on grass or insects, body-size relationships in food consumption, and excretion or degradation rates of the herbicide. When a quantitative estimate of dose for an animal exceeded the toxicity index, we determined that the result was a potential adverse effect.

Occasionally, estimated doses also exceeded known LOAELs. When herbicides exceeded a LOAEL, we further evaluated potential risk by using predicted acres treated annually with those herbicides. Predicted acres treated per year were taken from the cost analysis (Chapter 4.6.2).

Toxicity data for amphibians is much more limited than that available for mammals or birds. The data on amphibians for most herbicides are not sufficient to conduct quantitative estimates of exposure. The Forest Service/SERA Risk Assessments use information from the literature, when available, and the calculated concentrations of herbicide in water from runoff or accidental spill to determine risk to amphibians. When data on amphibian was not available, fish were used as a surrogate species. The total number of herbicides permitted in each alternative that could adversely affect amphibians was used as an indicator of risk for those species.

4.4.6 Incomplete or Unavailable Information

Invasive plant inventories on the National Forests are incomplete, so the locations of future projects cannot be predicted. Recently, a nation-wide database, NRIS-TERRA, has been implemented that will allow the tracking of existing infestations, the addition of new inventory locations, and the aggregation of invasive plant data at regional and national scales. However, it is unlikely that budget or staff time allotted will ever be sufficient to have complete inventories of invasive plants across the Region.

Research has not been conducted on the effects of these herbicides to most free-ranging wildlife species, so the relevant data to specifically evaluate effects to different wildlife species is incomplete or unavailable. Species and herbicide combinations number nearly 1,000 for just the terrestrial wildlife that are threatened, endangered, and Forest Service Sensitive species in Region Six. Each rigorous laboratory test conducted to determine the toxicity of a chemical to an animal is extremely expensive. Therefore, it is not possible to fund all of the expensive and time-consuming laboratory tests needed to provide all of the information required to fully evaluate risks to free-ranging wildlife.

Specific data that are lacking and would be relevant to this project include:

- The data gap between a dose that causes no effect and the dose known to cause some effect can be quite large (e.g. an order of magnitude difference in dose).
- There are no data on herbicide effects to reptiles or butterflies found in Region Six.
- There are only limited data available on herbicide effects to amphibians found in Region Six.
- Analysis of effects for any project involving herbicide use relies upon extrapolations from laboratory animals to free-ranging wildlife and controlled conditions to the natural environment.

- There are more data available for mammals than for birds, which requires the use of mammal toxicity values in bird exposure scenarios for some of the herbicides considered in this EIS.

Better estimates of risk could be calculated if laboratory data on the toxicity of the herbicides considered in this EIS were available for more groups of animals and more individual species. We would have more information on the comparative sensitivities of, and the types of adverse effects that may occur in, different wildlife groups or species.

However, because of the dynamic nature of wildlife and their habitat (behavior, weather, nutrient availability, contaminant presence, etc.), significant uncertainties would remain for predicting short and long-term reactions to herbicide presence in natural settings even if more laboratory data were available. Additional field studies of herbicides are not practical because field studies are considerably more costly than laboratory studies, and have a greater likelihood of resulting in insufficient or inconclusive data (Grue, 1994).

Limitations not withstanding, a substantial amount of scientific data on the toxicity of these herbicides to birds and mammals, and some amphibians and invertebrates exist. The data is generated by manufacturers to meet EPA regulations before an herbicide may be registered for use, and by independent researchers that have published findings in peer-reviewed literature. This data is then analyzed according to standard risk assessment methodology to reach a characterization of risk for each herbicide.

4.5 Human Health and Safety Effects

4.5.1 Introduction

This section evaluates Issue #4: Invasive plant treatments may result in risks to human health, including contamination of drinking water. The health and safety of forestry workers may be at risk from exposure to herbicides, working on uneven/broken terrain, use of hand and power tools, inhalation of smoke, driving vehicles, exposure to fire, exposure to falling/rolling debris, and the other accidents. The public may be exposed to herbicides through direct contact, drift, eating contaminated foods, or drinking contaminated water.

The public expressed particular concern about human health effects related to herbicide treatments in municipal watersheds, small watersheds with individual drinking water systems, or other areas where forest visitors may consume forest water. Public concerns focused on unintended public exposures to herbicides, and particularly upon risks associated with exposure to herbicides in drinking water. Public and internal Forest Service comments expressed concern about health risks from exposure of workers involved in herbicide treatments. All alternatives allow limited herbicide use but vary by the range of herbicides considered.

Internal Forest Service comments expressed concern about health and safety risks to workers associated with manual and mechanical treatments. All alternatives include varying amounts of manual/mechanical treatments. All methods used to treat invasive plants have some potential risk to human health. For biological and cultural methods, most risks are those common to any human activities in a wildland environment. Prescribed fire treatments bring additional risks associated with fire, smoke and machinery uses, however fire methods are predicted to be a minimal part of the Region's invasive plant treatment program (< 5 percent in every alternative). The principal potentially significant human health risks among alternatives result from the use of manual and mechanical methods, and from the use of herbicides.

The use of manual/mechanical treatments generally increases as herbicide treatments decrease. Therefore the response of the alternatives to the key issue of human health effects consists of two principal components: what exposures to health effects associated with manual/mechanical treatments of invasive plants are expected for workers and for the public; and what are the potential risks of health effects associated with worker and public exposures to herbicide use to treat invasive plants, particularly, but not limited to, drinking water exposures.

To address this issue, potential worker exposures to hazardous conditions, and toxicity data for various herbicides were analyzed for a variety of worker and public exposure scenarios. The factors for comparing alternatives are:

- Number of physical injuries to workers during manual and mechanical invasive plant treatment projects
- Number of NPE and herbicide worker exposure scenarios exceeding reference doses
- Number of NPE and herbicide public exposure scenarios exceeding reference doses (other than drinking water contamination)
- Number of NPE and herbicide public exposure scenarios for drinking water exceeding reference doses

- Acres of annual herbicide use associated with any plausible worker or public contamination scenario

4.5.2 Direct and Indirect Effects

Exposure to Hazards from Manual and Mechanical Treatment Methods

Manual (hand) and mechanical treatments pose hazards to forestry workers. Adverse weather and terrain commonly create unfavorable working conditions and increased hazards. Hazards associated with adverse weather conditions include extreme heat and cold, which can be exacerbated by very dry and very wet conditions. Other hazards include: falling objects-especially when cutting trees, tripping or slipping on hazards on the ground; protruding objects such as branches and twigs; poisonous plants and insects, and dangerous wildlife.

Tools and equipment present inherent hazards such as sharp edges on the tools themselves, and the hazardous nature of fuels and lubricants used in mechanized equipment. Manual and mechanical methods present potential ergonomic hazards related to lifting and carrying equipment, and when pulling vegetation.

Injuries can vary from minor cuts, sprains, bruises, and abrasions to major arterial bleeding, compound bone fractures, serious brain concussions, and death. Workers are subject to heat-related illness or hypothermia when working in extreme weather conditions, and may incur musculo-skeletal injuries related to improper body mechanics.

Equipment operators could be injured from improperly operating the equipment or losing control of equipment on steep or slippery terrain. Operators and nearby workers also can suffer hearing damage. Nearby workers and the public can be struck by flying debris around some machinery.

The potential for hazard exposure, i.e. risk of injuries, is exacerbated when workers are fatigued, poorly trained, or poorly supervised, and do not follow established safety practices. Appropriate training, together with monitoring and intervention to correct unsafe practices, would minimize risk of worker injury and illness. Compliance with Occupational Health and Safety Administration (OSHA) standards, along with agency, industry and manufacturers' recommendations reduces the potential exposure and risk of injury to workers. Members of the public are usually not at risk from manual and mechanical methods unless they are too close to machinery that is producing flying debris during treatment.

Comparison of Alternatives - Exposure to Health Hazards for Workers with Manual Treatments

Forest Service accident reports do not identify the type of work being done when an accident occurred, thus data on accidents related specifically to invasive plant treatment is not available. Worker exposure to hazards is the direct effect; exposure varies according to the amount of manual and mechanical treatment projected for each alternative. A quantified relationship between manual treatment acreage and worker exposure, expressed as productivity (time/acre pulled) was determined for a large, multiyear hand pulling project on the Wenatchee National Forest (Henry, 2003). This relationship is applied to EIS alternatives to estimate the number of full-time worker equivalents needed to accomplish annual manual treatments projected for each alternative. No comparable productivity data is available for mechanical treatments. Table 4-16 compares the alternatives in terms of acres of non-herbicide treatments and worker days of exposure related to that acreage.

Table 4-16 Acres of Treatment and Worker Days of Exposure, Manual Treatment

Alternative	Acres of Non-Herbicide Treatment	Worker Days of Exposure
No Action	8,610	36,593
Proposed Action	7,228	30,719
Alternative B	10,576	44,948
Alternative D	2,024	8,602

Risks to Workers and the Public From Herbicides

All alternatives allow limited herbicide use but vary by the range of herbicides considered and treatment/restoration standards that would apply to herbicide use. As with the previous issue about potential effects to wildlife, SERA risk assessments were used to evaluate how many worker or public exposure scenarios are plausible based on the relative mix of substances associated with each alternative and the toxicity of the chemicals involved. For a background discussion of all toxicological tests and endpoints considered in Forest Service Risk Assessments, refer to SERA, 2001-Preparation.

The human health hazards associated with each herbicide chemical and their selected formulations; and specific inert ingredients, impurities or metabolites were evaluated by a thorough review of available toxicological studies. Possible health effects may include short-term and long-term adverse effects. Short-term effects may include: nausea, headache, dizziness, eye or skin irritation, and coughing. Long-term effects may include: cancer; reproductive, endocrine, immunological, neurological effects; and genetic mutations.

Toxicity studies were evaluated individually for scientific quality, and cumulatively for all similar studies to identify the NOAEL and RfD for each potential effect.

Additional analysis is also detailed in the EIS human health risk assessment project file, on the potential for health effects on sensitive subgroups of the human population from the use of herbicides proposed in this EIS.

In addition to the analysis of potential hazards to human health from every herbicide active ingredient, potential hazards of other substances associated with herbicide applications (impurities, metabolites, inert ingredients and adjuvants) were considered. The surfactant NPE is the only substance associated with specific risks to human health. The SERA risk assessment found that NPE may contain nonylphenol, an EPA List 1[33] inert, which has potential for toxic effects, including endocrine disruption. Human health risks from exposure to NPE in invasive plant treatments are analyzed in the risk assessment.

The herbicides that would be available for invasive plant treatment under each alternative are compared based on Hazard Quotient (HQ), which is the ratio between the estimated dose (the amount of herbicide received from a particular exposure scenario) and the RfD. When a predicted dose is less than the RfD, then the HQ (estimated dose/RfD) is less than 1, and toxic effects are unlikely for that specific herbicide application.

Workers and the public may be exposed to herbicides. Workers are more likely to be exposed to herbicides, and risk assessments consider the exposure rates likely for workers. Workers include applicators, supervisors, and other personnel directly involved in the application of herbicides. The public includes non-project forestry workers, forest visitors or nearby residents who could be exposed through the drift of herbicide spray droplets, through contact with sprayed vegetation, or by eating, or placing in the mouth, contaminated food items or other plant materials, such as berries or shoots growing in or near forests, by eating game or fish containing herbicide residues, or by drinking water that contains such residues.

Worker Herbicide Exposure Analysis

Herbicide applicators are most likely to be exposed to herbicides. Two types of worker exposure assessments are considered: general and accidental/incidental. General exposure assessment is used to designate those exposures that involve estimates of absorbed dose based on the routine handling of a specified amount of a chemical during each of three application methods (backpack sprayer, ground boom, and aerial). The accidental/incidental exposure scenarios involve specific atypical but plausible events that could occur during any type of application.

The exposure for workers is based on the application rate selected for the herbicide, modified by several operational and human factors: number of hours worked per day, acres treated per hour, and variability in human dermal absorption rates. Rather than focus on a single average value, each of these exposure factors involves a range of values, which when combined create a range of potential exposure rates for any given application rate. This human health risk assessment displays potential risks for each of two application rates: a Forest Service typical rate and the maximum label rate. For each of these application rates, exposures and HQ's are displayed for two values from the potential range of exposures predicted for each herbicide: one typical of the average worker in average working conditions, and a maximum exposure value based on the maximum estimate for every exposure factor that is considered. Thus, this risk assessment presents four potential exposure levels for workers, ranging from the predicted average exposure (typical Forest Service rate-typical exposure variables) to a worst-case predicted exposure (maximum application rate, maximum exposure variables). For NPE, only the typical exposure rate for each of the typical and maximum-labeled rate is analyzed for human health risks.

Although herbicide application involves many different job activities, exposure rates can be defined for three categories: directed foliar applications involving the use of backpacks or similar devices including cut surface and streamline sprays; broadcast hydraulic spray applications; and aerial applications. In routine applications, workers may contact and internalize herbicides mainly through the skin, but also through the mouth, eyes or nose. Forest Service/SERA risk assessment methodology for estimating worker exposures from typical operations encompasses

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[33] "List 1" inerts are "Inerts of toxicological concern" EPA website www.oaspub.epa.gov/srs/srs_proc_qry.navigate.

the exposures predicted from multiple routes. Accidental worker exposures are most likely to involve splashing a solution of herbicides into the eyes or on the skin. Two general types of exposure were modeled: one involving direct contact with a solution of the herbicide and another associated with accidental spills of the herbicide concentrate onto the surface of the skin.

Public Herbicide Exposure Analysis

Under normal conditions, members of the general public should not be exposed to substantial levels of any of these herbicides. Members of the public would generally not be in areas infested with invasive plants during herbicide application. However, dispersed and developed recreation areas (trailheads, campgrounds, picnic areas, recreation sites, boat ramps, ski areas, work centers, etc) may occur in the vicinity of invasive plant infestations proposed for herbicide treatment.

The Forest Service/SERA risk assessments developed two types of public exposure situations called scenarios: acute exposures and longer-term or chronic exposures. Acute exposures assume that a person has contact with the herbicide either during or shortly after an application. Acute scenarios estimate herbicide doses received from direct spray, from dermal contact with sprayed vegetation, or from short-term post-spray consumption of contaminated fruit or fish. Chronic exposure scenarios estimate doses from long-term consumption of fruit or fish following a herbicide application. The risk assessments also estimate acute and chronic exposures and risks to the public from drinking contaminated water from two sources: from a stream, into which spray has drifted from an adjacent herbicide application, and from a pond, into which the spilled contents of a 200-gallon tanker truck that contains herbicide solution. Most of these scenarios model extreme situations that are highly unlikely to ever be encountered in herbicide applications conducted under alternatives in this EIS. Detailed summaries of the public exposure scenarios can be found in Forest Service/SERA Risk Assessments and in SERA 2001.

Estimates of public exposure from contact with direct spray or from different sources of herbicide residues are based on the application rate selected for the herbicide, modified by several operational and human factors. The EIS human health risk assessment displays potential risks for each of two application rates: a Forest Service typical rate and the maximum label rate. For each of these application rates, exposures and HQ’s are displayed for two values from the potential range of exposures predicted for each herbicide: one typical of the average estimates for each of the exposure factors conditions, and a maximum exposure value based on the maximum estimate for every exposure factor. The EIS effects analysis presents two potential exposure levels for members of the public, a predicted average exposure (typical Forest Service application rate-typical exposure variables) and a worst-case predicted exposure (maximum application rate, maximum exposure variables).

Comparison of Alternatives - Risks to Workers and the Public From Herbicides

The human health effects from the use of any herbicide depends on the toxic properties (hazards) of that herbicide, the level of exposure to that herbicide at any given time, and the duration of that exposure. Both the suite of available herbicides and the restrictions on their use vary by alternative. Significant health effects are not expected from herbicide use scenarios with a HQ less than 1 (expected dose<RfD). As the treatment HQ for an invasive plant control project increases above 1, the margins of safety decrease, compared to the most sensitive toxic effect shown in laboratory animal studies. If a predicted dose is greater than the RfD (HQ is greater than 1), then the base NOAEL and the uncertainty factors used in the RfD would be reviewed to refine the risk assessment for a particular project. Possible strategies for reducing human health risk at the project scale include: reducing the application rate of the herbicide; increasing personal protection or buffers; restricting applications to more favorable site conditions and/or using an application method with less human exposure. The EIS does not set an absolute threshold of unacceptable risk, however, treatments with estimated HQ's >10 (i.e. one order of magnitude greater than the RfD) are of particular concern. The identified threshold for serious risks of potential health effects of HQ>10 is based on professional judgment rather than EPA regulations. The threshold is intended to help reviewers distinguish moderate risks (HQ = 2-10), which could in most cases be mitigated through exposure-reducing project design criteria from significant health risks (HQ>10) that could be difficult to mitigate if Worst-Case situations occur at that the project level.

Potential techniques to minimize human exposures to herbicides include: selecting herbicides with low toxicity and low application rates; using application methods that minimize off-target movement and non-target exposures; reducing contamination of potential drinking water by using streamside no-spray zones; providing personal protective equipment for applicators, and posting of treated areas. Treatments under all alternatives would be accomplished according to strict safety and health standards as required by EPA pesticide regulations and incorporated into herbicide label instructions. The following findings apply to herbicides proposed for use in the action alternatives:

- Two herbicides, 2,4-D and triclopyr consistently have the greatest number of invasive plant treatment scenarios where both worker and public health risks exceed EPA target levels (i.e. the RfD's[34]). These two herbicides also generate nearly all application scenarios where the Hazard Quotient (HQ) is predicted to be greater than 10 (i.e. expected dose exceeds the RfD by greater than one order of magnitude).

- One herbicide, dicamba, and the adjuvant nonylphenol ethoxylate, have an intermediate number of scenarios where worker and public health risks exceed EPA target levels, and they have a few scenarios where the HQ exceeds 10. Human health risks could generally be mitigated at the project level, but in some limited situations, their use might present significant health risks.

- The remaining nine herbicides rarely and only minimally exceed the RfD's established by EPA. The scenarios that may slightly exceed EPA target levels are only associated with worst-case exposure assumptions and/ or using maximum (rather than typical) application rates, except for exposure to NPE (HQ=5) from drinking spill-contaminated pond water.

Because any risk assessment is based on a number of assumptions, readers and decision-makers should not make the conclusion that the risk values are absolute. If the assumptions are changed, the risk values change. However, the relative risk among herbicides or application methods should remain the same unless new toxicity data becomes available. Some qualitative comparisons can be made among alternatives, based on the theme, prevention and treatment emphases, and allowed herbicides and application methods for each. A table accompanies each alternative that displays the projected acres treated with each herbicide, and the number of associated worker and public exposure scenarios HQs that range between 1 and 10, and the number of HQ's that exceed 10.

All estimates of herbicide treatment acreage used in alternative comparisons are taken from the Economic Analysis (Chapter 4.6).

The EIS does not estimate the number of acres treated by alternative with NPE surfactants. NPE is appropriate for some applications where the herbicide label requires the addition of a surfactant. NPE surfactants may also improve efficacy in other herbicide applications where addition of a surfactant is optional. In some, but not all of these situations, there are alternative surfactants that would be effective that do not contain NPE. For all these reasons, the tables identify the number of scenarios where NPE application would exceed HQ thresholds, but no meaningful associated acreage can be estimated.

[34] See glossary for definition of reference dose.

The tables that address the issue of potential drinking water contamination display the herbicide scenarios that may exceed the RfD by either drinking from a stream contaminated by drift from a herbicide application, or by drinking from a pond that is contaminated by a spill of a large tanker truck transporting herbicide mix.

The EIS risk assessment found only one herbicide exposure scenario exceeds the RfD for drinking stream water contaminated by drift for any herbicide. The HQ for drinking stream water contaminated with drift from 2,4-D applied at the maximum allowable rate is projected to be 9. The herbicide 2,4-D is considered for use only in Alternative D.

The other herbicide application scenarios for contaminated drinking water that exceed the RfD involve drinking from a pond contaminated by a spill of a large tank of herbicide solution. The risk of a major accidental spill is not linked in a cause-and-effect relationship to how much acreage is treated with a particular herbicide; a spill is a stochastic event. A spill could happen whenever a tank truck involved in a herbicide operation passes a standing body of water. The use of large tank trucks to carry herbicide mix is only plausible for aerial applications, and some truck-based ground-boom sprayers. The tables display the number of scenarios for each herbicide that exceed the RfD for a child drinking from a spill-contaminated pond. These scenarios represent an extreme worst-case scenario that is unlikely to occur in any herbicide application conducted by the Forest Service.

Alternative B is considered the alternative with the overall least risk of herbicide-related health effects to workers and to the public. However, the only differences among Alternative B, No Action, and the Proposed Action, lie in potential risks associated with Worst-case scenarios. For typical Forest Service invasive plant treatment practices, No Action B and Proposed Action are essentially equal. No significant health effects to workers, nor to the public from invasive plant treatment would be expected. The six herbicides added to Proposed Action do not significantly increase risks to workers or the public from routine operations. The only risk identified with these alternatives from typical operations is a moderate risk of health effects (HQ= 5) if water is consumed from a pond into which the surfactant NPE is spilled in association with a herbicide.

No Action

The No Action alternative continues the current invasive plant management program. The amount and proportion of invasive plant treatments by manual, mechanical, biological, cultural and herbicide methods would remain approximately constant to recent historic practices.

The projected number of worker days of exposure to physical hazards during manual invasive plant treatment projects is 36,593.

Four herbicides are available for invasive plant treatments, one of which contains the carcinogenic contaminant hexachloribenzene (HCB). NPE, an adjuvant of potential toxicological concern, is also available. Refer to Tables 4-17, 4-18, 4-19, 4-29, 4-30, and 4-31 for Risks to workers and the public regarding the No Action alternative.

For herbicide treatments assuming typical application rates and exposure factors no worker exposures exceed the RfD (i.e. HQ <=1). For herbicide treatments assuming typical application rates and exposure factors no public exposure scenarios (non-water) exceed the RfD. One accidental drinking water exposure (to NPE) to spill-contaminated water exceeds the RfD (HQ=5).

For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be six worker exposures with HQ = 2-10 and five worker exposures with HQ > 10. One exposure (picloram) would result in a cancer risk probability of 2 in one million, exceeding the EPA cancer risk threshold of 1 in one million. For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be five public exposure scenarios with HQ = 2-10 and three public exposures with HQ > 10. Two accidental drinking water exposures to a spill-contaminated pond have HQ = 2-10, and three have HQ > 10. There are no exposure scenarios for drinking stream water contaminated by drift for any herbicide in this alternative that exceed the RfD.

Table 4-17 Worker Potential Health Risks (No Action)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Glyphosate	1365				
Picloram	11,050		1*		
Triclopyr	409		2		3
Dicamba	182		3		
Total	**13,646**				

Table 4-17 Worker Potential Health Risks (No Action)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Annual Acres where Scenarios May Occur		**0**	**12,281**	**0**	**409**
NPE	N/A		**3**		

* For ground broadcast application workers using picloram in this scenario, a cancer risk of 2 in one million is predicted, which exceeds the EPA cancer risk threshold of 1 in one million.

Table 4-18 Public Potential Health Risks (No Action) (Excluding Drinking Water)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Glyphosate	1365				
Picloram	11,050				
Triclopyr	409		2		2
Dicamba	182		3		1
Total	13,646				
Annual Acres where Scenarios May Occur		**0**	**591**	**0**	**591**
NPE	**N/A**		**1**		**1**

Table 4-19 Public Consumption of Contaminated Pond Water (No Action)		**Number of Worst-case Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical application rate**	**Maximum application rate**	**Typical application rate**	**Maximum application rate**
Glyphosate	N/A		1		
Picloram			1		
Triclopyr					1
Dicamba					1
NPE		1			1

Proposed Action

The Proposed Action expands the use of invasive plant prevention practices, which may result in a decrease in new infestations needing treatment. Existing infestations would be treated with manual methods in greater proportions than in Alternative D, but probably less than Alternative B. The exposure to risks, of mostly physical injuries associated with using manual and mechanical methods, would be less than Alternative B, but more than Alternative D.

The projected number of worker days of exposure to physical hazards during manual invasive plant treatment projects is 30,711.

The additional herbicides available for treatment in the Proposed Action, compared to Alternatives A and B, have low predicted risks to human health, so the risks to workers and to the public are not significantly different. In contrast, health risks for the Proposed Action are significantly less than for Alternative D.

Ten herbicides are available for invasive plant treatments, two of which contain the carcinogenic contaminant HCB. NPE, an adjuvant of potential toxicological concern, is also analyzed. Triclopyr is restricted to spot applications (i.e. backpacks, directed stem spray, OHV methods); thus certain worker and public exposure scenarios do not apply. Worker occupational exposures using triclopyr with ground boom and aerial application are not considered. Public exposures to triclopyr through direct spraying of individuals are essentially impossible, and they are not considered in this analysis. Dermal exposures through vegetation contact is reduced when only target vegetation is sprayed, and any accidental spill would be greatly reduced in magnitude and drinking water risk, compared to the tank truck example used in exposure modeling. Refer to Tables 4-20, 4-21, 4-22, 4-29, 4-30, and 4-31, for risks to workers and the public regarding the Proposed Action.

For herbicide treatments assuming typical application rates and exposure factors no worker exposures exceed the target HQ <=1. For herbicide treatments assuming typical application rates and exposure factors no public exposure scenarios (non-water) exceed the target HQ <=1. One accidental drinking water exposure (to NPE) to spill-contaminated water exceeds the RfD (HQ = 5).

For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be nine worker exposures with HQ = 2-10 and one worker exposure with HQ > 10. One exposure (picloram) would result in a cancer risk probability of 2 in one million, exceeding the EPA cancer risk threshold of 1 in one million. For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be three public exposure scenarios with HQ = 2-10 and two public exposures with HQ > 10. Five accidental drinking water exposures to a spill-contaminated pond have HQ = 2-10, and two have HQ > 10. There are no exposure scenarios for drinking stream water contaminated by drift for any herbicide in this alternative that exceed the RfD.

Table 4-20 Worker Potential Health Risks (Proposed Action)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Chlorsulfuron	620		1		
Clopyralid	4,648				
Glyphosate	4,649				
Imazapic	1,860				
Imazapyr	930				
Metsulfuron methyl	620				

Table 4-20 Worker Potential Health Risks (Proposed Action)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Picloram	2,790		1*		
Sethoxydim	930				
Sulfometuron methyl	620		3		
Triclopyr	930		2		1
Total	18,597				
Annual Acres where Scenarios May Occur		**0**	**4,960**	**0**	**930**
NPE	N/A		3		

* For ground broadcast application workers using picloram in this scenario, a cancer risk of 2 in one million is predicted, which exceeds the EPA cancer risk threshold of 1 in one million.

Table 4-21 Worker Potential Health Risks (Proposed Action) (Except Drinking Water)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Chlorsulfuron	620				
Clopyralid	4,648				
Glyphosate	4,649				
Imazapic	1,860				
Imazapyr	930				
Metsulfuron methyl	620				
Picloram	2,790				
Sethoxydim	930				
Sulfometuron methyl	620				
Triclopyr	930		2		1

Table 4-21 Worker Potential Health Risks (Proposed Action) (Except Drinking Water)		Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)			
		HQ = 2 - 10		HQ > 10	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Total	18,597				
Annual Acres where Scenarios May Occur		**0**	**930**	**0**	**930**
NPE	N/A		1		1

Table 4-22 Public Consumption of Contaminated Pond Water (Proposed Action)		Number of Worst-case Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)			
		HQ = 2 - 10		HQ > 10	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical application rate**	**Maximum application rate**	**Typical application rate**	**Maximum application rate**
Chlorsulfuron	N/A		1		
Clopyralid			1		
Glyphosate			1		
Imazapic			1		
Imazapyr					
Metsulfuron methyl					
Picloram			1		
Sethoxydim					
Sulfometuron methyl					
Triclopyr					1
NPE		1			1

Alternative B

Alternative B expands the use of invasive plant prevention practices, which may result in a decrease in new infestations needing treatment. Existing infestations would be treated with manual, mechanical, and cultural methods in greater proportions due to increased restrictions on herbicide use. The mostly physical injuries associated with manual and mechanical methods would be the highest among the alternatives.

The projected number of worker days of exposure to physical hazards during manual invasive plant treatment projects is 44,948. However, the total amount of treatment may be the lowest because the direct costs of manual treatment are higher per unit area than herbicide costs.

The risk of herbicide exposures to workers and the public that could cause health effects, would be reduced compared to other alternatives. Biological control may increase somewhat as existing infestations increase in size where manual treatments are ineffective and/or prohibitively costly.

Four herbicides are available for invasive plant treatments, one of which contains the carcinogenic contaminant HCB. NPE, an adjuvant of potential toxicological concern, is also analyzed. Triclopyr is restricted to spot applications (i.e. backpacks, directed stem spray, ATV methods); thus certain worker and public exposure scenarios do not apply. This restriction is identical to the Proposed Action. Refer to Tables 4-23, 4-24, 4-25, 4-29, 4-30, and 4-31 for risks to workers and the public regarding Alternative B.

For herbicide treatments assuming typical application rates and exposure factors no worker exposures exceed the RfD (i.e. HQ is <=1). For herbicide treatments assuming typical application rates and exposure factors no public exposure scenarios (non-water) exceed the target HQ <=1. One accidental drinking water exposure (to NPE) to spill-contaminated water exceeds the RfD with a HQ=5.

For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be five worker exposures with HQ = 2-10 and one worker exposures with HQ > 10. For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be three public exposure scenarios with HQ = 2-10 and two public exposures with HQ > 10. One accidental drinking water exposure to a spill-contaminated pond has HQ = 2-10, and two have HQ > 10. There are no exposure scenarios for drinking stream water contaminated by drift for any herbicide in this alternative that exceed the RfD.

Table 4-23 Worker Potential Health Risks (Alternative B)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical application rate**	**Worst Case exposure scenario**	**Typical application rate**	**Worst Case exposure scenario**
Glyphosate	2031				
Clopyralid	2030				
Sexothydim	508				
Triclopyr	508		2		1
Total	5077				
Annual Acres where Scenarios May Occur		**0**	**508**	**0**	**508**
NPE	N/A		3		

Table 4-24 Public Potential Health Risks (Alternative B) (Except Drinking Water)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Glyphosate	2031				
Clopyralid	2030				
Sexothydim	508				
Triclopyr	508		2		1
Total	5077				
Annual Acres where Scenarios May Occur		**0**	**508**	**0**	**508**
NPE	N/A		1		1

Table 4-25 Public Consumption of Contaminated Pond Water (Alternative B)		Number of Worst-case Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)			
		HQ = 2 - 10		HQ > 10	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical application rate**	**Maximum application rate**	**Typical application rate**	**Maximum application rate**
Glyphosate	N/A		1		
Clopyralid			1		
Sexothydim					
Triclopyr					1
NPE		1			1

Alternative D

Alternative D emphasizes local flexibility in implementing invasive plant prevention, and increased economic efficiency of treatments. The acreage treated with non-herbicide methods is predicted to be the lowest of all alternatives considered. Worker exposures to health hazards from manual treatment, would be correspondingly the lowest among alternatives.

The projected number of worker days of exposure to physical hazards during manual invasive plant treatment projects is 8,602.

The acreage likely to be treated with herbicides is the highest among alternatives. Twelve herbicides are available, including all higher-risk and intermediate-risk chemicals, without any restrictions to application methods (beyond those required by law and by the label).

Existing infestations would be treated with manual and mechanical in lower proportions than other alternatives. The exposure to risks of mostly physical injuries associated with using manual and mechanical methods would be the lowest among alternatives.

Herbicide treatment would be the highest among the alternatives. The additional herbicides available only in Alternative D have the highest risks of health effects to workers and the public, so overall herbicide health risks are likely to be greater than other alternatives.

Twelve herbicides are available for invasive plant treatments, two of which contain the carcinogenic contaminant HCB. NPE, an adjuvant of potential toxicological concern, is also analyzed. Refer to Tables 4-26, 4-27, 4-28, 4-29, 4-30, and 4-31 for risks to workers and the public regarding Alternative D.

For herbicide treatments assuming typical exposure factors for typical application rates, there is one occupational worker exposure and no accidental worker exposure that exceeds the target HQ <=1. For herbicide treatments assuming typical exposure factors for typical application rates, there are 3 operational public exposures and 2 accidental public exposures, and two public exposures that exceed the target HQ by a factor greater than 10.

For herbicide treatments assuming typical application rates and exposure factors one worker exposure exceeds the target HQ <=1. For herbicide treatments assuming typical application rates and exposure factors there are two public exposure scenarios with HQ = 2-10 and one public exposure with HQ > 10. One accidental drinking water exposure to spill-contaminated water exceeds the RfD (HQ = 5).

For herbicide treatments assuming Worst-case (maximum application rates and exposure factors) there would be twelve worker exposures with HQ = 2-10 and six worker exposures with HQ > 10. One exposure (picloram) would result in a cancer risk probability of 2 in one million, exceeding the EPA cancer risk threshold of 1 in one million. For herbicide treatments assuming Worst-case (maximum application rates and exposure factors), there are nine public exposure scenarios with HQ = 2-10 and nine public exposures with HQ > 10. Six accidental drinking water exposures to a spill-contaminated pond have HQ = 2-10, and four have HQ > 10. Alternative D has the only herbicide exposure scenario among all alternatives that exceeds the RfD for drinking stream water contaminated by drift for any herbicide. The HQ for drinking stream water contaminated with drift from 2,4-D applied at the maximum allowable rate is projected to be 9. (2,4-D is considered for use only in Alternative D).

For all application rates, both typical and maximum exposure assumptions, Alternative D has many more exposure scenarios that exceed EPA target exposure levels than any other alternative. Alternative D also has many more worker, and public exposure scenarios that exceed EPA target levels by a factor of greater than ten.

Table 4-26 Worker Potential Health Risks (Alternative D)		**Number of Plausible Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
2,4-D	13,765	1			3
Chlorsulfuron	1,147		1		
Clopyralid	688				
Dicamba	688		3		
Glyphosate	3,441				
Imazapic	3,441				
Imazapyr	688				
Metsulfuron methyl	1,147				
Picloram	6,882		1*		
Sethoxydim	688				
Sulfometuron methyl	1,147		3		
Triclopyr	688		2		3
Total	34,410				
Annual Acres where Scenarios May Occur	**Typical 13,765** **Worst-case 24,317**	**13,765**	**10,552**	**0**	**14,453**
NPE	N/A		3		

* For ground broadcast application workers using picloram in this scenario, a cancer risk of 2 in one million is predicted, which exceeds the EPA cancer risk threshold of 1 in one million.

Table 4-27 Public Potential Health Risks (Alternative D) (Except Drinking Water)		**Number of Plausible Exposure Scenarios** **(Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide	**Estimated Acres Treated Per Year**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
2,4-D	13,765	2	3	1	4
Chlorsulfuron	1,147				
Clopyralid	688				
Dicamba	688		3		1
Glyphosate	3,441				
Imazapic	3,441				
Imazapyr	688				
Metsulfuron methyl	1,147				
Picloram	6,882				
Sethoxydim	688				
Sulfometuron methyl	1,147				
Triclopyr	688		2		3
Total	34,410				
Annual Acres where Scenarios May Occur		**13,765**	**15,141**	**13,765**	**15,141**
NPE	N/A		1		1

Table 4-28 Public Consumption of Contaminated Pond Water (Alternative D)		**Number of Worst-case Exposure Scenarios (Blank = No Hazardous Exposure Scenarios)**			
		HQ = 2 - 10		**HQ > 10**	
Herbicide	**Estimated Acres Treated Per Year**	**Typical application rate**	**Maximum application rate**	**Typical application rate**	**Maximum application rate**
2,4-D	N/A		1		1
Chlorsulfuron			1		
Clopyralid			1		
Dicamba					1
Glyphosate			1		
Imazapic			1		
Imazapyr					
Metsulfuron methyl					
Picloram			1		
Sethoxydim					
Sulfometuron methyl					
Triclopyr					1
NPE		1			1

Note: Alternative D has the only herbicide exposure scenario among all alternatives that exceeds the RfD for drinking stream water contaminated by drift for any herbicide. The HQ for drinking stream water contaminated with drift from 2,4-D applied at the maximum allowable rate is projected to be 9.

Summary Tables

Table 4-29 Number of Plausible Exposure Scenarios (excludes drinking water scenarios)

	Worker Herbicide				Worker NPE				Public Herbicide				Public NPE			
	Typical Label Rate		Highest Label Rate		Typical Label Rate		Highest Label Rate		Typical Label Rate		Highest Label Rate		Typical Label Rate		Highest Label Rate	
	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10	HQ 2-10	HQ >10
No Action			6*	3			3				5	3			1	1
Proposed Action			7*	1			3				2	1			1	1
Alternative B			2	1			3				2	1			1	1
Alternative D	1		10*	6			3		2	1	8	7			1	1

* One scenario (ground broadcast application workers using picloram), predicts a cancer risk of 2 in one million, which exceeds the EPA cancer risk threshold of 1 in one million.

Table 4-30 Public Consumption of Contaminated Water: Herbicide + NPE Spill

	Typical Application Rate		Highest Application Rate	
	HQ 2 - 10	HQ > 10	HQ 2 - 10	HQ > 10
No Action	1		2	3
Proposed Action	1		5	2
Alternative B	1		2	2
Alternative D	1		6	4

4.5.3 Alternative Comparison

Table 4-31 Summary of Effects by the Measuring Factors

	Exposure Scenario	No Action	Proposed Action	Alternative B	Alternative D
Number of Worker Days of Exposure to Manual Treatment Hazards	N/A	36,593	30,711	8,602	44,948
Total Herbicide and NPE WORKER Scenarios that Exceed RfD	Typical Worst-Case	0 12	0 11	0 6	1 19
Total Acres Where Worker Scenarios > RfD May Occur	Typical Worst-Case	0 12,281	0 4,960	0 508	13,765 24,317
Total Herbicide and NPE PUBLIC Scenarios that Exceed RfD (other than drinking water contamination)	Typical Worst-Case	0 5	0 5	0 5	3 18
Total Acres Where Public Exposure Scenarios >RfD May Occur	Typical Worst-Case	0 591	0 930	0 508	13,765 15,141
Total Herbicide and NPE PUBLIC Scenarios that Exceed RfD for Drinking Water Contaminated by Spray Drift	Typical Worst-Case	0 0	0 0	0 0	0 1
Treatment Acres where Risk of Public Drinking Water Contaminated by Spray Drift >RfD	Typical Worst-Case	0 0	0 0	0 0	0 13,765
Total Herbicide and NPE PUBLIC Scenarios that Exceed RfD for Drinking Water Contaminated by Tanker Spill into Pond	Typical Worst-Case	1 5	1 7	1 4	1 10

Alternative B is considered the alternative with the overall least risk of herbicide-related health effects to workers and to the public. However, the only differences among Alternative B, No Action, and the Proposed Action, lie in potential risks associated with Worst-case scenarios. For typical Forest Service invasive plant treatment practices, Alternatives A, B and C are essentially equal. No significant health effects to workers, nor to the public from invasive plant treatment would be expected. The six herbicides added to the Proposed Action do not significantly increase risks to workers or the public from routine operations. The only risk identified with these alternatives from typical operations is a moderate risk of health effects (HQ= 5) if water is consumed from a pond into which the surfactant NPE is spilled in association with a herbicide.

4.5.4 Cumulative Effects

Two related possible categories of potential human health effects comprise "cumulative effects": synergistic effects from exposures to multiple chemicals that interact other than by additive effects; and additive cumulative effects resulting from multiple exposures to one herbicide chemical from multiple sources. Appendix G discusses the available data and risk analysis for each type of effect for each herbicide considered in this EIS. The potential for these effects from alternatives proposed in the EIS is discussed here.

The potential for cumulative risks to workers from non-chemical treatment methods is great. People may be injured more than once given the hazardous outdoor working conditions and use of chainsaws or heavy equipment. Forestry workers may be exposed to hazards on all land ownerships. No estimate of acreage of non-chemical invasive plant management is available. State Occupational Safety and Health Administration (OSHA) rules apply to non-herbicide work on all ownerships.

The potential for cumulative human health effects from repeated herbicide exposures, resulting from herbicide use proposed in this EIS is insignificant. Most of these herbicides do not bioaccumulate in humans, are rapidly eliminated from the body, and they persist in the environment for a relatively short time (generally less than 1 year). No additive doses from re-treatments in subsequent years are predicted. The herbicides clopyralid, picloram and sulfometuron methyl persist in the environment for more than one year; however, re-treatment in the following year is not expected; thus no additive doses from re-treatment are predicted.

The potential for cumulative human health effects from any herbicide use proposed in this EIS, combined with other potential herbicide applications in the analysis area, is encompassed in the chronic exposure scenarios, which consider the effect of repeated exposures. The risk of toxic health effects from repeated exposure to any of these herbicides at doses that are less than the chronic toxicity threshold (chronic RfD) is low. These chronic scenarios previously identified for each alternative with moderate or high risks of health effects, would reflect moderate or high risks of cumulative effects, from multiple applications made in compliance with EPA label requirements, and result in comparable repeated doses.

Herbicide use proposed in the alternatives would amount to less than three percent of total herbicide projected use in Oregon and Washington for invasive plant treatment. The quantities of herbicides proposed for use in EIS alternatives is further diminished in significance of their contribution to potential significant cumulative health effects in the context of all herbicide use in the analysis area. The choice between alternatives would not substantially affect overall herbicide use.

4.5.5 Methodology

The methodologies used to assess human health risks from alternatives in this EIS are based in the Forest Service Herbicide Risk Assessments for each herbicide considered. For a background discussion of all toxicological tests and endpoints considered in Forest Service Risk Assessments, refer to SERA, 2001-Preparation.

The risks of adverse health effects from the use of any herbicide depends on the toxic properties of that herbicide, the level of exposure to that herbicide at any given time, and the duration of that exposure. The EIS Human Health Effects section analyzes the potential for adverse health effects to workers and members of the public, from treatment of invasive plants using the herbicides as proposed in EIS alternatives. Most of the information and analysis used to estimate human health effects of EIS alternatives, is cited from risk assessments prepared for each individual herbicide by Syracuse Environmental Research Associates, Inc. (SERA), under contract to the USDA-Forest Service. Specific methods used in preparing the FS/SERA herbicide risk assessments are described in SERA, 2001-Preparation. To evaluate potential risks to human health and the environment, FS/SERA risk assessments use peer-reviewed articles from the open scientific literature and current EPA documents, including Confidential Business Information. Only specific information that is NOT derived from the relevant SERA Risk Assessments is specifically cited in this section.

The analysis of the potential human health effects associated with the use of herbicides uses the methodology of risk assessment generally accepted by the scientific community (National Research Council, 1983; EPA, 1987 in SERA, 2001-Preparation). FS/SERA herbicide risk assessments estimate doses to workers from herbicide application, and doses to the public from being on or near an application site. Estimated worker doses and public doses are compared to

Reference Doses (RfD). RfD's are quantified levels of exposure established by the U.S. Environmental Protection Agency's (EPA) to be considered protective of lifetime or chronic exposures. RfD's are based upon doses shown to cause no observed ill effects to test animals in either short-term (acute) or long-term (subchronic or chronic) studies. Human exposure doses are reduced from those found protective of test animals, based on possible variation between species and among individual people. Different types of possible effects are considered, including acute and chronic systemic effects, cancer and mutations, and reproductive effects.

The Invasive Plant EIS uses the threshold levels for acceptable risk established by EPA: the RfD is the threshold level for exposure for non-carcinogenic health effects, and 1 chance in 1 million is the cancer risk threshold level. A Hazard Quotient (HQ) has been computed for the exposures estimated for workers and members of the public by dividing the dose predicted from invasive plant treatment by the RfD. In general, if the HQ is less than or equal to 1, the risk of effects is considered negligible.

One of the primary uses of a risk assessment is for risk management. Decision-makers can use the EIS human health risk assessment to identify those herbicides, application methods, or exposure rates that pose the greatest risks to workers and the public. Specific mitigation measures can then be employed where the decision-maker feels the risks are unacceptably high. Reducing exposure can reduce risk. The use of streamside buffer zones, personal protective equipment for applicators, and posting of treated areas are all examples of ways to reduce exposure to workers and the public. Decision-makers would determine when to implement mitigation measures on specific treatment projects for herbicides available for use in the Record of Decision for the EIS.

Because any risk assessment is based on a number of assumptions, readers and decision-makers should not conclude that the risk values are absolute. If the assumptions are changed, the risk values change. However, the relative risk among herbicides or methods should remain the same unless new toxicity data becomes available.

Refer to EIS Chapter 3, Herbicide Risk Assessments, and EIS Chapter 4, Section 4.1.2 for additional discussion of the methodologies used to estimate risks to human health in this EIS.

4.4.6 Incomplete or Unavailable Information

For incomplete and unavailable information that is relevant to the toxicological tests and endpoints considered in all Forest Service Risk Assessments, refer to SERA, 2001. Incomplete and unavailable information relating to individual herbicides is identified in each Herbicide Risk Assessment, prepared for the Forest Service under contract by SERA, Inc. Incomplete information discussed in these assessments includes the interactions of the herbicides, associated chemicals, and other naturally-occurring and synthesized substances.

Refer to EIS Chapter 3, Herbicide Risk Assessments, and EIS Chapter 4, Section 4.1.2 for additional discussion of the significance of incomplete and unavailable information to EIS herbicide risk analysis.

4.6 Costs of Treatment and Effects on Land Use

4.6.1 Introduction

Management of invasive plants affects the goods, services, and uses provided by National Forest System land and the costs of managing those lands. Invasive plant management may compete with other important land management needs, resulting in cost tradeoffs. Management of timber, vegetation, roads, public access, range, recreation, lands, minerals, fire, and fuels may be affected by costs increases or loss of opportunity due to invasive plant management. For example, all action alternatives will require pack stock users to supply weed-free feed on some or all National Forest lands, which will increase the cost of using pack stock and may restrict their ability to use these lands.

Prevention and management of invasive plants can be costly and fiscal resources are always limited. Increased operating costs due to invasive plant management many result in direct or indirect transfer of costs to land management programs or users of National Forest lands.

Variations in standards between alternatives result in differences in the availability of management tools and the supply of goods, services, and uses. In turn, this affects the natural and human environment. Three categories of effects are considered for this issue:

1. Direct financial costs of the invasive plant treatment program projected for each alternative;

2. Direct and indirect costs to programs and outputs due to standards in each alternative; and

3. Effects to forest users and permittees due to changes in access or other program adjustments influenced by standards.

The measuring factors for the alternatives, related to these effects are:

- Annual acres of treatment and average treatment cost per acre;
- Percent increase in cost of heavy equipment work;
- Tendency of standards to result in road closures or loss of roaded access;
- Tendency of standards to affect range allotments and permittees; and
- Acres of National Forest land where weed-free feed is required.

Existing data were used to estimate impacts in quantitative terms such as dollars or reduction of output, where possible. Where existing data were inadequate to estimate quantitative effects, effects were explored in a qualitative fashion, based in consultation with professionals in the respective resource areas. Whether explored quantitatively or qualitatively, the effects disclosed in this section are based on the best reasonably available information from managers and scientists.

Chapter 4.6 is organized to display effects by the measuring factors. Chapter 4.6.2 discusses the cost of invasive plant treatment. Chapter 4.6.3 discusses the effects of the prevention standards. Chapter 4.6.4 discusses the cost of heavy equipment work. Chapter 4.6.5 discusses weed free requirements. Chapter 4.6.6 discusses effects to range allotments and permittees. Chapter 4.6.7 discusses effects to road and off-road vehicle access, and finally, Chapter 4.6.8 compares the alternatives by the measuring factors.

Additional effects analysis, background, and information is contained in the specialist report for land management impacts and economic analysis in the project analysis file.

4.6.2 Costs Of Invasive Plant Treatment

Direct and Indirect Effects

The Forest Service currently spends about 4.8 million dollars annually treating about 25,000 acres of invasive plants on National Forests in Region Six.

Table 4-32 identifies the current treatment costs and acres treated. Costs vary from $40 per acre using fire, to $340 per acre using manual methods. Approximately 54 percent of current treatments are ground-based herbicide applications. Manual treatments consume about 61 percent of total treatment expenditures. The action alternatives are compared to this baseline.

Table 4-32 Current Annual Treatment Acreage and Cost

Method	Average Acres per year	Percent Acres by Method	Cost Per Acre	Total Cost	Percent Cost by Method
Herbicide- Ground	13,646	54%	$125	$1,705,750	35%
Herbicide- Aerial	0	0%	$50		0%
Manual	8,610	34%	$340	$2,927,400	61%
Mechanical	770	3%	$100	$77,000	2%
Biological	996	4%	$70	$69,720	1%
Fire	382	2%	$40	$15,280	<1%
Cultural	202	1%	$50	$10,100	<1%
Total	24,606	100%		$4,805,250	100%

For the action alternatives, estimated costs are based on the first year of treating previously untreated areas. Some treatment methods (e.g. biological control) may be needed only one year. Other treatments may need to be reapplied at decreased levels (e.g. herbicides) and some treatments may need to be repeated annually with little or no reduction in application level (e.g. mechanical).

Standards in the action alternatives determine the suite of available treatment methods. Acres effectively treated change under each alternative when the budget is held constant. This is because costs vary by treatment method. Treatment costs per acre by method are based on costs reported by National Forests in Region six between 1997 and 2003, as well as estimates from other Regions. Manual treatment costs are $340 per acre for all alternatives except Alternative B. Costs are expected to be $400 per acre for manual treatments under Alternative B because areas that may be difficult to treat manually would be included, given its emphasis on non-chemical methods. The treatment cost per acre for all other non-herbicide treatment is constant across the alternatives.

Available herbicides varied between alternatives. Choices of herbicides caused variation in treatment cost per acre and total acres treated between alternatives, though to a lesser degree than treatment method. Herbicide use ratios were estimated for each action alternative, No Action ratios are based on Region Six herbicide use from 1999 to 2002.

<u>No Action</u> Average cost per acre is $25 based on:

10% Glyphosate at $29.38/acre
81% Picloram at $21.75/acre
3% Triclopyr at $115.50/acre
5% Dicamba at $17.35/acre

<u>Proposed Action</u> Average cost per acre is $38 based on:

25% Glyphosate at $29.38/acre
25% Clopyralid at $37.75/acre
15 % Picloram at $21.75/acre
10% Imazapic at $16.40/acre
10% Sulfonyl mix at $26.40-$32.10/acre
15% others at $24.06-$134.25/acre

<u>Alternative B</u> Average cost per acre is $41 based on:

40% Glyphosate at $29.38/acre
40% Clopyralid at $37.75/acre
10% Triclopyr at $115.50/acre
10% Sethoxydim at $24.06/acre

<u>Alternative D</u> Average cost per acre is $21 based on:

40% 2,4-D at $7.48/acre
20% Picloram at $21.75/acre
10% Imazapic at $16.40/acre
10% Sulfonyl mix at $26.40-$32.10/acre
10% Glyphosate at $29.38/acre
10% others at $17.35-$134.25/acre

Average herbicide treatment costs per acre, by method, were then estimated for each alternative (Table 4-33). For all alternatives, ground application is estimated at $100 per acre in addition to herbicide costs, and aerial application is estimated at $25 per acre in addition to herbicide costs.

Table 4-33 Average Per Acre Herbicide Treatment Costs by Alternative				
Method	**Current**	**PA**	**B**	**D**
Herbicide cost + Ground application cost ($100)	$125	$138	$141	$121
Herbicide cost + Aerial application cost ($25)	$50	$63	$66	$46

Holding the budget constant, differences in treatment costs per acre change the number of acres that can be treated each year. This affects the ability of the Forest Service to effectively control invasive plants. See Chapter 4.2.

Table 4-34 displays the average annual acres treated and the percent of acres by treatment method under each alternative, given a constant annual budget of $4.8 million. Figure 4-1 displays the average annual acres treated by alternative.

Table 4-34 Total Treatment Acres by Alternative Holding Total Cost Constant at $4.8 Million								
	No Action		**PA**		**B**		**D**	
Method	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Herbicide- Ground	13,646	54%	15,401	53%	4,062	20%	29,957	74%
Herbicide- Aerial	0	0%	3,196	11%	1,015	5%	4,453	11%
Manual	8,610	34%	6,393	22%	9,342	46%	2,024	5%
Mechanical	770	3%	1,453	5%	2,031	10%	1,214	3%
Biological	996	4%	1,743	6%	2,031	10%	1,619	4%
Fire	382	2%	581	2%	812	4%	810	2%
Cultural	202	1%	291	1%	1,015	5%	405	1%
Total	24,606	100%	29,058	100%	20,310	100%	40,482	100%

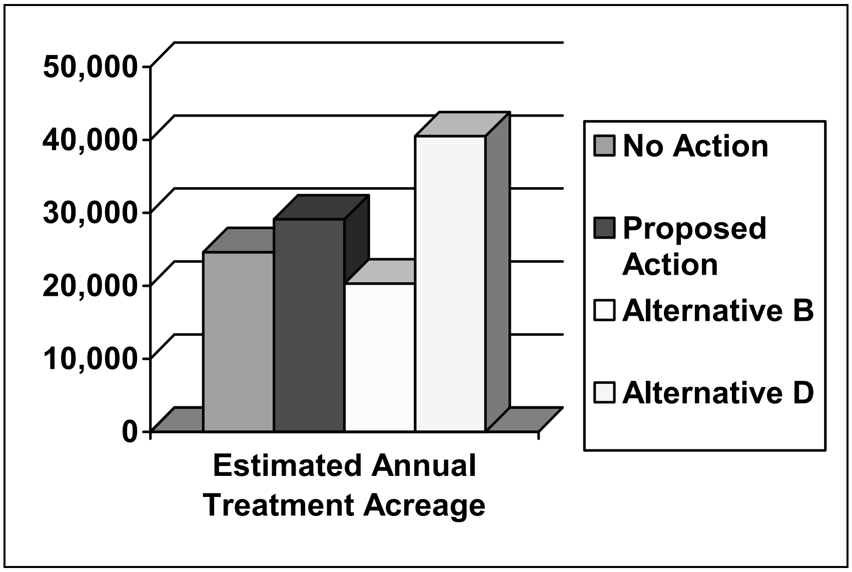

Figure 4-1 Acres Treated Annually Holding Budget Constraint at $4.8 Million

4.6.3 Effects of Prevention Standards

Prevention standards increase costs to National Forest users and change the requirements for land uses. The following summary describes the effects each prevention standard could have on land use activities and programs.

Standard #1 applies to all action alternatives and calls for consideration of invasive plants in new planning and analysis. Its effect on land use programs and activities is not measurable. While consideration of invasive plants in planning documents already occurs to some degree, this standard facilitates application that is more consistent. Costs for planning management of timber, other vegetation, road, livestock grazing, fire, fuels, recreation, and minerals and mining programs and projects increase under this standard. Uses and outputs would tend to decline, but the extent is considered very limited and not measurable. The additional requirement in Alternative B to emphasize healthy forest maintenance and restoration could further increase costs or limit land uses. For all alternatives, flexibility in timing, location, or intensity of land use could be adjusted to minimize adverse effects to programs and uses.

Standard #2 requires heavy equipment cleaning at varying levels based on the alternative. Implementation of this standard increases management costs for timber, other vegetation management, roads, livestock grazing, fire, fuels, recreation, and minerals and mining programs and projects. Currently, timber sale and road contracts contain equipment-washing clauses, but they are not universally applied. Other service contracts do not consistently contain these cleaning requirements.

Alternative B includes the additional requirement to clean vehicles other than heavy equipment authorized to operate outside the road surface on National Forest lands. Support vehicles that accompany heavy equipment would need to be washed more frequently, because they are generally used to access National Forest worksites on a daily basis. Heavy equipment is moved in and out far less often. Under Alternative B, this standard also results in increased initial costs to obtain or develop mobile washing stations. Until such stations are available, this standard in Alternative B may not be operationally feasible.

Standard #3 applies to all action alternatives and does not result in measurable cost increases. Most ground disturbing projects already have similar requirements for weed free straw and mulch in place. Weed free straw and mulch is preferred for projects in Region Six; this standard will facilitate consistency.

Standard #4 requires the use of weed free feed with variations by alternative. For the Proposed Action, weed free feed is required for pack stock using wilderness. This standard already applies to about 1 million acres of Wilderness on the Mt. Baker-Snoqualmie National Forest. Weed-free feed requirements increase the cost of using pack stock because weed-free feed is generally more expensive to purchase and distribution locations for weed-free feed are limited, resulting in additional purchase, travel and transportation costs to the user. The Proposed Action requires weed-free feed on about 3.6 million additional acres over No Action or Alternative D. Alternative B expands the weed free feed requirement to all 24.9 million acres of National Forest lands in Region Six.

Standard #5 applies solely to Alternative B. It requires that native vegetation and forest canopies be maintained within certain areas. This standard does not identify the specific areas where this may occur. Therefore, no estimates can be made about the extent of the impact. Vegetation management projects could cost more, or acres of accomplishment could be reduced, but adjustments may be made at the regional scale (e.g. overall sale size increased to maintain board feet output) to minimize the actual effects. Fire and fuels management programs are affected by this standard, and in extreme cases, applying the standard results in less effective fuels treatments and increased risk for wildfire damage. Implementation of this standard potentially reduces the ability of the Forest Service to appropriately respond to changing fire condition classes and may conflict with achieving the goals of the Healthy Forests Restoration Act of 2003.

Standard # 6 applies to all action alternatives and adds a requirement to incorporate invasive plant prevention methods into allotment planning and management. This requirement does not measurably affect the cost or extent of grazing operations, as invasive plants are already considered in many grazing management plans. Alternative B includes specific prevention practices that add more costs to allotment planning and management and potentially reduce livestock grazing levels.

Standard #7 varies by alternative and requires inspection and treatment of gravel, fill, sand, quarries, and borrow material for invasive plants. It increases costs of mineral source development and use depending on the extent of invasive plants in a given site. All alternatives increase costs of rock source development. Inspecting rock source areas before use results in a slight increase in rock source management costs. Under Alternative B, this cost is highest due to the requirement to inspect source sites annually. The Proposed Action and Alternative B also have the requirement to strip and stockpile material before use. This requirement results in additional costs of over $300,000 annually for Regions Six. Additional costs of Alternative B are incurred because herbicides are not used to treat mineral sources, but instead they are treated mechanically.

Standard #8 varies between the alternatives and requires consultation with invasive plant specialists on road maintenance. It increases the cost of these projects, reducing accomplishment where budgets remain static. Region 6 currently completes approximately 7,470 “lane miles” of road maintenance and 3,600 miles of ditch maintenance (information in specialist report). The additional work estimated to result from this standard in all alternatives is nearly a one percent increase in road maintenance costs. This is due to increased work force needs so that appropriate consultation occurs. Alternative B has an additional requirement that increases the time and resources needed to accomplish road maintenance work. This reduces the amount of maintenance work accomplished annually, given constant budgets.

Standard #9 applies solely to Alternative B. It calls for the closure or decommissioning of nonessential roads where invasive plant spread is of high risk. Given the wide distribution of invasive plants, the effect of this standard could be extensive. This standard results in more road closures than proposed under current management. As roads are closed or decommissioned, public access is decreased. People have expressed concern about the effects of road closure, including: making recreation areas inaccessible or less accessible, restricting access to areas for people with disabilities, reducing dispersed recreation opportunities, reduced fire suppression access, and increased costs of land use and management. The extent of these effects depends on the number of roads closed due to this standard, which cannot be quantified.

Standard #10 solely applies to Alternative B[35]. It calls for the prohibition of cross-country OHV use. This standard results in a shift away from "open to OHV use unless marked as closed" policy, to a policy where areas are considered "closed to OHV use unless marked as open". The standard does not specify how many areas would be closed or how quickly closures would be implemented. If OHV use is limited, this type of public access is decreased. Many people express concerns they are losing a sense of public ownership of lands when "open access" is reduced across the National Forest lands.

The potential effects of each prevention standard summarized above are also evaluated for their significance based on public scoping and concerns expressed by agency land managers. The most significant potential effects from the prevention standards are:

- Increases in costs of heavy equipment work due to vehicle cleaning requirements from Standard #2.
- Increases in costs or reduced ability for stock users to access part of the National Forests due to weed free feed requirements for pack stock from Standard #4.
- Grazing allotment management adjustments and adverse effects on permittees affected by requirements in Standard #6.
- Road and off-highway vehicle use closures that result from Prevention Standards #9 and #10 in Alternative B limiting this type of public access and recreational opportunities.

[35] The Forest Service is currently in the process of revising its national policy regarding OHV access, it is likely that all National Forest System lands will eventually go to a "closed unless designated open" approach.

4.6.4 Costs of Heavy Equipment Work

Direct and Indirect Effects

Standard #2 increases costs of heavy equipment work through vehicle cleaning requirements that are not currently universally applied. Forest Service specialists estimate that costs, for programs that use heavy equipment outside the road surface, will increase by about 2 percent. This is based on 2003 competitive sourcing road maintenance studies that found that the Region completes approximately $9.9 million dollars of road maintenance work annually. This budget equates to the work of approximately 193 pieces of heavy-equipment pieces working all year. These figures provide the baseline for comparison of the potential for Standard #2 to increase costs of heavy equipment work. Cost increases will apply to Forest Service and contract use of heavy equipment, thus contract bid prices will increase. Information about analysis methodology in the Engineering Specialist Report is in the project analysis files.

Under No Action, Standard #2 does not apply. Under The Proposed Action and Alternative D, vehicle washing requirements are estimated to cost about $215,000 for road maintenance equipment, approximately a 2 percent increase to current program costs. A similar 2 percent increase in heavy machinery operating costs is expected for all programs that operate heavy equipment outside the road surface, such as timber and vegetation management.

Alternative B further increases heavy equipment cleaning costs by approximately $1,125,000 annually. This equates approximately to an 11 percent increase to current program costs. A similar 11 percent increase in heavy machinery operating costs is expected for all programs that operate heavy equipment outside the road surface. Table 4-35 and Figure 4-2 display annual costs associated with the use of heavy equipment.

Table 4-35 Cost of Heavy Equipment

	Annual Heavy Equipment Cost	Approximate Increase in Cost	Approximate Percent Increase
No Action	$9,900,000	0	0%
Proposed Action	$10,115,000	$215,000	2%
Alternative B	$11,025,000	$1,125,000	11%
Alternative D	$ 10,115,000	$215,000	2%

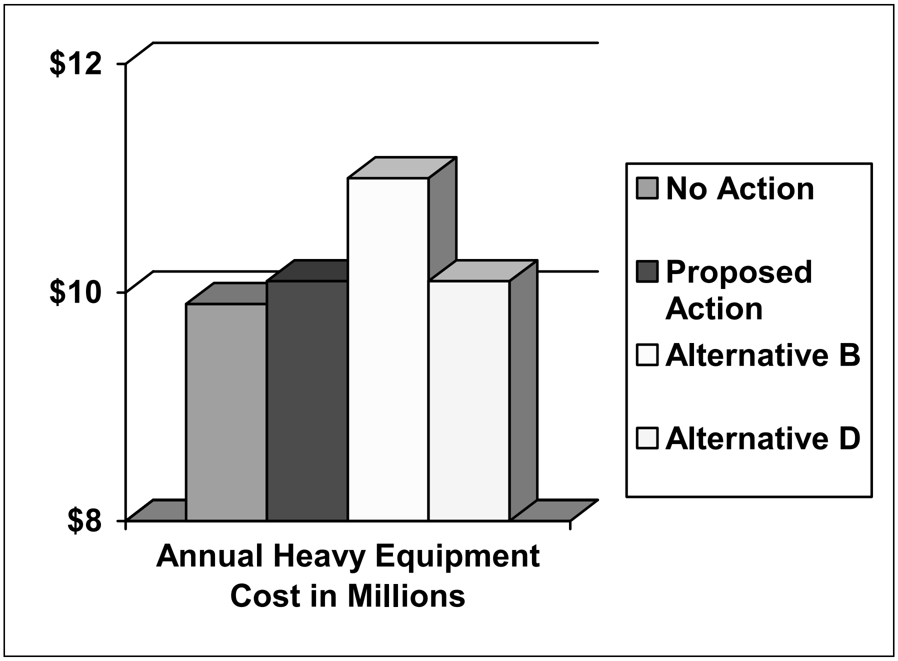

Figure 4-2 Annual Heavy Equipment Costs (in Millions)

Cumulative Effects

No additional costs to heavy equipment use are foreseeable from other actions. The recent Port-Orford-cedar decision applied standards similar to the Proposed Action for some portions of the Region. The invasive plant standards are compatible with the Port-Orford-cedar standards.

4.6.5 Weed Free Feed Requirements

Direct and Indirect Effects

Weed-free feed requirements increase the cost of using horses and other pack stock because weed-free feed is more expensive to purchase, distribution locations for weed-free feed may be limited, and recreationists may have to plan ahead to obtain the feed. The measure of this effect is acres of National Forest where weed free feed requirements apply.

Recreation users may experience additional travel costs to comply with this standard. Animal users may also decide not to use certain National Forest lands if they do not wish to comply with weed free requirements. Thus, some users and use impacts may be displaced to other federal, state, or private lands.

Alternative B requires the use of weed-free feed on all 24.9 million acres of National Forest lands in the Region. Refer to Table 4-36. This alternative requires weed free feed on 5 times as many acres as the Proposed Action and 25 times more than No Action and Alternative D. Thus, Alternative B has the greatest effects to animal users.

The Proposed Action requires use of weed-free feed in approximately 4.6 million acres of Wilderness Areas and at Wilderness Trailheads. This alternative requires weed-free feed on just over four times (about 3.6 million additional acres) as much land than the No Action Alternative or Alternative D. Thus the Proposed Action is less costly to animal users than Alternative B but more costly than the other alternatives.

The No Action Alternative and Alternative D do not include weed free feed requirements. However, about 1 million acres of Wilderness on the Mt. Baker-Snoqualmie National Forest require weed free feed under current direction. This direction will not change as a result of potential decisions associated with this EIS.

Table 4-36 Acres Where Weed Free Feed Would Be Required

Alternative	Acres Where Weed-Free Feed is Required For Pack Stock
No Action	1.0 million
Proposed Action	4.6 million
Alternative B	24.9 million
Alternative D	1.0 million

The more acres where weed-free feed is required, the more likely that animal users will experience cost increases or loss of options for access to National Forest. The precise measure of the impact is not known, and depends on the availability and cost of weed-free feed compared to current feed costs. This requirement is expected to be implementable over time, but may require some "ramp up" time as a weed-free feed certification, distribution and use becomes more widespread. Many pack stock users already comply with weed-free feed requirements as a part of special use permits on National Forests.

Cumulative Effects

Weed free feed use is common but not required throughout Oregon and Washington. Regardless of choice of alternative, pack stock use will continue to be a source of invasive plant spread (see Chapter Three for more discussion on this mechanism of dispersal). No additional restrictions on horse and other livestock users are foreseeable.

4.6.6 Tendency for Standards to Affect Range Allotments and Permittees

Direct and Indirect Effects

Requiring invasive plant prevention measures in range management may result in limitations on livestock grazing, including changes in grazing locations, timing, intensity, and outputs.

The Proposed Action and Alternative D require incorporation of invasive plant prevention measures in annual operating instructions and allotment management plans. Since invasive plants are already considered in many grazing management plans, the effect of this standard is mainly regional consistency. Alternative B takes this standard a step further by listing prevention measures.

The effects on livestock grazing levels and permttees under Alternative B could include:

- Changes in livestock movement patterns that require additional labor or may reduce outputs for certain allotments.
- Alteration of season of use affecting those allotments that operate as single-pasture season-long grazing systems, where alteration of season of use effectively delays turn-on in certain years and reduces output.

- Resting of pastures resulting in reduction of livestock use and output.
- Retirement of grazing allotments directly reducing the number of livestock (commonly measured by Animal Unit Months or AUMs) permitted on National Forest lands.
- Active restoration of native plant communities, which requires allotment resting for one to two seasons. In some cases fencing can be used to mitigate impacts.
- Reintroduction of livestock in areas of intact biological soil crusts is delayed for at least three years following wildfires. It is impossible to quantify the effects of such a delay due to the nature of wildfires, however it can be assumed that such effects would increase following years when many acres burn. Reintroduction of livestock following wildfires is typically delayed for at least one or two seasons.

Ultimately, these measures will tend to reduce the number of livestock grazing National Forest lands in Region Six. The actual reduction in AUMs cannot be quantified due to unavailable data and the dynamic nature of related variables.

These requirements under Alternative B for range management would require additional labor (riders, fence builder, etc.) and investments in range improvements to maintain near current grazing levels. It is possible that grazing levels may decline even with these additional efforts. It is anticipated that effects to most permittees will generally be minimal, however some individual permittees could experience impacts if their allotments require resting, changes in movement patterns, reduction in allotment AUMs, or wildfires occur in areas with biological crusts. It is unlikely, but possible that under certain circumstances, these measures could result in the reduced viability of some ranches or transfer additional impacts to private lands.

Effects on grazing and range management are displayed in Table 4-37.

Cumulative Effects

The authorized number of AUMs has been in a fairly static for the past decade, with slight decreases during drought years and as some small allotments are retired over the past 40-60 years, the trees and forest canopy have been increasing subtly, resulting in a reduction of forage and a decrease in available AUM levels. Cumulative impacts of current trends and invasive plant management will likely be a slight decrease in AUMs on National Forest lands over time. Alternative B has the greatest potential to influence AUMs and contribute to increased reductions over time.

Table 4-37 Effects on Grazing and Range Management	
Alternative	**Effects on Grazing and Range Management**
No Action	No Direct Effect.
Proposed Action	No Direct Effect.
Alternative B	Tendency for adjustments to range allotments and ultimate AUM reduction.
Alternative D	No Direct Effect.

4.6.7 Tendency for Standard to Affect Road and Off-Highway Vehicle Access

Direct and Indirect Effects

Alternative B includes standards that limit public access and result in road and OHV closures. Alternative B also requires use of weed-free corrals and OHV staging areas. The other alternatives, none of which possess similar standards, do not result in these effects (Table 4-38).

Standards restricting public access decrease some forest user sense of freedom to use public lands as they see fit or as they have done in the past. Some forest users may also be troubled by limited access to structures (roads) that already exist and are easily seen. These standards also increase costs to forest users, by limiting access locations or by changing use patterns thus adding to user transportation costs.

The actual results of applying Prevention Standards #9 and #10 are unknown and cannot be predicted due to the complexity of the factors. Alternative B results in more road closures than the other alternatives, but the extent to which roads and OHV use areas would actually be closed is not known.

Cumulative Effects

Currently, OHV management is a priority issue within the Forest Service, and along with invasive plants, is included in the top four threats facing National Forest lands. National OHV policy, currently drafted, limits OHV use to designated roads, trails and areas, having a similar effect as Alternative B and generally prohibiting cross-country OHV use. There may be no differences between alternatives once this policy is in place.

Table 4-38 Effects of Road and OHV Use Closures

Alternative	Effects on Road and OHV use Closures
No Action	No Effect.
Proposed Action	No Effect.
Alternative B	Roads are closed or decommissioned and OHV use areas are restricted. The extent to which this may occur is not known.
Alternative D	No Effect.

4.6.8 Alternative Comparison

Table 4-39 compares the alternatives by the measuring factors.

Table 4-39 Summary of Effects by Measuring Factors

	No Action	Proposed Action	Alternative B	Alternative D
Annual acres of treatment for each alternative as an indicator of relative costs	24,606	29,058	20,310	40,482
Estimated percentage increase in cost of heavy equipment work	0%	2%	11%	2%

Table 4-39 Summary of Effects by Measuring Factors				
	No Action	**Proposed Action**	**Alternative B**	**Alternative D**
Tendency for standards to result in road closures and loss of off-highway vehicle access	No Direct Effect. New restrictions on OHV use may occur from new national policy.	Same as No Action.	Tendency for more roads to be closed or decommissioned and OHV use areas to be restricted. New restrictions on OHV use may occur from new national policy.	Same as No Action.
Tendency for standards to affect grazing locations, timing, intensity and outputs	No Direct Effect.	No Direct Effect.	Adjustments to range allotments and ultimate AUM reduction likely.	No Direct Effect.
Acres of National Forest where weed free feed would be required	1.0 million	4.6 million	24.9 million	1.0 million

4.7 Other Issues

4.7.1 Soil Productivity

Introduction

Scoping input raised concern about the effects of herbicides on soil and soil organisms, including mycorrhizal fungi. Soil organisms perform important roles supporting plant growth and thus are fundamental to soil productivity. Some organisms convert nutrients to a usable form, some create soil structure and allow water and air to reach plant roots, while others interact with specific species and are necessary for survival of some plants. Regional soil productivity protection standards were originally implemented in 1976 and have been revised several times since then (Pacific Northwest Region Monitoring and Evaluation Report, 2001). The risk assessments (SERA, 1999, 2001, and 2003) included information about potential effects to soil organisms when it was available, which confirmed the relevance of the issue to this analysis.

All alternatives, including the No Action alternative, allow the use of herbicides in treatment of invasive plants. Although picloram and sulfometuron methyl are of particular concern due to toxicity to soil microorganisms and persistence in soil, all herbicides have some evidence of transient effects to soil microorganisms. All herbicides can persist under some circumstances related to soil texture, organic matter content, and soil moisture level, among others. All action alternatives include a standard requiring a long-term strategy for restoring infestations of invasive plants, which necessarily includes protecting or improving soil productivity and conditions for soil microorganisms (Standard 12). Applied thoughtfully, herbicides can provide these benefits while minimizing effects to soil organisms.

Successful restoration of native vegetation to areas infested with invasive plants is dependent, in part, on healthy soil organisms. Negative effects to soil organisms and soil productivity can complicate restoration and could delay restoration of native vegetation for a year or more.

Picloram is toxic to some soil organisms, even at low levels, based on increasing persistence with increasing application rates. Picloram is most toxic in acidic soil. Picloram has a typical half-life of 90 days, meaning that one-half of the amount applied remains in the soil after 90 days, one-fourth of the applied amount remains after 180 days, one-eighth after 270 days, and so on. Because picloram is toxic to microorganisms at low levels, toxic effects can last for some time after application. Field studies (Brooks et al. 1995; Nolte and Fulbright 1997) have not noted substantial adverse effects associated with the normal application of picloram, that might be expected if soil microbial activity were substantially damaged. (SERA, 2003-picloram)

Similarly, sulfometuron methyl is toxic to soil microorganisms. Microbial inhibition is likely to occur at typical application rates and could be substantial. The typical half-life for sulfometuron methyl varies from 10 to 100 days, depending on soil texture. Soil residues may alter composition of soil microorganisms. Sulfometuron methyl applied to vegetation at rates that control undesirable vegetation would probably be accompanied by secondary changes in the local environment affecting the soil microbial community to a greater extent or at least more certainly than any direct toxic action by sulfometuron methyl on the microorganisms (SERA, 2003-sulfometuron). Changes to mychorrhizal fungi from sulfometuron methyl can affect the productivity of native plant communities.

Direct and Indirect Effects

Picloram, applied at typical rates, is expected to changes microbial metabolism, though detectable effects to soil productivity are not expected. Persistence in soils could affect soil microorganisms by decreasing nitrification. Long term effects to soil microorganisms are unknown. (SERA, 2003-picloram) Under No Action, it is predicted picloram would be applied to about 11,000 acres annually, based on past use. Under the Proposed Action, it is predicted picloram would be applied to about 3,000 acres annually. Under Alternative B, no picloram would be used. Under Alternative D, it is predicted picloram would be applied to about 6,900 acres annually.

Sulfometuron methyl applied to vegetation at typical application rates will probably be accompanied by secondary changes to vegetation that affect the soil microbial community more certainly than direct toxic action of sulfometuron methyl on soil microorganisms. (SERA, 2003-sulfometuron methyl) Arthur and Wang (1999) found that a formulation of sulfometuron methyl had a negative impact on the abundance of microorganisms and decreased soil nitrogen content on a Christmas tree farm. Sulfometuron methyl is not allowed under No Action or Alternative B. It is predicted that sulfometuron methyl would be applied to about 600 acres under the Proposed Action. Under Alternative D, it is predicted sulfometuron methyl would be applied to about 1,100 acres.

Other herbicides have affected soil microorganisms for a few days, as shown by indirect measures. One herbicide, imazapic, has no information about effects to soil microorganisms. Under No Action, about 2,600 acres would have another herbicide applied, with less toxic and less persistent effects to soil microorganisms. About 15,200 acres would have other herbicides applied under the Proposed Action. About 5,100 acres would have other herbicides applied under Alternative B. About 26,400 acres would have another herbicide applied under Alternative D.

Cumulative Effects

Both picloram and sulfometuron methyl are relatively water soluble and could move off-site in water. These herbicides are moderately adsorbed to soil particles and could be moved off-site with wind or mass soil movement. It is possible these herbicides could be introduced to NFS lands from other sources, though it is more likely that they would move off NFS lands to other ownerships. Forest Service use of picloram is less than 1percent of agricultural use (SERA-, 2003-picloram), while Forest Service use of sulfometuron methyl nationwide is less than 1 percent of all use in California (SERA, 2003-sulfometuron methyl). Movement of these herbicides to NFS lands is not expected to affect soil productivity, because most NFS lands are upstream or upwind of other ownerships.

Methodology, Unknown Information and Approach to Uncertainty

Information about specific herbicide effects to each of the myriad of soil organisms is not available. Much of the research is based on indirect effects such as changes in persistence or metabolism of nutrients. The observed changes may mean a temporary depression in the activity of existing soil organisms, or could signal a complete change in the organisms present. Soil organisms are important to the human environment because they can affect soil productivity, and none of the herbicides under consideration has notable effects to soil productivity. Hence, the unavailable information is insignificant in terms of providing a clear basis for choice between alternatives.

The analysis file contains the soil scientist specialist report. Individual risk assessments contain more details about the toxicity of individual herbicides to soil organisms, information about studies considered in the risk assessment, modeling of individual herbicide movement, and specific information about herbicide properties such as persistence, adsorption to soil, and solubility in water.

4.7.2 Aquatic Organisms

Introduction

Public comments expressed concern that the application of herbicides in riparian areas would contaminate water and harm fish and other aquatic species. One formulation of glyphosate, applied at the highest application rate, could negatively affect fish. Herbicides that do not directly affect fish may affect their food chain through contamination of riparian and aquatic plants, algae, and terrestrial and aquatic invertebrates. Sub-lethal effects, such as behavior changes, could result in increased vulnerability to predators. The public also expressed concern about estrogenic effects to fish.

Public comments indicated concern about contaminating streams with herbicides, compromising the health of aquatic species such as salmonids, and other aquatic flora and fauna. Concern for protecting riparian area function was also highlighted by public comments. Riparian areas directly affect water quality, habitat, and the food web for aquatic species. Risk assessments modeled potential concentrations of herbicides in water under a variety of scenarios. Accidental spills of large amounts of herbicide into small water bodies, could reach concentrations of concern for most herbicide formulations. Modeling showed herbicide application at typical rates, did not reach a concentration of concern for fish, from any herbicide formulation considered under any alternative. Modeling of glyphosate formulations containing surfactants, applied at the highest rate, reached a level of concern for fish. Modeling results with regard to amphibians is discussed with wildlife effects. Modeling showed herbicide application at typical and high rates reached a level of concern for aquatic plants, for most herbicides.

Public comments also indicated concern about sub-lethal effects to fish. Sublethal effects are those that may lead to harmful, but non-lethal effects that may impact the ability of wildlife species to maintain normal populations. Examples include changes in behavior that make the fish more vulnerable to predation or illness, and hormonal effects that change reproductive success.

All action alternatives include standards to protect aquatic species. Standard 15 ensures use of trained herbicide applicators in treatment projects. Standard 18 requires risk assessment of herbicide formulation additives. Standard 19 requires the use of site-specific information to choose herbicide formulations, buffers, application methods, and timing. Standard 20 is intended to minimize effects to species covered under the ESA, and by extension provides protection to other aquatic species. Glyphosate is included in all alternatives, including No Action. Thus, this issue does not provide a basis for choice between alternatives.

Direct and Indirect Effects

Concentrations of herbicide in water that exceed the no observable effect concentration (NOEC) level are of concern. The NOEC is the concentration at which no effect has been observed in the study species. The LOEC effects are subtle, and may or may not be significant to the survival of the study organism. Sub-lethal effects are effects observed at this concentration. Sub-lethal effect may be observable, but not significantly affect survival. However, they may also alter predator avoidance, feeding, or reproductive behavior, potentially resulting in mortality or reduced reproduction.

Glyphosate is the only herbicide of those considered in this EIS, where use at label doses could result in concentrations in water which exceed the NOEC. Standard 19 in all alternatives, would preclude the use of glyphosate formulations that could affect fish in riparian areas. Glyphosate would be applied to 1,400 acres annually under No Action; 4,600 acres annually under the Proposed Action; 2,000 acres annually under Alternative B; and 3,400 acres annually under Alternative D.

For herbicides to directly affect aquatic species, the herbicide must enter water and reach concentrations of concern for aquatic species present in the stream. Overspray or drift may result in introduction of herbicides to water during application, while leaching or erosion can introduce herbicides to water following application. Standards 15 through 22 would govern the application of herbicides. They are designed to minimize herbicide introduction to surface water, prevent herbicide concentrations from reaching a level of concern, and protect water quality and aquatic biota, among other ecosystem components.

At the highest application rates, concentrations of chlorsulfuron, dicamba, imazapic, imazapyr, metsulfuron methyl, picloram, sulfometuron methyl, triclopyr, and 2,4-D could exceed the NOEC for aquatic plants(macrophytes or algae). The No Action alternative includes three of these herbicides, the Proposed Action includes seven, Alternative B includes one, and Alternative D includes all nine. The No Action would treat 0.5 percent of riparian areas with herbicides annually, the Proposed Action would treat 0.6 percent annually, Alternative B would treat 0.1 percent annually, and Alternative D would treat 1.2 percent annually. The differences between the alternatives would not result in significantly different levels of risk to aquatic organisms.

Herbicide effects to aquatic plants are unlikely because few aquatic plants are found in mountain streams and lakes. Mountain lakes are typically not very productive, and aquatic plants are not an important part of the food chain. Small low elevation lakes may include aquatic plants as an important part of the food chain. Primary production for food chains, in moving water ecosystems, in the region is generally based on organic material, leaves and insects, falling into the water from riparian areas. Fallen leaves from treated areas could affect stream food chains locally. Standards 19 and 20 are expected to mitigate most risk from actually occurring.

Cumulative Effects

Most, but not all, National Forest lands in Region Six are upstream of other sources of herbicides. Forest Service use of herbicides is typically a small percent of the herbicides used in a given watershed. (See SERA Risk Assessments, Section 2.5, from 1999, 2001, and 2003 for use statistics.)

Some herbicide formulations contain surfactants that are also found in other commonly used chemicals, such as shampoo. There is ongoing research into the effects of surfactants, particularly those that may have estrogenic effects to fish. A risk assessment addressing a group of surfactants of concern, indicated that Forest Service use is not likely to reach levels of concern for estrogenic effects to fish (Bakke, 2003). Little is known about the additive or synergistic effects of most herbicides on aquatic organisms. Analysis at the site-specific project level, can address the potential of specific herbicide mixes or concurrent herbicide applications.

Cumulative effects are not expected to be significant for the reasons discussed throughout this chapter; these substances are eliminated rapidly from the bodies of aquatic animals, and do not accumulate up the food chain.

Methodology, Unknown Information and Approach to Uncertainty

Studies of effects to aquatic fungi or unicellular organisms are generally not available. Herbicide effects to these organisms are likely, though the available information shows both benefits and negative effects. Effects to aquatic fungi and unicellular organisms are likely to be transient and localized. Standards that protect other aquatic organisms should also serve to protect these organisms. Similarly, information about herbicide effects to amphibians is scanty. See the discussion of wildlife effects for more information.

Information about sublethal herbicide effects to fish is incomplete. In some cases, the risk assessments were based on studies that identified the no observable effect concentration directly (See SERA-Chlorsulfuron 2003; Imazapic 2003; Metsulfuron Methyl 2003; Sulfometuron Methyl 2003; 2,4-D, 1998; and Bakke, 2003). These risk assessments were most likely to adequately identify sublethal effects to fish, and their significance to fish populations. Other herbicides identified the no observable effect concentration using other methods, which would not identify specific sublethal effects. Most acute fish toxicity studies report the results as LC_{50} values, and there are sound statistical reasons for this approach (SERA, 2003-clopyralid). The estimated no observable effects concentrations are very conservative, in part to take into account potential sublethal effects. All alternatives, including No Action, consider herbicides with estimated no observable effects concentrations, so there is no difference between alternatives.

The aquatic resources specialists' report contains information about herbicide effects on water quality, riparian function, and aquatic biota, which can be found in the analysis file. Individual herbicide risk assessments compile information about studies of herbicide effects on aquatic biota, as well as information about predictive modeling (SERA, 1999, 2001, 2003). The analysis file includes reports about analysis methods, and effects of non-herbicide treatment.

4.7.3 Federally Listed and Forest Service Sensitive Species

Introduction

Invasive plant management has the potential to affect federally listed and Forest Service Sensitive plant, wildlife, and fish species. Forest Service policy related to the National Forest Management Act and the Endangered Species Act require analysis of effects to threatened, endangered, and proposed species. Any practice focused on reducing introduction and spread of invasive plants will indirectly benefit threatened, endangered or sensitive species, or critical habitat adversely affected by infestations.

The Endangered Species Act of 1973, as amended (ESA), requires federal agencies to ensure their actions do not jeopardize the continued existence of endangered or threatened species, or result in destruction of critical habitat. Some members of the public expressed concern over potential effects of invasive plant treatments to endangered species.

Effects determinations for special status plants, animals and fish are the same for all alternatives, even though the alternatives result in different kinds of risk, as described in sections 4.3, 4.4, and 4.7. The vast majority of invasive plant treatment and restoration projects can be designed to reduce or eliminate adverse effects to some special status species. However, adverse effects could occur under any alternative for some treatment methods. Some projects must have a short-term adverse effect in order to provide a long-term benefit to special status species.

Federally Listed Plants

Direct and Indirect Effects

Treatments to control invasive plants may indirectly harm native plants as discussed under Issue #2. However, invasive plant treatments are more likely to benefit special status plant species because threats to native plants from invasive plants, are greater than the threats from the treatment methods considered in this EIS. Careful treatment around listed populations would increase habitat quality, and improve chances for expansion of special status plant species.

Herbicide treatments have the potential to affect special status species in Region Six. As mentioned in Chapter 3.2, herbicides that target broadleaf plants in general, tend to more negatively affect plants in the sunflower, legume, and mustard families. Therefore, there may be the potential for increased risk for such listed species as, Kincaid's lupine (legume family) and McDonald's rock-cress (mustard family) when herbicides are part of the treatment strategy in potential habitat. Damage to Kincaid's lupine from herbicide spraying has already been documented under its Federal Register listing (USDI FWS 2000-Erigeron). Some of the sulfonylurea group of herbicides, known to be harmful to onions (members of the lily family), may more readily affect Gentner's fritillary, also a member of that family. Damage to individuals in a single population may adversely affect the rarest plants.

In most cases, these effects could be mitigated through Standard 20 by such means as buffering, timing of treatments during dormancy, exclosures or flagging of individuals before treatments most likely for ground based treatments.

The following table (Table 4-40) summarizes the effects determinations made on federally listed documented and suspected plant species for this EIS in Region Six. At this programmatic scale, all action alternatives are likely to adversely affect some listed species. Not Likely to Adversely Affect (NLAA) determinations are applied to those species that are either not found on National Forest in Region Six, or are not susceptible to invasive plants and therefore not likely to be treated. Site-specific treatments would require NEPA and FWS consultation. Detailed mitigation through project design criteria at the project level would tend to reduce the potential for adverse effects. Aerial spraying, especially in Alternative D would tend to make adverse effects more plausible.

Two federally-listed species documented in Region Six are most likely be adversely affected by invasive plant treatments under aerial spray treatments circumstances in Alternative D. McFarland's four o' clock and Spaulding's Catchfly could be affected if specific populations or suitable habitat are located on steep, inaccessible canyon terrain, where aerial spraying would most likely occur.

The EPA has issued pesticide use limitations for Wallowa County, Oregon to protect MacFarlane's four-o'clock. A list of herbicides and corresponding buffers was issued by the agency and most recently updated in 2003. The herbicides on the list covered under this EIS are dicamba, picloram, sulfomethuron methyl and 2,4-D. This group of herbicides cannot be applied within 100 yards of species habitat for aerial application or within 20 yards of species habitat for ground applications. Also, sulfomethuron methyl cannot be applied on rights-of-way within species habitat. These limitations are required in two specific areas in the county (http://www.epa.gov/espp/oregon/wallow.htm). This extra restriction would limit adverse effects on this species in these specific areas.

Table 4-40 Potential Effects and Determination Statements for Federally Listed Plants

LAA = Likely to Adversely Affect; NLAA = Not Likely to Adversely Affect; NE = No Effect

Species and Listing Category	Determination and Basis for Determination
Showy Stickseed Hackelia venusta Endangered	NLAA. One known site.Very little potential habitat is available on Forest Service land and habitat is not susceptible to invasion.
Wenatchee Mountain Checkermallow Sidalcea oregana var. calva Endangered	LAA. One site (of five known) on Forest Service land with no current invasive plant problems. Draft recovery plan completed. The potential threat of non-native grasses was documented in the draft plan. Critical habitat designated. Likelihood that individual projects would result in LAA is very low.
MacDonald's Rockcress Arabis macdonaldiana Endangered	NLAA. Habitat is in a plant community with low susceptibility to invasive plants.
Gentner's fritillary Fritillaria gentneri Endangered	LAA. Found in plant communities susceptible to invasion. Majority of populations are not on Forest Service land, but potential habitat is present. Likelihood that individual projects would result in LAA is very low.
Kincaid's Lupine Lupinus sulphureus ssp. kincaidii Threatened	NLAA. Found in plant communities susceptible to invasion (roadsides), but only one population on Forest Service land with no current invasive plant problems.
MacFarlane's Four O'Clock Mirabilis macfarlanei Threatened	LAA. Although the species should benefit from invasive plant treatments in its habitat, adverse effects could occur especially under aerial spray conditions if accidental drift occurs. Damage from herbicide drift to this species has already been documented in Idaho (Federal Register 1996).
Spaulding's Catchfly Silene spauldingii Threatened	LAA. In canyon grassland habitat threatened by invasives. Although the species should benefit from invasive plant treatments in its habitat, adverse effects could occur especially under aerial spray conditions if accidental drift occurs.
Marsh Sandwort Arenaria paludicola Endangered (S)	NLAA. Considered extirpated in Region Six. Closest population in San Luis Obispo county, CA.
Water howellia Howellia aquatilis Threatened (S)	NLAA. Closest known location is downstream of the Columbia River Gorge National Scenic Area.
Western Lily Lilium occidentale Endangered (S)	NLAA. All known locations are south of Siuslaw National Forest. Potential habitat exists but susceptibility to invasion is low.

Table 4-40 Potential Effects and Determination Statements for Federally Listed Plants

LAA = Likely to Adversely Affect; NLAA = Not Likely to Adversely Affect; NE = No Effect

Species and Listing Category	Determination and Basis for Determination
Cook's Lomatium Lomatium cookii Endangered (S)	NLAA. Found in plant communities susceptible to invasion, but very little potential habitat on Forest Service land.
Nelson's Checkermallow Sidalcea nelsoniana Threatened (S)	LAA. Found in plant communities susceptible to invasion. Potential habitat exists.
Ute Ladies Tresses Spiranthes diluvalis Threatened	LAA. Very few known populations. Difficulty in locating this species and variable fluctuations in population size could lead to adverse effects from accidental treatment.
Howell's Spectacular Thelopody Thelypodium howellii ssp. spectabilis Threatened (S)	LAA. All known sites have been invaded by invasive plants. Known impacts from mowing and herbicide use have been documented.

Cumulative Effects

Herbicide treatments in Oregon and Washington have the potential to damage federally listed species. Multiple incidents of damage to federally listed plants are extremely unlikely, but possible, especially for species that occur in roadside habitat (e.g. Kincaid's lupine). Damage to Kincaid's lupine from roadside herbicides spraying has already been documented under its' *Federal Register* listing (2000).

Other federal agencies (such as Bureau of Land Management) adhere to Endangered Species Act requirements and other special status species policies, ensuring protection of native plants and threatened, endangered or sensitive species. State agencies follow state policies. For example, the Oregon Endangered Species Act (OAR 603-073) protects state listed threatened and endangered plants on state-owned and state-managed lands. Protection and conservation programs are managed by the Oregon Department of Agriculture (the same entity managing invasive plants).

In Washington, a similar act does not exist, but the Washington Natural Heritage program is required by law (RCW 79.70) to manage a statewide system of natural areas. A biennial Natural Heritage plan lays out such a system based on prioritization of rare plants and plant communities in need of protection. It is administered by the Washington Department of Natural Resources. Oregon also has a Natural Heritage Plan using a similar approach to protection of priority plants and plant communities as Washington. Both states maintain a Natural Heritage list of rare plants and animals, ranked by level of threat, following the same global ranking used by the Nature Conservancy (described in Chapter 3).

Increased herbicide use by the Forest Service, combined with increased use by adjacent landowners, would create the highest potential for adverse effects to federally listed species under all land ownership.

Regional Forester's Sensitive Plants

The potential to affect documented and suspected sensitive plants in Region Six varies by plant family. Species within the sunflower, legume or mustard family may be the most sensitive to herbicide treatment in general. Numerous genera from these families occur on the list including *Arabis*, *Erigeron*, and *Astragalus*. Species in the lily family may be more sensitive to some of the sulfonylurea herbicides. The lily family is a large component of the Region Six sensitive species list. The genus *Calochortu*s (or Mariposa Lily) alone has eight species on the list. The Region Six sensitive species list includes 38 sedge species.

Any species along roadsides or where activities occur that disturb native plant communities will be threatened by not only invasive plants, but by invasive plant treatments. Some sensitive plants actually do well in disturbed areas because the natural processes which created openings or gaps have been eliminated. For example, the species *Sophora leachiana* in the legume family, which occupies a very narrow range in southwestern Oregon, has moved into roadside and skid trail areas since gaps in forest canopy have been reduced due to lack of natural fire.

Recently, 80 fungi and non-vascular (lichens and bryophytes) plants have been added to the regional sensitive species list. Some species and their communities could be negatively affected by at least two active ingredients (triclopyr and glyphosate). Fungi could be negatively affected by herbicides known to affect soil mycorrhizae (sulfometuron methyl, picloram, glyphosate). These species are associated with late successional forest ecosystems, which are not usually of high susceptibility to invasion and would not contain the vegetation communities most likely to be treated by aerial application of herbicides.

Direct and Indirect Effects

The Proposed Action may impact individuals, but is not likely to lead to federally listing any sensitive plants. Alternative B may impact individuals, but is not likely to lead towards a trend to federally list any sensitive plants. Alternative D has the most potential to impact individuals, due to more reliance on aerial application of herbicide, but is not likely to lead to federally list.

Aerial spraying could be problematic to non-vascular or fungi species in general, but habitat for these species is not likely to occur where conditions are most appropriate for use of aerial application methods.

Cumulative Effects

Cumulative effects on sensitive species are the same as those described previously under federally listed species. More information on sensitive plants can be found in the project analysis file.

Federally-Listed Wildlife

Consultation with the U.S. Fish and Wildlife Service (FWS) has been initiated, and is ongoing regarding effects determinations for federally listed wildlife species. The Biological Assessment for this EIS is in progress, but has not been completed. This section displays preliminary effects determinations that have been discussed, and approved by an interagency consultation team.

Invasive plants are adversely affecting habitat for grizzly bear, woodland caribou, western snowy plover, Fender's blue butterfly, and Oregon silverspot butterfly. Invasive plants are adversely affecting the habitat of prey for the gray wolf and Canada lynx. See Chapter 3 for more information about how invasive plants affect wildlife.[36]

The differences between the alternatives do not result in different effects determinations for federally listed species. The primary impacts that could lead to adverse effects on wildlife are from ground disturbance related to manual/mechanical treatments, and noise/human activity that disturbs individual wildlife. All of the alternatives approve similar non-chemical methods of treatment, and would result in similar impacts to listed species.

The discussions about potential adverse effects of herbicides to federally listed species, (and Region Six sensitive species discussed later in this section) are based on FS/SERA risk assessments that correlate laboratory results to wildlife using exposure scenarios. Results of exposure scenarios were applied to federally listed species of similar type (i.e. mammal, bird,

[36] Life history information on wildlife species listed as threatened or endangered under the provisions of the Endangered Species Act are included in a report in the project file ("Brief Life History Narratives for Federally Listed and Forest Service Sensitive Animals and Plants in Region Six").

etc.), body size, and diet[37]. The scientific uncertainty discussed in Chapter 4.4 also applies to the discussions on federally listed species.

Direct and Indirect Effects

No direct effects on threatened or endangered wildlife are associated with prevention standards, because they deal with procedural requirements. To the extent they are effective, prevention standards would have positive indirect effects by reducing the damage to habitat caused by invasive plants. No suite of prevention measures will be completely successful at protecting habitat for threatened and endangered species, because invasive plants can be introduced and spread by means other than those within management control (natural vectors, illegal disposal or introduction, adjacent land activities, etc.). Successful control of invasive plant infestations provides long-term benefits to populations of listed species, by restoring native habitat and preventing future degradation of habitat.

Methods used to treat invasive plants or restore habitat may affect federally listed wildlife. The effects of each method to wildlife are discussed in specialist reports in the analysis files: "The Effects of Non-Herbicidal Methods of Invasive Plant Treatment on Wildlife, Fish and Plants," and potential effects from herbicides are discussed in "Summary of Herbicide Effects to Wildlife".

Direct effects from invasive plant treatment include disturbance caused by noise, smoke, aircraft, people and vehicles. These activities could potentially disturb grizzly bear, gray wolf, Canada lynx, woodland caribou, bald eagle, northern spotted owl, marbled murrelet, and western snowy plover during the breeding season, causing the birds to leave nests, or mammals to change feeding or denning location. The absence of parent birds, or disturbance of a parent bird on the nest, may result in mortality to eggs or young. However, invasive plant projects involve very short-term disturbance with few people, and might only be repeated once in the same growing season. The life history traits of the species, current literature, existing guidelines, and expert opinion of biologist's familiar with the species, indicate that the level of disturbance expected from any invasive plant project is not likely to adversely disturb grizzly bear, gray wolf, Canada lynx, or woodland caribou.

Oregon silver spot butterfly adults appear to be unaffected by disturbance (Frounfelker, personal communication). The butterfly larvae are underground when mowing is conducted to improve

[37] Results of exposure scenarios are detailed in a report in the project file ("Summary of Herbicide Effects to Wildlife").

habitat for the food plant, *Viola adunca*. Livestock used specifically for invasive plant control are not likely to adversely affect any listed species within the Region.

American brown pelicans do not occur in the vicinity of invasive plant infestations, and will not be directly or indirectly affected by treatment methods. Fender's blue butterfly does not occur on National Forest Land and will not be directly affected by treatment methods. Potential effects to the food plant of the Fender's blue butterfly (Kincaid's lupine) are discussed in the section on federally listed plants.

The vast majority of invasive plant treatment and restoration projects can be designed to reduce or eliminate adverse effects to listed species, as required in Standard 20 for all alternatives. However, invasive plant projects that benefit wildlife in the long run may have short-term adverse effects. For example, short-term disturbance near snowy plovers may be warranted if it allows treatment of invasive plants that threaten the long-term viability of the plover's habitat.

Little research has been done on the direct effects of specific herbicides, or other control techniques on listed species. The ESA often prohibits experimental testing directly on a listed species. On the rare occasions that samples could be taken from listed species, the limited conditions under which they are taken may bias the results (see Wiemeyer et al., 1993 for example). For this analysis, toxicity data collected using surrogate species were applied to similar types of wildlife.

Actual herbicide exposure to most of these listed species is very unlikely due to their diets, behavior, distribution, and the life history traits of their prey. Effects from disturbance are the most likely to occur. Alternative B has a higher likelihood of disturbance than other alternatives due to the increased number of acres projected to be treated manually or mechanically. However, the total number of acres treated in close proximity to listed species is likely to be very low for all alternatives, because most species distributions are limited in the project area, and projects can be designed to avoid these effects as required by Standard 20. Therefore, the minor differences in acres treated by the various methods, do not result in any substantial differences in potential effects to listed species between the alternatives. Exposure scenarios used to analyze potential effects from herbicides are discussed in "Summary of Herbicide Effects to Wildlife" (analysis file).

Results of worst-case scenarios applied to species listed under the ESA are displayed in Table 4-41. The potential effects displayed are not likely to occur under actual field conditions, because the worst-case scenarios do not account for plausibility of exposure, differences in application methods and timing, seasonal presence, species behavior, current protection measures in place, the current distribution of the species, or the standards included in each alternative in this EIS.

Grizzly bears and woodland caribou forage on vegetation in the spring, so they could be exposed to herbicide residues on vegetation from broadcast spray applications. Estimated doses to a grizzly bear- or caribou-sized herbivore for triclopyr, dicamba, and 2,4-D exceed known LOAEL's for these herbicides.

However, grizzly bears are unlikely to be exposed to doses of herbicide that would exceed the toxicity indices, or cause adverse effects because grass is not intentionally treated by herbicides in their habitat; they eat other items besides grass, meadows are not broadcast sprayed, and these herbicides are generally not used on the invasive plants in meadows that grizzly bears use. Also, the bears would avoid treatment areas because of disturbance, they have extremely large home ranges, are unlikely to intersect treatment areas, and Standard 20 requires projects to be designed to mitigate the potential for adverse contaminant exposure.

Caribou may forage on grasses and broad-leaved herbaceous plants during the spring. Treatment of meadows used by caribou in the spring does not occur until later in the year (Ridlington, personal communication). Caribou are not likely to receive doses exceeding the toxicity indices, or that cause adverse effects, because they range over very large areas, would not forage solely within the treatment area, herbicide use and their presence would occur at different times of the year, and Standard 20 requires projects to be designed to mitigate the potential for adverse contaminant exposure.

Projects in grizzly bear and caribou habitat that treat invasive plants with herbicide are ongoing and have been able to avoid any potential adverse effects to these two species (McGowan, personal communication).

Gray wolf and Canada lynx would have to eat an entire day's supply of prey that had been directly sprayed to receive doses exceeding the toxicity indices. This is extremely unlikely because their prey are not susceptible to inadvertent direct spraying. Similarly, the prey of spotted owls is mostly arboreal and/or nocturnal, making it highly unlikely that it could be directly sprayed. The ocean fish that marbled murrelets and American brown pelicans feed on will not be exposed to herbicides from invasive plant control on the National Forests. Western snowy Plovers feed upon insects along the surf-line, which will also not be exposed to herbicides. Bald eagles could ingest fish that have been exposed to herbicide that entered the water through runoff or accidental spill. However, the herbicides considered in this EIS do not concentrate up the food chain, and none of the contaminated fish scenarios exceed the toxicity indices.

Herbicides have not been used in habitat for the Oregon silver spot butterfly, but they may need to be used in the future if invasive plants with thickly matted root systems threaten the butterfly's food plant. Potential effects to butterfly larvae or eggs, or food plants, may occur from herbicide use in their habitat. However, herbicides have been used in some butterfly habitat without apparent adverse effects to butterfly populations (Bramble et al., 1997; Bramble et al., 1999).

Table 4-41 Summary of Worst-Case Exposure Scenarios for Federally Listed Wildlife
Symbol meanings are as follows:

-- Exposure scenarios result in a dose below the toxicity index at typical and highest application rates.
★ Exposure scenarios exceed the toxicity indices at the typical and highest application rates.
♦ Exposure scenarios exceed the toxicity indices at the highest application rate only.
Italicized herbicides are not included in the Proposed Action.

SPECIES	Chlorsulfuron	Clopyralid	*Dicamba*	Glyphosate	Imazapic	Imazapyr	Metsulfuron methyl	Picloram	Sethoxydim	Sulfometuron methyl	Triclopyr	*2,4-D*
Grizzly Bear	--	--	★	♦	--	--	--	♦	--	♦	★	★
Gray Wolf	--	--	--	--	--	--	--	--	--	--	★	★
Canada Lynx	--	--	--	--	--	--	--	--	--	--	★	★
Woodland Caribou	--	--	★	♦	--	--	--	♦	--	♦	★	★
American Brown Pelican	--	--	--	--	--	--	--	--	--	--	--	--
Bald Eagle	--	--	--	--	--	--	--	--	--	--	--	--
No. Spotted Owl	--	♦	--	--	--	--	--	--	♦	--	♦	★
Marbled Murrelet	--	--	--	--	--	--	--	--	--	--	--	--
Western Snowy Plover	--	--	--	--	--	--	--	--	--	--	--	--
OR Silver Spot Butterfly[1]	--	--	--	♦	--	--	---	--	--	--	♦	★

1 There are no exposure scenarios for butterflies, so the honeybee scenario is used as a surrogate for this table. Toxicity data for butterflies is not available, so while a "diamond" or "star" indicates a definite concern for terrestrial invertebrates, a "minus" does not necessarily indicate an absence of concern.

Indirect effects to federally listed species would consist of changes to their habitat. Invasive plant treatments will not remove or degrade suitable habitat for any federally listed species. Successful control of invasive plant infestations provides long-term benefits to populations of listed species, by restoring native habitat and preventing future degradation of habitat. Indirect effects of herbicide are not likely for any listed species because exposure for these species is so unlikely.

The following table (Table 4-42) summarizes the potential effects to each listed species. The uncertainty regarding herbicide exposure or proximity of disturbance prevent making a determination of "not likely to adversely affect" (NLAA) for some species. However, the vast majority of projects conducted under this DEIS are not likely to adversely affect listed species.

Critical habitat is designated for the northern spotted owl, marbled murrelet, western snowy plover, and Oregon silverspot butterfly. Invasive plant treatment and restoration projects will not affect any of the primary constituent elements for critical habitat for the northern spotted owl (USDI FWS, 1992-Northern), or marbled murrelet (USDI FWS, 1996-Murrelet). Invasive plant treatment projects in western snowy plover critical habitat are implemented to restore the function of the primary constituent elements, which have been eliminated by invasive European beach grass. These projects will beneficially affect critical habitat for the western snowy plover. Invasive plant treatment projects in Oregon silverspot butterfly critical habitat are implemented to protect and restore the larval food plant populations and nectar sources for this species. These projects beneficially affect critical habitat for the Oregon silverspot butterfly.

Table 4-42 Potential effects and Determination Statements for Federally Listed Wildlife

LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect.

Species and Listing Category	Potential Effects	Determination and Basis for Determination
Grizzly bear ***Threatened***	Infrequent and short-term disturbance from treatment projects. Herbicide exposure possible, but not very plausible.	NLAA. Interagency guidelines reduce disturbance potential to NLAA.. Herbicide exposure highly unlikely due to feeding behavior and home range size.
Gray wolf ***Endangered***	Infrequent and short-term disturbance from treatment projects could occur. Worst-case herbicide exposure is highly unlikely.	NLAA. Wolves are rare in the Region Disturbance not of a magnitude or intensity that would adversely affect wolves.
Canada lynx ***Threatened***	Infrequent and short-term disturbance from treatment projects could occur. Worst-case herbicide exposure is highly unlikely.	NLAA. Canada lynx are rare in the Region. Disturbance not of a magnitude or intensity that would adversely affect the lynx.

Table 4-42 Potential effects and Determination Statements for Federally Listed Wildlife

LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect.

Species and Listing Category	Potential Effects	Determination and Basis for Determination
Woodland caribou ***Endangered***	Infrequent and short-term disturbance from treatment projects could occur. Forage on plants similar to broad-leaved forbs that might be treated (e.g. hawkweeds).	NLAA. Disturbance regulated by Interagency Grizzly Bear Guidelines (caribou habitat is completely encompassed by grizzly bear recovery areas). Herbicide exposure highly unlikely due to feeding behavior and home range size.
American brown pelican ***Threatened***	No effects are likely because of seasonal occurrence, prey will not be exposed, loafing and foraging sites are far removed from invasive plant locations.	No Effect. Invasive plant treatments do not occur in pelican habitat and prey will not be exposed to herbicide.
Bald eagle ***Threatened***	Infrequent and short-term disturbance near nests. Worst-case exposure does not exceed toxicity index from ingesting contaminated fish.	LAA. Disturbance closer than acceptable limits to nest or roost sites may occur. Frequency of LAA projects is expected to be very rare.
Northern spotted owl ***Threatened***	Infrequent and short-term disturbance near nests. Exposing prey to herbicide is not plausible due to arboreal and/or nocturnal habit of prey.	LAA. Disturbance closer than acceptable limits to nest and roost sites may occur. Frequency of LAA projects is expected to be very rare, if at all, because weeds are minimal in late-successional habitats.
Marbled murrelet ***Threatened***	Infrequent and short-term disturbance near nests. Prey will not be exposed.	LAA. Disturbance closer than acceptable limits to nest sites may occur. Frequency of LAA projects is expected to be very rare, if at all, because weeds are minimal in late-successional habitats.
Snowy plover ***Threatened***	Infrequent and short-term disturbance near nests. Prey will not be exposed.	LAA. Disturbance closer than acceptable limits to nest sites may occur. Current projects mitigate potential effects, reducing determinations to NLAA. Frequency of LAA projects is expected to be rare due to habitual nature of current protection measures.
Oregon silverspot butterfly ***Threatened***	Butterfly and their larvae appear to be insensitive to disturbance. Data on the effects of herbicides to butterflies are almost non-existent. Herbicide use may affect food plants.	LAA. Herbicide use may affect food plants or larvae. Frequency of LAA project is expected to be rare.

Table 4-42 Potential effects and Determination Statements for Federally Listed Wildlife LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect.		
Species and Listing Category	**Potential Effects**	**Determination and Basis for Determination**
Fender's blue butterfly ***Endangered***	None anticipated.	No effect. This species does not occur on National Forest Land.

Cumulative Effects

All the federally listed species in the project area, except Oregon silverspot butterfly, migrate or move large distances across multiple ownership boundaries, potentially increasing the likelihood that they would be exposed to multiple uses of herbicide and several instances of disturbance. Forest Service Region Four (Intermountain Region) is immediately adjacent to the project area and includes populations, recovery areas, and/or habitat for grizzly bear, woodland caribou, Canada lynx, and gray wolf. Region Four has an active program to control invasive plants and is conducting projects within the habitats of these species. Herbicide exposure to American brown pelican, Fender's blue butterfly, gray wolves, Canada lynx, grizzly bear, woodland caribou, western snowy plover, marbled murrelet, and northern spotted owl are unlikely to occur for invasive plant treatment projects, so there will be no cumulative effects from projects conducted under this EIS. Minimal herbicide exposure is possible for bald eagle, and for projects conducted under this EIS. However, the herbicides in this document are excreted rapidly and do not accumulate up the food chain ("Summary of Herbicide Effects to Wildlife", project file).

Herbicide exposure from invasive plant projects is unlikely to add to, or accumulate with herbicide exposures from other projects. Herbicide use within the project area for invasive plant control is insignificant in comparison to total herbicide use on other ownerships[38], and for other purposes (see previous discussions).

Oregon silverspot butterfly do not migrate and appear to be limited to existing sites. Potential herbicide use within their critical habitat in the project area is likely the only herbicide to which they could be exposed. Therefore, there will be no cumulative effects from herbicide exposure. These butterflies are not sensitive to disturbance, so there will not be any cumulative effects from disturbance either.

[38] National Center for Food & Agricultural Policy (NCFAP). 1997 Pesticide Use Database. available online at http://www.ncfap.org/database/state/default.asp

The short-term and infrequent disturbance from invasive plant treatment projects is managed as part of the total allowable disturbance for grizzly bear, and indirectly for woodland caribou. It will not contribute to adverse cumulative effects. The short-term and infrequent disturbance from invasive plant treatments for other listed species is also insignificant compared to that occurring from existing roads (where most of the invasive plant infestations occur), recreation, and other activities.

Forest Service Sensitive Wildlife

Direct and Indirect Effects

Invasive plants are currently adversely affecting some sensitive wildlife species. Chapter 3 discusses the effects on habitats from invasive plants. The effects of invasive plant treatments to wildlife are discussed in two reports in the project file ("Summary of Herbicide Effects to Wildlife" and "The Effects of Non-herbicidal Methods of Invasive Plant Treatments on Wildlife, Fish and Plants"). The environmental effects to Forest Service Sensitive Species[39] do not vary between the alternatives.

No direct effects on Region Six Sensitive wildlife are associated with the prevention standards because they deal with procedural requirements. To the extent they are effective, prevention standards would have positive indirect effects by reducing the damage to habitat caused by invasive plants. No suite of prevention measures will be completely successful at protecting habitat for sensitive species, because invasive plants can be introduced and spread by means other than those within management control (natural vectors, illegal disposal or introduction, adjacent land activities, etc.).

Indirect effects to Forest Service Sensitive species would consist of changes to their habitat. Invasive plant treatments will not remove or degrade suitable habitat for any sensitive species. Successful control of invasive plant infestations provides long-term benefits to populations of sensitive species, by restoring native habitat and preventing future degradation of habitat.

Sub-lethal doses of herbicide could indirectly increase susceptibility to predation within a day or two of exposure. Longer-term indirect effects to sensitive species from cumulative herbicide

[39] Life history information on Forest Service Sensitive wildlife species (including former Survey and Manage Species) are included in a report in the project file ("Brief Life History Narratives for Federally Listed and Forest Service Sensitive Animals and Plants in Region Six").

exposure are not likely to occur, because the herbicides in this EIS are excreted rapidly (often within 24-48 hours), and do not accumulate up the food chain.

Direct effects from non-herbicidal methods of invasive plant treatment include disturbance caused by noise, smoke, aircraft, people and vehicles. Herbicides have potential for direct adverse effects to sensitive species due to toxicity of the herbicides.

Since data do not exist for most individual wildlife species in the Region, the Forest Service Sensitive wildlife species evaluated in this EIS were placed into exposure groups of similar niche, body size, and food habits. Table 4-43 lists the exposure groups, the exposure scenarios and the members of each group used for this analysis. Exposure scenarios are described in a report in the project file ("Summary of Herbicide Effects to Wildlife").

Table 4-43 Exposure Groups, Exposure Scenarios, and Species Included

Exposure Group	Exposure Scenarios	Species Included
Large Herbivorous Mammal	Consumption of 100% contaminated grass	Rocky Mountain bighorn sheep
Small Herbivorous Mammals	Consumption of 100% contaminated leaves and leafy vegetables Direct spray on 50% of body, complete absorption Consumption of water contaminated by an accidental spill.	Western gray squirrel, pygmy rabbit, Western (Mazama) pocket gopher, Oregon red tree vole
Carnivorous Mammals	Consumption of an entire days diet of prey that has been directly sprayed on 50% of body surface	California wolverine, Pacific fisher
Small Insectivorous Mammal	Consumption of an entire day's diet of contaminated insects	Pacific pallid bat, Townsend's big-eared bat, spotted bat, Pacific fringe-tailed bat, bats, Baird's shrews, Pacific shrews
Herbivorous Birds	Consumption of 100% contaminated grass	Western sage grouse[1], sharp-tailed grouse, Columbian sharp-tailed grouse
Insectivorous Birds	Consumption of an entire days diet of contaminated small insects using empirical relationships for residues in vegetation (no data available on concentrations of pesticides in insects)	black swift, gray flycatcher, ash-throated flycatcher, yellow-billed cuckoo, green-tailed towhee, tricolored blackbird, bobolink, greater yellowlegs, upland sandpiper, yellow rail, bufflehead, harlequin duck

Table 4-43 Exposure Groups, Exposure Scenarios, and Species Included

Exposure Group	Exposure Scenarios	Species Included
Predatory Birds	Consumption of an entire day's diet of small mammal prey that has been directly sprayed	northern goshawk, ferruginous hawk, American peregrine falcon[2], great gray owl, greater sandhill crane
Fish-eating Birds	Consumption of fish contaminated by an accidental spill	common loon, Clark's grebe, eared grebe, red-necked grebe, horned grebe, least bittern
Reptiles	None available. Information from literature is used.	Sharptailed snake, California mountain kingsnake, common kingsnake, striped whipsnake, Northwestern pond turtle, painted turtle
Amphibians	For sulfometuron methyl, used water concentrations from runoff and percolation estimates. For other herbicides, information from literature is used.	California slender salamander, Oregon slender salamander, black salamander, Cope's giant salamander, Del Norte salamander, Larch Mountain salamander, Siskiyou Mountain salamander, Van Dyke's salamander, Cascade torrent salamander, Columbia torrent salamander, Olympic torrent salamander, southern torrent (seep) salamander, foothill yellow-legged frog, northern leopard frog, Columbia spotted frog, Oregon spotted frog
Insects	Direct spray of bee with 100% absorption, and literature	Mardon skipper
Terrestrial mollusks	None available. Information from literature is used.	Puget Oregonian, Columbia Oregonian, evening field slug, Oregon shoulderband, Burrington's jumping slug, warty jumping slug, Malone's jumping slug, panther jumping slug, Chace sideband, Dalles sideband, Chelan mountainsnail, Crater Lake tightcoil, blue-gray taildropper, Hoko vertigo

1 Most animals will eat more than one type of food. Species were placed in groups that represented the majority of their diet, or the type of diet that would pose the most risk.
2 No scenario is yet available for animals that feed primarily on birds, so exposures from mammal prey are used.

The following table (Table 4-44) summarizes the potential effects to each sensitive species group.

Table 4-44 Potential Effects to Sensitive Species		
Sensitive Species Group	**Potential Effects**	**Determination**
Large herbivorous mammal	Fire may increase incidence of cheatgrass reducing forage diversity. Worst-case exposure exceeds toxicity index from ingesting forage that has dicamba, glyphosate, picloram, sulfometuron methyl, triclopyr, or 2,4-D, if broadcast sprayed. Worst-case herbicide exposure is highly unlikely for non-selective herbicides; more likely for selective herbicides.	MINL[1] Bighorns utilize cheatgrass, reducing somewhat the effects of fire. Worst-case exposure unlikely to occur in most cases, but is possible for some large-scale broadcast applications.
Small herbivorous mammals	Fire and mechanical treatments may reduce cover and increase incidence of cheatgrass in pygmy rabbit habitat. Worst-case exposure exceeds toxicity index from ingesting forage that has been sprayed with triclopyr, 2,4-D, if broadcast sprayed. Worst-case herbicide exposure is highly unlikely for non-selective herbicides; much more likely for selective herbicides.	MINL. Short-term adverse effects provide long-term benefit. Worst-case exposure unlikely to occur in most cases, but is possible for some large-scale broadcast applications.
Carnivorous mammals	Infrequent and short-term disturbance may occur. Worst-case exposure exceeds toxicity index from ingesting prey that has been sprayed with triclopyr or 2,4-D.	No Effect. Disturbance unlikely reach an intensity or duration that would cause an adverse affect. Worst-case herbicide exposure is not plausible.
Insectivorous mammals	Fire and mechanical treatments may reduce foraging areas. Worst-case exposure exceeds toxicity index from ingesting prey that has been sprayed with clopyralid, dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, triclopyr, and 2,4-D if broadcast sprayed. Worst-case herbicide exposure is highly unlikely for bats, somewhat more likely for shrews.	MINL. Little overlap between invasive plants and shrew habitat. Bats may forage over large areas, reducing exposure.
Herbivorous birds	Fire, grazing, and mechanical treatments may reduce cover and increase incidence of cheatgrass within grouse habitat. Worst-case exposure exceeds toxicity index from ingesting forage that has been sprayed with clopyralid, dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, triclopyr, and 2,4-D if broadcast sprayed. Worst-case herbicide exposure is highly unlikely for non-selective herbicides; much more likely for selective herbicides.	MINL. Adverse effects to individuals are possible, but all species are wide-ranging, occurring in several states, so effects from isolated invasive plant treatments are not likely to lead to a trend toward federal listing.

Table 4-44 Potential Effects to Sensitive Species

Sensitive Species Group	Potential Effects	Determination
Insectivorous birds	Manual, mechanical, grazing and fire could trample or harm eggs or young of ground- or low-nesting species during the breeding season. Worst-case exposure exceeds toxicity index from ingesting prey that has been sprayed with clopyralid, dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, triclopyr, and 2,4-D if broadcast sprayed. Worst-case herbicide exposure is plausible for grassland species on large projects.	MINL. Adverse effects to individuals are possible, but all species are wide-ranging, occurring in several states, so effects from isolated invasive plant treatments are not likely to lead to a trend toward federal listing.
Predatory birds	Manual, mechanical, and fire treatments could disturb species during the nesting season. Worst-case exposure exceeds toxicity index from ingesting prey that has been sprayed with sethoxydim, triclopyr, and 2,4-D if broadcast sprayed.	MINL. Disturbance possible, but would be short-term and low intensity. Worst-case exposures to herbicides not plausible.
Fish-eating birds	Manual and mechanical treatments could disturb species during the nesting season. Worst-case exposure does not exceed toxicity index for any herbicide.	MINL. Disturbance possible, but would be short-term and low intensity.
Reptiles	Mechanical and fire treatments could trample or harm individuals. Insufficient data to determine potential effects from herbicides.	MINL. Adverse effects to individuals are possible, but all species are wide-ranging, occurring in several states, so effects from isolated invasive plant treatments are not likely to lead to a trend toward federal listing.
Amphibians	Manual or mechanical treatments could trample some individuals. Applications or accidental spills of glyphosate, triclopyr, or 2,4-D could harm or kill amphibians.	MINL. Treatment areas would be very small relative to species distributions. Riparian weeds are usually treated with selective methods.
Insects	Manual, mechanical, and fire treatments could trample or harm Mardon skipper larvae. If bees are suitable surrogate, worst-case exposure exceeds the toxicity index if directly sprayed with glyphosate, triclopyr, and 2,4-D. Herbicides could kill larval food plants and/or adult nectar plants. Effects must be evaluated at project level.	MINL. Mardon skipper occurs in Oregon, Washington, and California. Invasive plant treatments would be conducted to protect skipper habitat from invasive plants, providing long-term benefits to population.

Table 4-44 Potential Effects to Sensitive Species		
Sensitive Species Group	**Potential Effects**	**Determination**
Mollusks	Most species very susceptible to heat and drying caused by fire. Exposure to picloram did not increase mortality to brown garden snail (*Helix aspersa*). Terrestrial slugs (*Deroceras reticulatum*) can absorb 2,4-D through contact with contaminated soil. No other data is available for herbicide effects to terrestrial mollusks. Must be evaluated at project level to determine likelihood of exposure.	MINL. Little overlap between most habitats and invasive plant occurrences, but specific data is lacking. Risk from herbicides largely unknown.

1 MINL = may impact individuals, but not likely to lead to a trend toward federal listing

Cumulative Effects

Several of the sensitive species within the project area have relatively small home ranges, like shrews and salamanders for example, so they are not likely to be exposed to multiple invasive plant treatment projects.

For wide-ranging species, like insectivorous birds, bats, ducks, and large mammals, cumulative effects are similar to those discussed for wildlife in Chapter 4.4.

Herbicide use occurs on lands other than National Forest System land. Agricultural, lawn care, forest and rangeland improvement, utility corridors, and road rights of way account for large amounts of herbicide use. Some of the sensitive species in the project area move long distances or migrate, so they can be exposed to herbicides on adjacent lands or along their migration routes.

The small contribution that FS use of herbicide for invasive plant control makes to the statewide totals[40] for herbicide use indicates that the potential cumulative effect from FS actions is very small. Likewise, the relatively small differences between the alternatives, in comparison to the total herbicide use within Oregon and Washington, make any differences in potential for cumulative effects to sensitive wildlife insignificant.

[40] National Center for Food & Agricultural Policy (NCFAP). 1997 Pesticide Use Database. available online at http://www.ncfap.org/database/state/default.asp

Federally-Listed Fish and Mollusks

Consultation with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration – Fisheries Division, has been initiated for the invasive plant management program, and is ongoing. The Biological Assessment for this DEIS is in progress, but has not been completed. The effects determinations made here are preliminary, but have been discussed and agreed to by the interagency consultation team.

Life history information on fish and mollusk species listed as threatened or endangered under the provisions of the Endangered Species Act are included in a report in the project file ("Brief Life History Narratives for Federally Listed and Forest Service Sensitive Animals and Some Plants in Region Six").

Direct and Indirect Effects

In terms of effects to federally listed aquatic species, there are no substantial differences between the alternatives. No direct effects on threatened or endangered aquatic species are associated with prevention standards because they deal with procedural requirements. To the extent they are effective, prevention standards would have positive indirect effects by reducing the damage to riparian areas caused by invasive plants.

Methods used to treat invasive plants or restore habitat may affect federally listed aquatic species. The effects of each method to fish are discussed in "The Effects of Non-Herbicidal Methods of Invasive Plant Treatment on Wildlife, Fish and Plants," and potential effects from herbicides are discussed in "Summary or Herbicide Effects to Aquatic Species".

Indirect effects to listed aquatic species would consist of changes to their riparian areas, food chain, and water quality. Invasive plant treatments will not remove or degrade suitable habitat for any listed species. Successful control of invasive plant infestations provides long-term benefits to populations of listed species, by restoring native habitat and preventing future degradation of habitat. Indirect effects from herbicide use are not likely to occur, because the herbicides considered in this EIS do not accumulate in bodies nor concentrate up the food chain.

Exposure scenarios used to analyze potential effects from herbicides are discussed in "Summary or Herbicide Effects to Aquatic Species" (project file). We conducted the same type analysis for federally listed aquatic species, as that presented in Chapter 4.7.2 for other aquatic species. Modeled concentration of glyphosate formulations with surfactants, applied at the highest rate, was the only herbicide that reached a level of concern for fish.

The vast majority of invasive plant treatment and restoration projects can be designed to reduce or eliminate adverse effects to listed species, as required in Standard 20 for all alternatives. However, adverse effects could occur under any alternative to some species, for some methods. There may be instances where it is prudent to conduct a project that has a short-term adverse effect, in order to provide a long-term beneficial effect to the habitat.

In terms of effects to federally listed aquatic species, there are no substantial differences between the alternatives. Herbicide exposure to listed aquatic species is possible, though concentrations of concern are unlikely because Standards 19 and 20 provide general direction on how to mitigate effects. Fine sediment introduction to streams due to soil disturbance or temporary loss of vegetative cover, is the most common effect of any invasive plant treatment or restoration method. The total number of acres treated in riparian areas near listed aquatic species is likely to be very low for all alternatives, and projects can be designed to avoid these effects as required by Standard 20. Therefore, the minor differences in acres treated by different methods would not result in any substantial differences in potential effects to listed species between the alternatives.

The following table (Table 4-45) summarizes the potential effects to each listed aquatic species. The determination for all listed fish is "likely to adversely affect" (LAA) because some projects will be conducted in riparian areas and there is substantial uncertainty regarding potential herbicide exposure and sediment introduction. However, the vast majority of projects conducted under this EIS are not likely to adversely affect listed aquatic species.

Table 4-45 Potential Effects to Listed Aquatic Species

Species	ESA Status	ESA Determination
Snake River Sockeye Salmon - Migratory Habitat Only	Endangered	LAA
Upper Columbia River Spring Chinook	Endangered	LAA
Upper Columbia River Steelhead	Endangered	LAA
Lost River Sucker	Endangered	LAA
Shortnose Sucker	Endangered	LAA
Oregon Chub	Endangered	LAA
Southern Oregon/Northern California Coast Coho Salmon	Threatened	LAA
Oregon Coast Coho	Threatened	LAA
Snake River Spring/Summer Chinook	Threatened	LAA
Snake River Fall Chinook	Threatened	LAA
Puget Sound Chinook Salmon	Threatened	LAA
Upper Willamette River Chinook	Threatened	LAA

Table 4-45 Potential Effects to Listed Aquatic Species		
Species	**ESA Status**	**ESA Determination**
Lower Columbia River Chinook	Threatened	LAA
Snake River Steelhead Trout	Threatened	LAA
Lower Columbia River Steelhead	Threatened	LAA
Mid Columbia River Steelhead	Threatened	LAA
Warner Sucker	Threatened	LAA
Hood Canal Chum Salmon	Threatened	LAA
Columbia River Chum Salmon	Threatened	LAA
Klamath River Bull Trout	Threatened	LAA
Columbia River Bull Trout	Threatened	LAA
Coastal/Puget Sound Bull Trout	Threatened	LAA
Bliss Rapids Snail	Threatened	LAA

Cumulative Effects

Chinook salmon, steelhead trout, coho salmon, and chum salmon migrate across multiple ownership boundaries. The Bliss Rapids Snail has a relatively small home range, so they are not likely to be exposed to multiple invasive plant treatment projects. All other endangered or threatened species move over shorter distances, and may cross ownership boundaries. Most, but not all, streams on NFS lands are upstream from other sources of herbicides or sediment. Migration and exposure to water that flows through other ownerships increase the likelihood that fish would be exposed to multiple uses of herbicide. It is unlikely that herbicide exposure from invasive plant projects would add to or accumulate with herbicide exposures on other projects. Herbicides used for invasive plant control, within the project area, are insignificant in comparison to total herbicide use on other ownerships and for other purposes (see Chapter 4.4).

Forest Service Sensitive Aquatic and Commercially Important Fish Species

Consultation with NOAA- Fisheries on commercially important fish species, covered under the Magnuson-Steven Conservation and Management Act, is completed in conjunction with consultation with this agency on endangered and threatened species. The Magnuson-Stevens Fishery Conservation Act requires the identification of habitat essential to conserve and enhance federal fishery resources that are commercially fished. Essential Fish Habitat (EFH) is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50CFR 600.10). Essential fish habitat includes all streams, lakes, ponds, wetlands, tributaries, and other water bodies currently viable and most of the habitat historically accessible to these fish.

The Regional Forester's Sensitive Animal List is currently being revised and final additions and effective dates have not yet been determined.

Direct and Indirect Effects

Effects on sensitive and commercially important fish species are similar to those discussed under federally-listed fish. Table 4-46 summarizes the potential effects to each sensitive species.

Table 4-46 Potential Effects to Sensitive Fish Species

Sensitive Species	Determination
Pit-Klamath Brook Lamprey	MINL*
Goose Lake Lamprey	MINL
Klamath River Lamprey	NE**
Malheur Mottled Sculpin	MINL
Margined Sculpin	MINL
Pit Sculpin	MINL
Slender Sculpin	MINL
Olympic Mud Minnow	MINL
Pit Roach	MINL
Pygmy Whitefish	MINL
Oregon Lakes Tui Chub	NE*
Goose Lake Tui Chub	MINL
Blue Chub	MINL
Umpqua Chub	MINL
Goose Lake Sucker	MINL
Klamath Largescale Sucker	MINL
Salish Sucker	NE*
Chinook Salmon - WA Coast	MINL
Chinook Salmon - OR Coast	MINL
Chinook Salmon - Southern OR/Northern CA	MINL
Chinook Salmon - Mid-Columbia Spring Run	MINL
Chinook Salmon - Deschutes River Summer/Fall Run	MINL
Chum Salmon- Puget Sound	MINL
Chum Salmon-Pacific Coast	MINL
Coho Salmon - Puget Sound	MINL
Coho Salmon - SW WA, Lower Columbia	MINL
Sockeye Salmon - Lake Pleasant	MINL
Sockeye Salmon - Quinalt Lake	MINL

Table 4-46 Potential Effects to Sensitive Fish Species	
Sensitive Species	**Determination**
Sockeye Salmon - Baker River	MINL
Steelhead Trout - Oregon Coast	MINL
Steelhead Trout - Klamath Mountain Province	MINL
Coastal Cutthroat Trout - Puget Sound	MINL
Coastal Cutthroat Trout-Olympic Peninsula	MINL
Coastal Cutthroat Trout - OR Coast	MINL
Coastal Cutthroat Trout - Southern OR/CA Coasts	MINL
Westslope Cutthroat Trout	MINL
Interior Redband Trout	MINL
Umpqua Dace	MINL
Klamath pebblesnail	MINL
tall pebblesnail	MINL
Klamath Rim pebblesnail	MINL
basalt juga	MINL
Columbia duskysnail	MINL
Washington duskysnail	MINL
Sinitsin rams-horn	MINL
MINL = May impact individuals, not likely to lead to a trend toward Federal Listing. NE = These species are not believed to be present on any National Forests in Region Six.	

The following table (Table 4-47) summarizes the potential effects to commercially-important species:

Table 4-47 Potential Effects to Commercially Important Fish Species	
Species	**Magnuson-Stevens EFH Determination**
Upper Columbia River Spring Chinook	May Adversely Affect Habitat
Southern Oregon/Northern California Coast Coho Salmon	May Adversely Affect Habitat
Oregon Coast Coho	May Adversely Affect Habitat
Snake River Spring/Summer Chinook	May Adversely Affect Habitat
Snake River Fall Chinook	May Adversely Affect Habitat
Puget Sound Chinook Salmon	May Adversely Affect Habitat
Upper Willamette River Chinook	May Adversely Affect Habitat
Lower Columbia River Chinook	May Adversely Affect Habitat
Puget Sound pink salmon	May Adversely Affect Habitat

Cumulative Effects

Chinook salmon, coho salmon, pink salmon, sockeye salmon, chum salmon, steelhead trout, some lamprey species migrate across multiple ownership boundaries. The sensitive aquatic mollusk species within the project area have relatively small home ranges, so they are not likely to be exposed to multiple invasive plant treatment projects. All other sensitive species move over shorter distances, and may cross ownership boundaries. Cumulative effects for these species are described under cumulative effects for endangered and threatened species.

4.7.4 Environmental Justice and Tribal/Treaty Rights

Executive Order 12898 ordered federal agencies to identify and address the issue of environmental justice (i.e., adverse human health and environmental effects of agency programs that disproportionately impact minority and low income populations). Executive Order 12898 also directs agencies to consider patterns of subsistence hunting and fishing when an agency action may affect fish and wildlife. Such "Attention to minority and low-income communities and the natural resource upon which they depend is necessary because actions that adequately protect the general population may not always protect discrete segments of the population" (Hill and Targ, 2000).

For the scale of this analysis disproportionate impacts of treatments to minority and low income populations are difficult to identify and quantify. Such impacts will need to be reconsidered at district, forest, community or other relevant site-specific levels as projects that tier to this EIS go through relevant environmental analysis.

American Indians and Hispanics are groups that may be disproportionately affected by the standards proposed in the action alternatives. American Indian tribes may be disproportionately affected because they are dependent on native plants for cultural and traditional uses and because they may consume more fish (that could be contaminated with herbicides) than the general public (see Human Health and safety effects). Hispanics may be more likely, than the general population, to be injured during manual treatments or by exposure to chemical treatments, because they may be disproportionately represented on some work crews (see Human Health and Safety Effects). Hispanics are a growing population in Region Six and will need to be considered in future project planning. Other ethnic/socioeconomic groups may be disproportionately affected by the standards proposed in the action alternatives, however at the Regional scale, these groups and effects are not reasonably identifiable. Examples of other affected or perceived to be affected groups may include those recreating on National Forest system lands, those gathering and using mushrooms, beargrass, and other ethnically related forest products and those who hunt, fish or ingest wildlife or fish harvested on or near National Forest lands. For instance, harvesters of matsutake mushrooms represent a diverse group of often mobile and low-income harvesters. Members of the Crescent Lake Mushroom Monitoring Project have expressed interest in project level planning that will tier to this EIS.

No significant, discernible differences between alternatives relative to environmental justice were found at the Regional scale. However, environmental justice issues must be further analyzed through NEPA related analyses at the site-specific level before projects related to this document are undertaken. Environmental justice issues will be much more reasonably identifiable, and changes to projects made (plans, mitigation, extended consultation, etc.) at the site-specific level.

Members and/or decision makers of the Native American groups listed in Chapter 3 were sent a scoping letter (Appendix A) seeking their input for the preparation of this EIS. The Bureau of Indian Affairs also received the tribal comment scoping letter. In total 107 tribal scoping letters were sent and personal contact was pursued with each tribe.

Scoping comments expressed overwhelming support for region-wide action to reduce and control of invasive plants. The letters expressed a need to address invasive plants on forest lands, as invasive plants have (or may in the future) negatively impacted treaty rights of Native Americans. Impacts to cultural plants were of specific concern. Comments expressed support for components of some of the alternatives including: commitment to adaptive management, inventory and early detection, coordination/partnerships with neighboring land owners and managers, and restricted road building, road maintenance, and access. Concerns, specifically related to environmental justice of treatments were focused on water quality; namely that invasive plant treatments should not degrade or compromise water quality for salmon and steelhead fisheries, which are an important part of Native American tradition and a major source of food and income for many Native Americans in the Pacific Northwest and elsewhere.

None of the alternatives, including No Action, would change, restrict or abrogate treaty rights. However, implementation of the standards may affect natural resources on which the tribes depend. Consultation with tribal governments would occur during site-specific project planning in all alternatives, so that adverse effects to traditional uses and treaty and other rights are avoided or appropriately mitigated.

Invasive plant treatments may also have the potential to affect traditional cultural properties or Indian gravesites. Compliance with the National Historic Preservation Act (NHPA) and the Native American Graves Protection and Repatriation Act is accomplished through consultation with the respective tribe or elders or religious leaders. Consultation with tribal elders and spiritual leaders takes place early in the planning process. Consistency with the American Indian Religious Freedom Act must be discussed in project environmental documents. Individual Indian interests as provided for in NHPA are a separate from the tribal consultation process. Where individual interests may be affected, such as traditional cultural properties, the agency must consider appropriate mitigation or provide for protection measures.

Consultation with tribes and consideration about the potential for disproportionate effects is required under current direction. Worker health and safety standards are also common to all alternatives.

4.8 Specifically Required Disclosures

4.8.1 Adverse Environmental Effects that Cannot be Avoided

Unavoidable potential environmental and human health risks associated with the use of herbicides include effects on non-target plant species, entry of minute amounts into surface waters, and absorption by wildlife, fish, and people. However, these risks would not result in significant environmental impact under reasonably foreseeable circumstances because extremely low amounts of herbicides would be used and safety and environmental standards would be applied under all alternatives, including No Action.

Without the use of herbicides, invasive plants could continue to expand resulting in serious unavoidable adverse effects on a broad range of resources across the Region, including neighboring private and other public lands.

4.8.2 Relationship Between Short-term Uses and Maintenance of Long-term Productivity

The continued expansion of invasive plants within the National Forests of Region Six would result in serious, long-term adverse effects on a broad range of resources, reducing the long-term productivity of the forests. Neighboring private and other public lands would also be affected. Invasive plants spread across landscapes, unimpeded by ownership boundaries. All land ownerships (private, corporate, tribal, and government) in the Pacific Northwest are affected by invasive plants. All land ownerships have the potential to spread invasive plants from their property to the property of their neighbors. A sustainable solution to the problem will require cooperation and a long-term commitment from all landowners.

The relationship between uses and long-term productivity as it relates to invasive plant management is described throughout this EIS. The DFC, goals and objectives common to all action alternatives in Chapter 2 recognize the relationship between land uses and potential loss of productivity. Chapter 3 discusses the relationship between land management and use activities and invasive plants. Chapter 4 describes the effects of invasive plant standards on land management and use activities. All action alternatives would result in reduced activity levels so that long-term productivity is maintained.

4.8.3 Irreversible or Irretrievable Impacts

Implementation of the Proposed Action would not produce irreversible or irretrievable commitment of resources. The management direction adopted through this action would apply to site-specific projects and activities, and would be conducted within the constraints of the amended forest-plans and other national and regional management direction (which incorporates applicable law, regulation, and policy). Management direction adopted through this action would guide (rather than mandate) a particular site-specific project; hence, there would be no change in the physical environment. Any subsequent site-specific federal action that may change the environment would be subject to NEPA and other relevant planning regulations.